The British Academy

CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE

Global (Dis)Order
international policy programme

Navigating governance for transnational and planetary challenges: technical innovations and political consent

Contents

The Global (Dis)Order international policy programme

Today's international system is in flux with the need to navigate competing power aspirations and nodes of order. To generate fresh insights and creative thinking for policymakers and practitioners in this contested environment the British Academy and the Carnegie Endowment for International Peace have begun a new joint international policy programme on Global (Dis) Order. The programme is centred around four main themes: illuminating dynamics of and within international order, diagnosing and rethinking a changing world economy, governing transnational and planetary challenges, and managing violence and (in)security.

The programme is focused on shedding light on the history, current nature, and potential future trajectories of global orders, while acknowledging that these understandings are diverse and often contested. It also provides an opportunity to think in broader, longer-range ways, drawing in a breadth of disciplines and expertise from policy, practice and research that is both historical and future-oriented. This requires us to marshal diverse perspectives and visions from around the world, as well as expertise that bridges the worlds of research, policy, and practice. It also requires us to take a long view, to better understand the historical antecedents and precedents for contemporary geopolitical, economic, political, societal, technological, ecological, and other trends.

To achieve this goal we will analyse potential pathways and trajectories for global (dis)order and propose strategies and approaches to collectively manage shared geopolitical, economic, transnational, planetary and security challenges and dilemmas. To this end, the British

Academy and Carnegie Endowment for International Peace have commissioned a series of policy discussion papers to prompt engagement and debate among policy audiences, by posing challenging questions and highlighting gaps and opportunities for policy.

Preface

Whether and how critical global actors cooperate to govern transnational and planetary challenges will help define this century's legacy, and perhaps even the fate of humanity itself. Effective, sustainable, and legitimate governance will require innovations in technology and decision-making architectures and instruments as well as the consent and mobilisation of numerous groups at multiple levels. Balancing these pillars of innovation and consent, and ensuring that they are mutually reinforcing rather than oppositional, is critical in supporting the emergence of sustainable governance solutions.

The British Academy and Carnegie Endowment for International Peace have commissioned this set of seven papers to stimulate and provoke discussions of policy and political dimensions of transnational and planetary challenges, in the hope of informing the work of decision-makers grappling with their governance.

Governance instruments often struggle to keep pace with emerging technology and its burgeoning applications. To transition from reactive regulation to proactive governance frameworks and norms, in concert with relevant stakeholders and sectors, will require significant investments of time, resources, and expertise—all themselves scarce resources.

At times, institutional innovation and efficiency can result from learning, whereby existing governance approaches, frameworks, and norms are translated and transferred from established domains to new and emerging areas. This is precisely what the first three papers in this series seek to demonstrate.

Hartmann responds to growing security concerns about the sabotage of critical transnational infrastructure, namely undersea pipelines and cables. He argues that we can improve international accountability and enforcement through creative interpretation and application of existing piracy definitions under the United Nations Convention on the Law of the Sea (UNCLOS). In a similar vein, Marino highlights several emerging challenges created by accelerating lunar exploration. She argues for a creative application of existing environmental instruments that can foster international collaboration and agreement on equitable and sustainable lunar governance. Continuing this theme, Tucker applies a responsible use of AI framework to the healthcare sector. He invites public bodies and industry to embed principles and standards that take a greater consideration of the wider vulnerabilities and value of existing systems and supply chains in order to implement appropriate organisational and systemic transformations.

The other four papers tackle the thorny question of political consent. They suggest that technical advancements and innovations, if they are to have any chance of sustainable adoption, need to faithfully respond to complex political and economic realities. Genovese analyses from a comparative and historical perspective the growing backlash to the Paris Agreement, driven by political economic grievances associated with climate action policies and strategies. She argues that the state's role will need to expand in specific economic domains to maintain public support for transition policies. Newell contends that large-scale transitions have historically failed to be either orderly or just. To be sustainable and just, an accelerated energy transition across multiple domains will require innovations in deliberative

public engagement. In his own contribution, Kenny discusses the demographic and migration challenges facing advanced economies over the coming half-century. He argues that there are viable policy pathways to rebuild consent around migration through efficient skills matching and ecosystems. Finally, Lavery discusses internal political tensions within EU industrial policy formation, in particular those exposed by its approach to semiconductors. He argues that the EU's strategic positioning within the global economy is creating market distortions and deepening existing economic divides between its export core and southern and eastern peripheries, undermining the sustainability of this policy shift.

Responsive governance can often feel like a Sisyphean task. Policymakers may feel resigned to expend energy and resources pushing the boulder of cross-sectoral cooperation up the mountain, only to watch the forces of emergent technology push it back down. But innovative adaptations of existing instruments and sensitive understanding and incorporation of democratic political engagement can smooth out this co-production and co-legitimation process. We hope that this collection of papers can be a resource to policymakers and citizens alike in this endeavour.

When sabotage becomes piracy: rethinking the legal protection of undersea infrastructure

Jacques Hartmann, University of Dundee

Abstract

This article explores whether deliberate attacks on undersea cables and pipelines could be classified as piracy under international law. Amid rising threats to undersea infrastructure and in light of inadequate legal frameworks, it argues for a reinterpretation of the piracy definition in the United Nations Convention on the Law of the Sea (UNCLOS). The article identifies key legal gaps, examines the definitional elements of piracy, and contends that certain attacks may fall within this framework, permitting their interdiction and subsequent prosecution of foreign-flagged vessels. It concludes that such a reinterpretation offers a timely and legally sound approach to enhancing the protection of critical global infrastructure.

Introduction

Undersea cables and pipelines form the backbone of the modern world. These global networks transmit vast volumes of data and energy between continents. It is estimated that fibre-optic cables alone carry up to 99 per cent of the world's digital communications, including financial transactions valued at approximately USD 10 trillion each day (Bueger, Franken & Liebetrau 2022). Economic and societal dependence on this infrastructure is immense. While electricity and gas pipelines may not have the same global reach, they are indispensable to regional and national economies. Recent events in the Baltic Sea and elsewhere have illustrated the vulnerability of these networks.[1]

These infrastructures underpin core state functions yet lie predominantly outside territorial jurisdiction, exposing tensions between sovereignty, interdependence, and the governance of common spaces.

Beyond their technical importance, undersea cables and pipelines offer a revealing lens through which to examine the current limits of the global order. These infrastructures underpin core state functions yet lie predominantly outside territorial jurisdiction, exposing tensions between sovereignty, interdependence, and the governance of common spaces. Their vulnerability illustrates how international law may struggle to accommodate emerging forms of disorder, coercion, and strategic competition in a multipolar environment. As such, the legal challenges surrounding undersea infrastructure speak directly to broader questions of how global orders are evolving and how existing frameworks may need to adapt to new geopolitical and technological realities. Yet even against this backdrop, the legal tools available to respond to intentional acts of sabotage, particularly beyond the 12-nautical-mile territorial sea, remain strikingly limited.

Under UNCLOS, maritime zones beyond the territorial sea include the exclusive economic zone (EEZ) and, beyond this, the high seas. The EEZ extends up to 200 nautical miles from the coast. Within this zone, states have sovereign rights (not sovereignty) for the purpose of exploring, exploiting, conserving, and managing natural resources (UNCLOS, art. 56). They also have limited enforcement powers, for instance in relation to fisheries and marine pollution. However, UNCLOS preserves the freedoms of navigation for all states (UNCLOS, art. 58), and the interdiction of foreign vessels remains tightly circumscribed. On the high seas, even fewer enforcement options are available. Interdiction of foreign-flagged ships is only permitted in cases of piracy, slave trade, unauthorised broadcasting, and ships without nationality

1 For an overview of recent incidents in Europe, see A. Lott, Unconventional Legal Approaches to Protecting Underwater Infrastructure (HCSS, 31 March 2025). For incidents beyond Europe, see e.g. Dan Milmo, 'Risk of undersea cable attacks backed by Russia and China likely to rise, report warns' (The Guardian, 17 July 2025). <https://www.theguardian.com/technology/2025/jul/17/risk-undersea-cable-attacks-backed-russia-china-likely-rise-report-warns> (accessed 11 December 2025).

(UNCLOS, arts. 99, 105, 109, 110).[2] Thus, even when a vessel is suspected of engaging in sabotage, the protections afforded to freedom of navigation significantly constrain the ability of states to interfere.

Although largely privately owned, undersea cables and pipelines underpin critical state functions, including those related to the economy, national security, and governance. This reliance underscores the increasingly blurred boundary between public and private interests, raising difficult legal questions about how responsibility is assigned, particularly where sabotage may be carried out by proxies or under the guise of 'plausible deniability'.

This article examines whether attacks on undersea cables and pipelines may, under certain conditions, fall within the definition of piracy. If accepted, this interpretation would permit all states to interdict foreign-flagged vessels involved in, or preparing for, acts of intentional damage to undersea infrastructure in the EEZ or on the high seas.

While this article focuses on legal classification, the layout and ownership of undersea cables and pipelines are shaped by colonial and postcolonial power dynamics. Many cable routes trace colonial-era telegraph lines. These enduring topographies influence today's global communications architecture, with key chokepoints often near former imperial hubs. This legacy fuels contemporary tensions over access and control, showing that protecting undersea infrastructure is not just a technical issue but one rooted in geopolitics and structural inequality (Starosielski 2015).

This article next outlines the definitions of undersea cables and pipelines, before turning to gaps in the current legal framework. It then examines the definition of piracy under UNCLOS and assesses whether attacks against undersea infrastructure satisfy the definition's elements. The final section considers the legal and operational implications of classifying such acts as piracy and the opportunities this interpretation may offer for strengthening the protection of critical infrastructure.

Definition of undersea cables and pipelines

International law governing undersea infrastructure is primarily found in UNCLOS, which is strongly influenced by the 1884 Convention for the Protection of Submarine Telegraph Cables. Despite their long-standing regulatory roles, neither treaty defines the terms 'cable' or 'pipeline'. Some commentators argue that the 1884 Convention's scope is limited to telegraph cables, (Halog, Margat & Stadermann 2023), but this view is not widely accepted.

The International Law Association (ILA), a network of scholars and practitioners, considers telegraph cables to be the direct precursors of modern fibre-optic and power cables and thus interprets UNCLOS in light of this understanding (ILA, First Interim Report 2020, paras 11–14). This article adopts the ILA's approach. Accordingly, the term 'cables' refers to both fibre-optic and power cables, while 'pipelines' includes all maritime pipelines used to transport oil or gas. For ease of reference, the term 'undersea infrastructure' is used to refer collectively to both.

2 A 'maritime casualty' is defined as 'a collision of vessels, stranding or other incident of navigation, or other occurrence on board a vessel or external to it resulting in material damage or imminent threat of material damage to a vessel or cargo' (Guilfoyle 2009).

Gaps in the current legal framework

Most academic commentary highlights significant gaps in the existing legal framework. The ILA has noted that nothing in UNCLOS 'expressly permits warships of States other than the flag State to interdict vessels suspected of breaking or injury of submarine cables or pipelines in the high seas' (ILA 2024: para 47). Beckman notes that 'there are serious security gaps in the current legal regime and that neither the 1884 Cable Convention nor UNCLOS adequately address the issue of intentional damage caused to submarine cables' (Beckman 2014: 289). This is a conclusion echoed by many (e.g. Liao 2019, 458; Matley 2019; Burnett 2021: 1675; Bueger & Liebetrau 2021: 398; Davenport 2024; Halog, Margat & Stadermann 2023; Shepherd 2020: 208).

A variety of proposals have been put forward to close these gaps. Some rely on the interpretation and extension of existing treaties or principles of customary international law. For example, one proposal suggests drawing on the environmental provisions in UNCLOS (Sari 2025). Articles 220 and 221 confer limited pollution-related enforcement powers on coastal states in the EEZ. These provisions do not apply to sabotage of submarine cables, which does not amount to 'pollution from vessels' under Article 220 and rarely involves a 'maritime casualty'.[3] They apply to pipelines only where damage results in pollution or a credible threat of pollution, such as the release of oil or gas, which may reasonably be expected to cause major harmful consequences to the coastal state (ILA 2024: para. 69). Article 221 therefore offers a narrow basis for action, as it is triggered only by pollution or a threat of pollution arising from a maritime casualty, significantly limiting its relevance for sabotage involving undersea infrastructure, especially cables.

Another proposal to extend existing treaties is for counterterrorism treaties to provide a basis for prosecuting intentional damage to undersea infrastructure (Beckman 2014; Davenport 2015). While the 1997 Terrorist Bombing Convention and the 1988 SUA Convention oblige parties to criminalise terrorism in their domestic law, they do not authorise interdiction of foreign-flagged vessels.

Another approach is to advocate for the development of new legal instruments. For example, there have been calls for a dedicated treaty for the protection of underwater infrastructure beyond territorial waters (Coventry 2024). Although treaties can be concluded relatively quickly – the Terrorist Bombing Convention, for instance, was drafted within a year – a new instrument on undersea infrastructure is unlikely to attract the participation of the most relevant states.[4] Moreover, if such a treaty follows the model of existing counterterrorism conventions, then it would not permit the boarding of foreign-flagged vessels without the consent of the flag state.

Still other proposals focus on the adoption of resolutions by the United Nations Security Council or other international organisations, but these face similar challenges. For example, while the Security Council could, in theory, adopt a resolution expanding the enforcement

3 A "maritime casualty" is defined as 'a collision of vessels, stranding or other incident of navigation, or other occurrence on board a vessel or external to it resulting in material damage or imminent threat of material damage to a vessel or cargo' (UNCLOS, art. 221(2)).

4 The 'most relevant' states include those with significant dependence on submarine cables or pipelines and/or substantial naval or maritime enforcement capacity. These include, among others, the United States, China, Russia, Singapore, Japan, Australia, the UK, France and Norway. Without their participation, a treaty regulating activities affecting undersea infrastructure beyond territorial waters would have limited practical effect.

powers of coastal states, such a measure would likely face a veto.[5] Likewise, initiatives at the International Maritime Organization may face political resistance and are unlikely to achieve consensus among member states. Suggestions to push for coordinated diplomatic action within the EU and NATO may enhance policy coherence but cannot, in themselves, change international law.

One approach that is actively being used in some places is to establish safety or protection zones around undersea infrastructure in the EEZ, within which certain activities – such as anchoring – are either restricted or prohibited. Although the legality of such zones has been questioned, countries such as Denmark, New Zealand, and Australia have unilaterally established protection zones within their respective EEZs. Yet, as Lott notes, the prevailing view is that Article 60(4) UNCLOS does not permit safety zones around most cross-border submarine cables and pipelines, and even where coastal States adopt a more expansive interpretation in practice, such zones remain confined to the EEZ and do not authorise the interdiction of foreign-flagged vessels suspected of sabotage (Lott 2024).

One final proposal – examined in detail in the remainder of this article – is to reinterpret the definition of piracy under UNCLOS to encompass intentional attacks against undersea infrastructure.

Reframing attacks on undersea infrastructure as piracy

A more immediate and pragmatic approach would be to classify attacks on undersea infrastructure as piracy.

Many of the proposals outlined above face significant challenges. A more immediate and pragmatic approach would be to classify attacks on undersea infrastructure as piracy. Piracy is defined in Article 101 of UNCLOS as:

> (a) Any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or aircraft, and directed:
> (i) on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft;
> (ii) against a ship, aircraft, persons or property in a place outside the jurisdiction of any State.

As noted in section 1, UNCLOS grants states only limited rights to board foreign-flagged vessels. Piracy is one of the few exceptions that triggers universal enforcement jurisdiction. The courts of the state that carries out a seizure of a suspected pirate ship may impose penalties and decide on the fate of the ship and its property (UNCLOS, art. 105). Even so, successful prosecutions for piracy remain relatively rare, often due to evidentiary difficulties, political sensitivities, or lack of domestic legal frameworks (Kontorovich and Art 2010).

The definition of piracy is complex and has generated extensive legal debate.[6] Most scholars agree that piracy consists of four or five key elements:

5 On 27 March 2023, the UN Security Council voted on a draft resolution concerning the Nord Stream pipeline incident. The resolution, tabled by Russia and co-sponsored by several other states, condemned the 'act of sabotage' against Nord Stream 1 and 2 and called on the Secretary-General to establish an international commission to investigate. The draft, however, failed to pass as it did not receive the necessary support – garnering only three votes in favour (from Brazil, China, and Russia) and twelve abstentions. (UN Security Council, 9295th meeting, SC/15243, 27 March 2023).

6 For a detailed analysis of the debate, see ILC 2024, A/CN.4/767

i. Any illegal acts of violence or detention, or any act of depredation;
ii. Committed for private ends;
iii. By the crew or the passengers of a private ship or a private aircraft;
iv. Directed against another ship or aircraft, or against persons or property on board such ship or aircraft;
v. On the high seas or in a place outside the jurisdiction of any State.

Each element of the definition requires careful consideration, particularly as applied to undersea infrastructure. Most have, moreover, been the subject of considerable academic debate (see ILC 2024).

Before analysing the elements, it is important to note that the current definition of piracy has deep historical roots. The codification process began in 1924, when the League of Nations identified piracy as an issue suitable for international regulation. This prompted the Harvard Law School's 1932 Draft Convention on Piracy, which became a foundational source for subsequent treaty provisions.[7]

In 1954, the International Law Commission (ILC) drew heavily on the Harvard Draft when preparing the Draft Articles on the High Seas, which formed the basis for the 1958 Convention on the High Seas. These, in turn, informed the piracy provisions in UNCLOS, with Article 101(a)(ii) added by the ILC. Yet even as the drafting unfolded, piracy was not regarded as a matter of practical urgency. States had already questioned its contemporary relevance during the League of Nations codification effort in the 1920s, and a similar sentiment persisted through the ILC discussions in the 1950s. By the time negotiations for the Third United Nations Conference on the Law of the Sea began in the 1970s, piracy was widely considered a relic of the past.[8]

During the ILC's work on the law of the sea in the mid-1950s, the Commission focused on questions of jurisdiction, the distinction between piracy and other maritime crimes (e.g. mutiny), the definition of 'private ends', the issue of public versus private vessels, and the legal scope for universal jurisdiction, rather than attacks against infrastructure (Rubin 1988: 305–347). Consequently, the drafting history offers little guidance in relation to undersea infrastructure.

In any case, the drafting history is only a supplementary means of treaty interpretation. The primary source is the ordinary meaning of the treaty's text, interpreted in light of its context and purpose (Vienna Convention on the Law of Treaties 1969, art. 31). The next sections considers the five elements of piracy and their potential interpretations in relation to attacks on undersea infrastructure.

i. Illegal acts of violence or detention, or any act of depredation

The first element is notably broad. Most commentators agree that it encompasses acts against persons or property, such as undersea infrastructure. It may consist of a single incident and does not require theft, intent to steal, or even actual damage (ILC 2024: para 77). One of the most prominent issues in the literature concerns the significance of the word 'illegal' qualifying 'acts of violence or detention'. Various interpretations have been proposed – some based on domestic law, others on international law – but none would exclude attacks on undersea

7 On early doctrinal developments, see also Stiel 1905; Perels 1903; and von Martens 1795, which helped shape twentieth-century understandings of piracy and privateering.
8 For the drafting history, see A. P. Rubin, The Law of Piracy (2nd ed., 1998), 305–347.

infrastructure. Petrig and Geiß note that the qualification is 'self-evident' and that it refers 'to the illegality of the acts under the law of the State which decides to exercise its adjudicative jurisdiction over acts of piracy and to prosecute alleged offenders under its domestic laws' (Petrig & Geiß 2011:60). The same interpretation has been put forward for similar requirements in various counterterrorism treaties. Ultimately, the meaning could be clarified through subsequent state practice (Vienna Convention on the Law of Treaties, art. 31(3)(b)).

ii. The private ends requirement

The 'private ends' requirement arguably presents the greatest hindrance for classifying attacks on undersea infrastructure as piracy.

The 'private ends' requirement has likewise been the subject of considerable debate. Two main interpretations have emerged: one holds that any acts not authorised by a state are 'for private ends', while the other defines the element as the opposite of 'political ends' (ILC 2024: para 87). The 'private ends' requirement arguably presents the greatest hindrance for classifying attacks on undersea infrastructure as piracy. In general, actions by private individuals are not attributable to a state under international law. However, attribution may arise if individuals or groups act under the instruction, direction, or control of a state, or if their conduct is subsequently acknowledged and adopted by the state as its own (ILC 2001: arts. 8 and 11). Therefore, attacks on undersea infrastructure carried out by non-state actors without a clear connection to a state may be considered an act of piracy, whereas acts attributable to a state are excluded from the definition. This limitation arguably helps preserve a legal distinction between criminal conduct and acts of state, yet it also creates an operational consequence: where a state conducts or supports an operation under a cloak of plausible deniability, attribution may be impossible to establish. In such circumstances, the absence of confirmed state responsibility enables affected states to classify the conduct as piracy and to rely on the associated enforcement jurisdiction. The implications of this dynamic will be examined further below.

iii. Acts by the crew or passengers of a private ship or aircraft

The term 'ship' is interpreted broadly, and the literature also addresses the status of autonomous and remotely operated craft. For example, the Institute of International Law has concluded that 'crew' can encompass those who operate uncrewed vehicles, suggesting that acts involving remote or autonomous vehicles may also fall within the definition of piracy.[9] Importantly, none of these interpretations would exclude attacks on undersea infrastructure by the crew or passengers of a private vessel from qualifying as piracy. On the contrary, this broad interpretation ensures that evolving maritime technologies may be included.

iv. The 'two-vessel' requirement

The fourth requirement has also generated considerable controversy and is often referred to as the 'two-vessel' or 'dual condition' requirement (ILC 2024: para 107). According to this interpretation, acts committed aboard a single ship by its crew or passengers do not fall within the definition of piracy. This was confirmed in the Arctic Sunrise arbitration, where it was stated that an 'essential requirement of Article 101 is that the act of piracy be directed against another ship'.[10] However, this traditional interpretation appears to conflate the requirements of subparagraph (i) and (ii) and fails to account for the significance of the disjunctive 'or' in the

9 Institute of International Law, Report of the Eleventh Commission, Piracy, present problems, p. 199.
10 Annex VII Arbitral Tribunal, Arctic Sunrise Arbitration, PCA Case No. 2014-02 (The Netherlands v. Russian Federation), Award on the Merits of 14 August 2015, para 238.

text. Article 101(a)(i) of UNCLOS does expressly require that the act be committed 'against another ship or aircraft', supporting the two-vessel interpretation. By contrast, Article 101(a)(ii) omits this requirement, instead referring to acts 'against a ship, aircraft, persons or property in a place 'outside the jurisdiction of any State'.

On its ordinary meaning, piracy under Article 101(a)(ii) could therefore be read to encompass:

> Any illegal acts of violence … or any act of depredation, committed for private ends by the crew … of a private ship … and directed against … property in a place outside the jurisdiction of any State.

The Institute of International Law has observed that, while the terms 'violence' and 'detention' refer to illegal acts against persons, 'depredation' appears to denote acts against property (Institute of International Law, Report (2021), p 189). This interpretation opens the door to the possibility that attacks on undersea infrastructure could fall within the definition of piracy, provided they are committed in a place outside the jurisdiction of any state, discussed immediately below.

v. Geographic scope: high seas or areas beyond national jurisdiction

The final element of the definition concerns the geographical scope of piracy. Two specific zones are mentioned: acts occurring 'on the high seas' under subparagraph (i), and acts committed 'in a place outside the jurisdiction of any State' under subparagraph (ii).

Article 101(a)(ii) was introduced by the ILC to cover acts against persons or property 'on an island constituting 'terra nullius' or on the shores of an unoccupied territory' (ILC 1956: 282) This was primarily a policy-driven addition, rather than one based on established case law or legal principles (Rubin 1988: 322).

At first glance, subparagraph (ii) might appear to exclude acts committed in the EEZ. However, Article 58(2) of UNCLOS clarifies that Articles 88 to 115 – including Article 101 on piracy – apply to the EEZ 'in so far as they are not incompatible' with the EEZ regime. Most commentators agree that there is no incompatibility, in which case the piracy provisions would apply in the EEZ (ILC 2024: para 116). Accordingly, the geographic limitation is generally understood to only exclude acts committed within a state's territorial sea. Such acts, even if they meet the other elements of piracy under Article 101, fall outside the scope of the definition and are instead governed by the coastal state's domestic law; in practice, they are classified as armed robbery to distinguish them from piracy.[11]

vi. Can attacks on undersea infrastructure be piracy?

As the preceding analysis demonstrates, attacks on undersea infrastructure can, in principle, meet the definitional elements of piracy under Article 101(a)(ii) of UNCLOS – provided they are committed by non-state actors, for private ends, and occur beyond the territorial sea. This interpretation is grounded in the ordinary meaning of the treaty text and supported, albeit indirectly, by its drafting history.

11 Within the territorial sea, the coastal state can rely on several grounds to undertake enforcement measures against ships suspected of intentional damage to submarine cables and pipelines. Within the UK's territorial sea, acts of sabotage against undersea infrastructure would not be treated as piracy but would rather fall under the Criminal Damage Act 1971. (see Hirst 2003, 305).

While the exclusion of acts of states narrows the scope of piracy, it arguably also preserves international stability by reducing the risk of diplomatic escalation or retaliatory enforcement between states.

The main legal constraint to this interpretation is the 'private ends' requirement, which excludes acts attributable to states. In some cases, a ship's crew may receive remuneration for carrying out sabotage, but this does not, in itself, resolve the issue. What matters is not the presence of payment, but the degree of control exercised by a state.[12] Even where individuals are paid, the act will not satisfy the 'private ends' requirement if their conduct is not attributable to a state under international law. Conversely, where such control cannot be established, remuneration does not preclude classification as piracy. While the exclusion of acts of states narrows the scope of piracy, it arguably also preserves international stability by reducing the risk of diplomatic escalation or retaliatory enforcement between states. By limiting piracy to private actors, UNCLOS reinforces the legal distinction between individual criminal acts and interstate conflict.

The so-called 'two-vessel' requirement does not preclude that attacks on undersea infrastructure may constitute piracy. Article 101(a)(ii) refers to acts directed against 'property in a place outside the jurisdiction of any state', omitting the need for a second vessel. This broader language supports the inclusion of fixed infrastructure, such as undersea cables and pipelines, within the definition.

Although this interpretation is not novel, it remains underexplored in the literature and, apart from one pre-UNCLOS example, has not been reflected in state practice.[13] Nevertheless, several commentators have acknowledged its potential. Burnett and Green note that 'submarine cable depredation appears easily situated within Article 101' (2008, 577), while Guilfoyle, Paige, and McLaughlin argue that 'depredations against submarine cables in the high seas by non-State actors may constitute piracy' (2022: 673). The ILA has likewise concluded that this interpretation is legally plausible, although it notes that 'it is uncertain whether States will accept that they have this right vis-à-vis intentional damage to submarine cables and pipelines under [UNCLOS] Articles 101 and 105' (ILA 2024: para. 50).

In sum, while the reinterpretation of Article 101(a)(ii) to include attacks on undersea infrastructure remains largely untested in practice, it is legally supportable and consistent with the general rule of treaty interpretation. It offers a pragmatic legal pathway for extending enforcement jurisdiction in response to evolving threats against critical subsea assets.

Advantages of classifying attacks as piracy under UNCLOS

Undersea infrastructure is crucial to modern society yet remains highly vulnerable. Existing treaties such as the 1884 Cable Convention and UNCLOS provide a fragmented and, in many respects, outdated framework ill-suited to address the challenges posed by deliberate attacks on undersea infrastructure. As illustrated above, various proposals have been made to fill this legal gap, but many of these options face serious practical or political limitations.

12 See Military and Paramilitary Activities in and against Nicaragua (Nicaragua v. United States of America), Merits, ICJ Reports 1986, pp. 53 ff., paras 93 ff.; Case Concerning Application of the Convention on the Prevention and Punishment of the Crime of Genocide (Bosnia and Herzegovina v. Serbia and Montenegro), ICJ Reports 2007, pp. 206 ff., paras 396 ff.

13 Already in 1869, the US proposed that attacks against undersea cables be viewed as an act of piracy (ILA 2024, para 78). See also International Law Institute, Piracy, Present Problems, 11th Commission, Rapporteurs: Tullio Scovazzi & Tullio Treves, at 164.

Given the limitations of existing tools and potential resistance to developing new ones, reinterpreting piracy provisions offers a promising and underexplored legal solution. Unlike other proposals, it would have the advantage of immediately activating the enforcement provisions of UNCLOS, particularly the right of all states to seize pirate ships and prosecute suspected perpetrators. However, while such a right exists in international law, its effective implementation would still require a clear mandate in domestic law.

It is true that recasting attacks on undersea infrastructure as piracy would still exclude state-sponsored acts of sabotage, which fall outside the definition due to the 'private ends' requirement. Yet this is not necessarily a disadvantage, as clear state involvement would instead engage the rules on state responsibility. Much of the current activity targeting undersea infrastructure moreover appears under a 'cloak of plausible deniability' – arguably, this very ambiguity allows states to treat such attacks as piracy and thereby activates a criminal rather than a state responsibility response.

Despite the legal plausibility of this interpretation, it is not yet supported by state practice or judicial confirmation. If states are reluctant to classify such acts as piracy, they may likewise be hesitant to take enforcement action or recognise the jurisdiction of other states to do so.

Thus, for this reinterpretation to operate in practice, states would need to take several steps. First, domestic criminal law must be aligned with the full scope of Article 101(a)(ii), ensuring that national piracy offences encompass acts directed against property and fixed infrastructure, and that courts are empowered to exercise universal jurisdiction over such offences. Second, states that support this approach could issue coordinated interpretative statements clarifying that deliberate attacks on undersea cables or pipelines by non-state actors fall within the definition of piracy. Third, operational arrangements would need strengthening: states could develop common protocols for interdiction, evidence collection, and chain-of-custody in suspected sabotage cases, supported by enhanced, real-time information-sharing mechanisms.

Regional organisations such as ASEAN, the African Union, or the Pacific Islands Forum could provide platforms for dialogue and endorsement.

Finally, broadening support beyond Western states would be essential. Many states in the Global South rely heavily on subsea connectivity and may favour a more robust enforcement regime if it enhances security without diminishing navigational freedoms. Regional organisations such as ASEAN, the African Union, or the Pacific Islands Forum could provide platforms for dialogue and endorsement. Over time, such alignments could build a coherent pattern of state practice capable of shaping the interpretation of UNCLOS.

While the reinterpretation of piracy offers a legally grounded stopgap, its uptake will depend on political will. Some states, such as the US, EU member states, Japan, and Australia, may be more inclined to support expanded enforcement mechanisms. However, building consensus around such a reinterpretation is likely to face resistance from states concerned about freedom of navigation and from coalitions that view universal enforcement as a potential encroachment on sovereign prerogatives.

The need to respond to piracy is far more than theoretical. Incidents such as the Nord Stream pipeline explosions in 2022, the damage to Baltic telecommunication and energy cables in 2023 and 2024, and increasing pressure on cable networks in the South China Sea illustrate the geopolitical salience of these legal gaps. Addressing these issues requires further scholarly engagement, targeted policy debate, and, crucially, concerted action by states with a strategic interest in safeguarding global communications and energy infrastructure.

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From disorder to harm? Governing the Moon and protecting its sites of interest

Alessandra Marino, The Open University

Abstract

This paper synthesises literature from geography, law, planetary science and astrobiology on the protection of sites of interest on the Moon and discusses possibilities for more effective environmental governance in space. First, it takes stock of the drivers of current disorder in lunar exploration activities. It looks at the fragmentation of the international legal order, identifies shortcomings of current regulatory frameworks, and demonstrates that the siloing of disciplinary knowledge about the Moon is an obstacle to robust governance proposals. The paper's four objectives are: (i) to review literature on the safeguard of sites of interest on the Moon, discussing different stakeholders' interests; (ii) to systematise knowledge on existing and envisaged mechanisms for environmental governance of lunar sites of scientific interest; (iii) to summarise the possible use of analogues from governance on Earth; (iv) finally, to suggest directions and principles for sustainable and equitable lunar governance.

Introduction

The global governance of the Moon is a subject of growing debate due to increased lunar exploration. Sample return missions of major space agencies, such as China's Chang'e-6 and India's Chandrayaan-4, are collecting and studying lunar regolith (the layer of dust and broken rocks on the Moon's surface) and sediments. These will help gain insight into exploiting resources available in situ, with much interest focused on extracting water from ice deposits to build habitats and to use the hydrogen as propellent (Lockheed Martin 2024). Moreover, some companies are interested in exploiting lunar resources and minerals to expand the frontier of available resources for use on Earth. Most nations are supportive of commercial space activities; the Artemis Accords, now signed by over 60 countries including the United Kingdom, encourage commercial regolith extraction and utilisation, making commercialisation of resources compatible with the absence of sovereignty claims in space. China, not a signatory to the Artemis Accords, instead has emphasised the importance of non-appropriation, prioritising scientific investigations and sustainable exploration.

Future activities such as strip mining and extracting water from a finite number of craters in permanent shadow have the potential to permanently change the lunar environment. This paper examines why existing governance mechanisms are insufficient to protect sites of interest for their scientific, historical and cultural significance or the sustainability of future missions, highlighting the international legal order's fragmentation and the shortcomings of current regulatory frameworks. Multiple challenges in lunar governance exist, including fears of militarization of the domain, balance between state and commercial activities and others, and the issue of sites of interest matters because these sites will see interest of several actors collide and could be the setting of potential conflict (for resources or the protection of property rights). Their governance is thus crucial for the future of the Moon. This paper then explores potential analogues on Earth that could inform space governance and suggests directions and principles for sustainable and equitable lunar governance.

Part I: Understanding lunar disorder and environmental governance

In this new space age, the space economy has fragmented away from the hegemony of larger space agencies, while capabilities to conduct exploration and exploitation activities have expanded. These changes have not been met with coordinated international regulatory responses to protect sites that are fragile or unique. The 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (also called the Outer Space Treaty (OST)) remains the primary regulating tool of space activities, with 115 state parties. The treaty comprises high-level statements of principles, not operational details. It rejects claims of state sovereignty in space and upholds the principles of collaboration and reciprocity. Crucially, Article IX states that exploration on the Moon and other celestial bodies shall be conducted 'so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose'. However, the Treaty does not define either 'harmful contamination' or the related 'harmful interference' that follows in the same article.

As Cheney et al. (2020) note, in international environmental law, harm is broadly understood as direct or indirect harm to 'life'. Hence, 'harmful contamination' can be interpreted to be about biological contamination of celestial bodies and to apply particularly where and when there is the potential for life or related indicators. On the Moon, only a few sites have the potential to be of interest to studies of life in the universe (astrobiology); the OST provisions are therefore weak at protecting sites of interest for other reasons. Marino and Cheney (2023) highlight that environmental protection remains peripheral to space law, and the failure of The Moon Agreement (1979)—which has only 17 state parties and does not include any of the older space actors (Tronchetti 2024)—deprives the Moon of specific protections against environmental disruption or for identifying sites of interest.[1] In the context of intensified landing, sampling, prospecting, and mining, Killen et al. (2024) have called for the lunar environment to be handled with care. Instead, existing regulation leaves sites of interest and the lunar environment highly vulnerable to such engagements with the Moon. Krolikowski and Elvis (2024) have predicted 'irreversible damage' to multiple sites of significance unless new regulating mechanisms are established.

...existing regulation leaves sites of interest and the lunar environment highly vulnerable to such engagements with the Moon.

Sustainable lunar exploration

Since the Moon Agreement, most governance innovation has come from customary international law and voluntary instruments and guidelines – so-called 'soft law.' Debates on legal frameworks for space activities are held at the UN Committee on the Peaceful Uses of Outer Space (COPUOS), the main forum for the development of space law. A UN Working Group on Legal Aspects of Space Resource Activities has recently proposed draft guidelines for resource use, and an Action Team on Lunar Activities Consultation (ATLAC) has a mandate

1 The Moon Agreement (1979) clearly states the importance of not introducing adverse changes to the lunar environment. Article 7(1) states: 'In exploring and using the Moon, States Parties shall take measures to prevent the disruption of the existing balance of its environment, whether by introducing adverse changes in that environment, by its harmful contamination through the introduction of extra-environmental matter or otherwise'. This language of environmental protection is not restricted to protecting life and can be interpreted as enabling restrictions to surface and subsurface exploitation activities. Article 7.3 gives consideration to designating areas of special scientific interest as "international scientific preserves." with special protective arrangements. However, the Moon Agreement's limited international endorsement is an obstacle to this being acted upon.

to discuss sites of interest for different actors. These forums are of strategic importance because they may be where early conflicts arise.

The non-binding COPUOS Guidelines for the Long-term Sustainability of Outer Space Activities (COPUOS 2018: 2) define long-term sustainability as: 'The ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes, in order to meet the needs of the present generations while preserving the outer space environment for future generations.'

This definition of sustainability encompasses the principle of equitable access to the benefits of exploration and use of outer space among all communities, both currently and into the future, in a way that echoes the language of the OST. Equitable access is reiterated in the UN Working Group's Draft Set of Recommended Principles for Space Resource Activities, which contains principles on sustainability and the protection of the environment of Earth and outer space (Principle 5) (Freeland & Ahmed 2025). Here, sustainability is presented as a balance between meeting 'the needs of the present generations while preserving the outer space environment, including the Moon and other celestial bodies, for future generations'.

However, despite this aspiration for sustainable and equitable future missions, the environmental footprint of the space sector is creating sustainability pressures both on our planet and beyond. Wilson and Vasile (2023) argue we face a 'space sustainability paradox', as the space activities predicated under the banner of sustainability and in support of the Sustainable Development Goals nonetheless can be environmentally unsustainable. Atmospheric pollution deriving from space launches, increased energy consumption, and accumulation of orbital debris illustrate this argument in relation to orbital environments (Miraux 2022; Rivera-Ingraham et al. 2021; Yap and Truffer 2022). Intensified lunar exploration requires regulations, and new international policy proposals, that set standards of sustainable use and protection of lunar sites, while simultaneously addressing concerns about the footprints of space activities and their benefits on Earth.

Sites of interest on the Moon for scientific purposes

...demands to provide specific sites with protection are being raised internationally by communities with disparate interests which are siloed in different disciplines.

The Moon holds a record of the solar system's evolution (Crawford 2010; 2015; Crawford et al. 2021). In the absence of plate tectonics, its surface has preserved a well-defined record of its geological evolution, and its unique features are of interest to planetary scientists and astrobiologists. The Moon is also the first place outside Earth where humans have set foot, and traces of those early journeys are preserved. However, demands to provide specific sites with protection are being raised internationally by communities with disparate interests which are siloed in different disciplines. This section shares insights from astronomy, astrobiology, and planetary science.

Due to the special features of the lunar environment, telescopes on the Moon can cover a wide range of astronomical observations, providing opportunities for infrared, gravitational wave and cosmic-ray astronomy (Silk et al. 2024). However, Elvis, Krolikowski, and Milligan (2021) highlight that the sites that make the lunar environment particularly suitable for astronomy are:

- Peaks of eternal light: Regions near the poles which are almost continuously illuminated by the Sun, and thus valuable for solar power and to avoid the significant temperature variations between night and day.
- Permanently shadowed regions (PSRs), also known as 'cold traps': Located in permanently dark craters at the poles, these may contain volatile materials from the

early solar system and water in ice deposits. The coldest of the cold traps present opportunities to passively cool far-infrared telescopes.

- Large areas of smooth terrain on the far side: radio telescopes for cosmology will require locations smooth and large enough to accommodate arrays of antennae spanning 200 km. The far side of the Moon always faces away from Earth, so it is shielded by the Moon itself from radio-frequency interference. Such a radio-quiet location enables the sensitive detection of ultra-low-frequency radio signals.

In 2024, the International Astronomical Union's (IAU) Working Group on Astronomy on the Moon published recommendations for protecting Sites of Extreme (also referred as Extraordinary) Scientific Interest (SESIs). Identified SESIs are: 1) the lunar far-side's radio quiet zones, where an array of antennae spanning some 200 km could be located for exoplanet research); 2) cold traps (PSRs), to passively cool telescopes; 3) seismically quiet cold traps for gravitational wave detectors. The Guidelines stress the need to protect the ability to make radio astronomical observations unique to the shielded zone of the moon (SZM, defined as such by the International Telecommunication Union) and build gravitational wave detectors for multi-messenger astrophysics.

Plans for these scientific facilities on the Moon rely on the assumption that SESIs will remain free from noise and interference. However, human exploration and commercial activities would inevitably threaten those conditions. PSRs with the potential to cold-trap volatile materials in the form of ice are a likely source of water on the Moon, making them a target for in-situ resource utilisation plans such as the extraction and use of hydrogen as propellent. Studies have mapped and ranked PSRs according to their resource potential. Lemelin et al. (2021) identify 169 water-ice-bearing PSRs and determine some optimal sites for studying lunar polar volatiles. Brown et al. (2022) maintain that an analysis of PSRs' volatile ranking, grade, and estimated tonnage can help prioritise sites to prospect. They identify 65 PSRs and rank them for probability of finding water ice and site accessibility. This gives an idea of how finite usable PSRs can be, and of their need to be protected while their utility for science is further explored.

Astrobiology's interests relate to 'the survival of microorganisms, plants and humans in space and the spread of microbial contaminants in extreme planetary conditions' (Crawford 2010: 1). By removing UV radiation and high temperatures, which represent two major threats to life in space, PSRs could be protective niches where cells may remain viable in a cryptobiotic state (Moores, et. al. 2025). Planetary protection ensures that scientific investigations of possible extraterrestrial life forms, precursors, and remnants are not jeopardised. The Committee on Space Research (COSPAR), an international body comprising of representatives of national space agencies and academic experts and one of the leading examples of 'soft law' within space governance, has issued its Planetary Protection Policy (PPP). Where there may be a possibility that life exists on Mars, the PPP establishes Special Regions: 'a region within which terrestrial organisms are likely to replicate. Any region which is interpreted to have a high potential for the existence of extant Martian life forms is also defined as a Special Region' (COSPAR 2024: 33). No Special Regions are currently identified.

The COSPAR PPP defines the Moon as a whole Category II, which means that there is significant interest relative to the process of chemical evolution and the origin of life, and only a remote chance that contamination carried by a spacecraft could compromise future investigation (COSPAR 2021). However, in 2021 COSPAR upgraded its PPP requirements for polar missions to the Moon, adding Category IIb, under which PSRs and the lunar poles (latitudes south of 79°S and north of 86°N) must follow more stringent guidelines. For missions in these sites and regions, the recommendation is to provide planetary protection

documentation and a full organic inventory, i.e. for solids and volatiles (currently for masses above 1kg).

Nonetheless, the PPP is non-binding, and such voluntary documentation requirements may be insufficient to protect fragile environmental features from contamination (Crawford 2022), and more research is needed to identify lunar sites of astrobiological interest beside PSRs. This includes analysing and modelling the spread of volatiles on the Moon to understand risks of harm to sites of interest due to the proximity of missions.

Tangible and intangible heritage

...in absence of agreed international guidelines, heritage may be damaged or lost...

Concerns about sites of interest requiring protection extend to cultural heritage sites. The Artemis Accords have provisions to protect lunar sites that hold tangible heritage, such as the debris of spacecrafts and the first human footsteps.[2] NASA's recommendations for protecting the landing sites of Apollo 11 and Apollo 17 define minimum-approach distances for rovers (75m and 225m respectively) (NASA 2011). However, in absence of agreed international guidelines, heritage may be damaged or lost: a mission flying or landing too close to the footprints could wipe them out forever.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) recognizes sites of 'outstanding universal value' through the World Heritage Convention. Although the Convention cannot be applied to outer space as it relies upon states to nominate heritage sites (Rotola 2020), it has been picked up as a model for what could be done. Early in 2025, the World Monuments Fund (WMF), an organisation dedicated to safeguarding the world's heritage, listed the Moon as a threatened historic site, bringing the issue of protecting heritage sites on the Moon to the forefront. Marino and Avjeski (2025) argue that prioritising the protection of sites of early Moon exploration may have two drawbacks: 1) it can overemphasise the importance of older space powers and histories of the space race that have excluded and marginalised communities and non-spacefaring states; 2) it does not address questions about what is worth preserving or how, nor about the proliferation of debris from human activities. For example, will every nation be allowed to protect the site of their first scientific mission on the Moon? And what will that mean for future activities? Such questions need answers that consider the principle of equal distribution of the benefits of exploration as written into the OST.

The question 'whose heritage is this?' is particularly important at a time when new space powers are making major inroads in exploration. In the 1960s, critics denounced the US government's prioritisation of the Apollo Programme at a time of civil rights protests as a political choice steeped in racial inequality (McKinson 2020). A parallel movement is rising today as the commercial agenda of New Space enterprises and its discourse around space settlements have drawn criticisms for recalling space colonisation. Space actors' territorial ambitions beyond Earth may not only be incompatible with the OST but also as a revival of older colonial imaginaries (Smiles 2020; Trevino 2020). In this context, cultural concerns of earthly communities, such as Indigenous communities, have so far been marginalised. For example, the Navajo Nation, whose people hold the Moon sacred, has long objected to the scattering of human ashes on its surface, yet commercial ventures have recently proposed more activities such as this.[3]

2 The website of the Artemis Accords contains documentation and updates on signatories: https://www.nasa.gov/artemis-accords/ (accessed 13 May 2025). A list of heritage sites on the Moon is available at: https://lunarresourcesregistry.com/list-of-heritage-sites-on-the-moon/ (accessed 9 May 2025).

3 For more on Navajo culture and the Moon, this podcast features Justin Ahasteen, then-Executive Director of the Navajo Nation Washington Office: https://airandspacelaw.olemiss.edu/2024/12/30/the-moon-indigenous-cultures-and-space-sustainability-with-justin-ahasteen-giuliana-rotola-and-les-tennen/ (accessed 30 April 2025).

While the Artemis Accords have provisions for the protection of specific sites (such as the Apollo landing sites) and guidelines for sustainability that refer to practical aspects of missions (i.e. debris removal for end-of-life), such Indigenous claims call for respect for the Moon as a whole, avoiding activities that may be culturally offensive or alter the Moon's environment for good. These demands clash with the approach of protecting the Moon by dividing and parcelling it into reserves. Indigenous astronomers such as Duane Hamacher have advocated for Indigenous beliefs and their astronomical knowledge of the Moon to be acknowledged and respected (Hamacher 2021). These can be thought to constitute intangible heritage.

As Gorman highlights in a report for the Global Expert Group on Sustainable Lunar Activities, both tangible and intangible heritage in outer space deserve protection:

> 'A lunar cultural heritage site is any place with the material remains of human activities on the Moon, or any place that is associated with intangible practices, representations, expressions, knowledge, or skills, and that has historic, social, aesthetic, spiritual or scientific significance for present and future generations.' (Gorman 2023, p.10)

In absence of a comprehensive framework for deciding upon lunar activities, reframing sustainable lunar activities as protection of both natural and cultural heritage sites would be a welcome step.

This definition supports the coexistence of values and claims to the Moon that make it a shared cultural heritage. The Burra Charter (The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance 2013) is an example of an effective method for assessing the significance of cultural heritage sites in space that hold shared cultural value (Gorman 2016). Article 13 explicitly refers to the existence of conflicting cultural values that need to be given due consideration, through the preparation of written statements and the assessment of needs associated with a place. Groups and individuals with associations with a place as well as those involved in its management should be provided with opportunities to contribute to and participate in understanding the cultural significance of the place. In absence of a comprehensive framework for deciding upon lunar activities, reframing sustainable lunar activities as protection of both natural and cultural heritage sites would be a welcome step. This could be aided by the creation of a Lunar Heritage Register, as advocated by the Moon Village Association's Global Expert Group on Sustainable Lunar Activities (GEGSLA) in their 2022 report. However, it is essential that such a register deals with interests and claims that go beyond scientific rationales and dominant space powers. Consultative approaches, citizen science projects, and other social research methods are needed to gather perspectives that have so far been marginalised both in science and regulation.

Part II: Envisioning sustainable governance

This paper has so far argued for the need to chart a new regulatory route in which sustainable lunar activities are encouraged to avoid unsustainable uses of the Moon. For Morin and Tepper (2023: 3), 'rules can direct actors' behaviour, modify the distribution of resources, impact interest calculations, create new identities, shape social relations, and establish shared meanings'. The literature on environmental protection of the Moon deals with the protection of sites of scientific interest and cultural heritage through the proposed creation of enclosed spaces: the drawing of borders around identified sites and regions such as 'Space nature reserves' (Krichevsky & Bagrov 2019: 45), planetary parks (Cockell & Horneck 2006), or zones with specific designations for tourism, facilities, and so on (McKay 2022:115). These proposals have seen two main objections: their objectives are too narrow and technical; and the enclosure of sites, such as landing sites, may allow nations possessing artifacts on the Moon to

de facto territorialise portions of the lunar surface, in violation of the non-appropriation clause of the OST. Moreover, all these proposals lack operational details, such as what the surveillance of activities in and around these sites would look like, sanctions for violation of terms of use, etc. Producing recommendations to this effect is beyond the scope of this paper; however, learning lessons from environmental and legal governance analogues on Earth, such as Antarctica, can help us extracting principles for territorial use that do not rely on sovereignty claims. Analogues can also help shape principles for sustainable lunar activities.

Antarctic Treaty

Antarctica is both an environmental and a legal analogue for outer space (Collis 2017; Salazar 2017): firstly, it has enabled studies on the survivability of microorganisms at extreme temperatures; secondly, the OST was modelled upon the Antarctic Treaty, which halted territorial claims and banned mining in Antarctica.[4] While mining and other extractive activities are not prohibited on the Moon, there is growing interest in protecting areas that may be fragile or unique. In 2002, Annex V to the Antarctic Treaty's Environmental Protection Protocol (EPP) created Antarctic Specially Protected Areas (ASPAs), inaccessible without permit, which are worthy of protection for 'outstanding environmental, scientific, historic, aesthetic or wilderness values, any combination of those values, or ongoing or planned scientific research' (EPP Annex V, Article 3(1)). ASPAs resonate with proposals for lunar and space preservation, but they have not been used to devise practical protection for sites on the Moon.

The precautionary principle (principle 15 of the 1992 Rio de Janeiro Declaration), which says that lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures where there are threats of serious or irreversible damage to the environment, is understood to form part of the spirit of the Antarctic Treaty. It can be seen as the underlying argument for measures such as environmental impact assessments (EIAs) and the establishment of the Committee for Environmental Protection (CEP). Wheeler et al. (2023) suggest that the precautionary principle should also inform how environmental aspects are considered for space activities. In the context of lunar sites of interest, principles of customary law such as 'do no harm' and the precautionary principle can and should be used to protect the environment by, respectively, emphasising avoiding actions that cause environmental damage and taking preventative measures when there is a potential for harm, even when there is scientific uncertainty.

Planetary parks

Given the presence of areas of interest for science such as PSRs both near the north and south poles of the Moon, Crawford et al. (2022) suggested that one of the poles should be protected. While missions have landed or plan to land near the south pole, astrobiologists Cockell and Horneck (2006; 2024) call for protecting the north pole as a planetary park. Planetary parks could preserve space wilderness in ways that are similar to national parks; that is, by exerting control over the types and frequency of activities that are permissible in tightly enclosed areas. Cockell and Horneck refer explicitly to the US Wilderness Act of 1964 to situate their proposal of planetary parks as delimited areas where specific rules would apply: 'no waste to be left in the park, no landing of robotic spacecraft, and movements of people or robotic vehicles only along specified routes' (Cockell & Horneck 2006: 256).

4 The full text of the 1959 Treaty and its 1991 Environmental Protocol can be found at: https://www.ats.aq/e/antarctictreaty.html (Accessed 14/05/2025).

Using postcolonial legal and cultural scholarship, Marino (2023) cautions that drawing new borders on the Moon, such as those for a park, should not be considered a neutral activity: it can be an ordering device that attempts to tame and classify the diversity of outer space environments. Under the proposed approach to planetary parks, practices outside of park borders such as mining and junk accumulation could potentially be unrestricted. Also, proponents of planetary parks accept that if individuals or groups can transform land through productive activities, such 'land becomes their property' (Cockell & Horneck 2006: 260). This view of asserting property rights over a territory is in direct contravention to the OST and raises doubts over the sustainability of such proposed parks. Moreover, the creation of protected zones or reserves on the Moon and other planets beside Earth must not overshadow the need for robust regulations of activities in non-park territories.

UNESCO Geoheritage

Recent scholarship proposes exogeoconservation, an approach to protect geological heritage in outer space, such as the outstanding universal geoheritage value of Mars that provides insights into the planet's deep history and evolution (Fletcher et al. 2024). This work implicitly points to the potential applicability of schemes such as UNESCO Global Geoparks in outer space. UNESCO Global Geoparks are single, unified geographical areas where education, conservation, and sustainable development meet. They cannot formally apply to outer space given that Global Geoparks are located within national jurisdictions; however, their emphasis on partnerships between local and regional stakeholders and authorities (including Indigenous people and local organisations) is interesting when looking at the Moon, which is important for a wide range of stakeholders. Their emphasis on education and the use of sites for wider engagement and knowledge sharing can be seen as mechanisms for more 'equitable environmental governance' (Dawson et al. 2024), in which different and competing perspectives are considered and fed into decision-making.

Fletcher et al. (2024) suggest that honoring geological heritage in space requires borrowing tools from geoconservation on Earth and critically assessing the feasibility of EIAs. Currently, assessments for space missions focus on the terrestrial impacts of space launches (e.g. the European Space Agency uses life cycle assessments to determine the impacts of activities on Earth's environment), but the environmental impacts on extraterrestrial bodies are not adequately considered in space mission assessments (Dallas et al. 2021). Impacts assessment and management strategies for the Moon and beyond have been advocated for (Kramer 2014; Vikari 2004). EIAs can enable the application of the precautionary principle, improving evaluation of the potential impact of activities, prohibiting activities where characteristics of an area are unknown, and limiting certain kinds of activities (Larsen 2006). While an EIA can be an imperfect tool to address the feasibility of environmental projects, building on this literature may enable assessment of costs and benefits of space activities in environmental, social, and cultural terms.

The phrase 'common heritage of mankind' is also used and defined in the Moon Agreement, but in negotiations for that treaty it was opposed by actors such as the USA who believed the concept could be harmful to their own interests.

Underwater preservation

The ocean is often referenced as an analogue to outer space (Iavicoli 2015). The UN Convention on the Law of the Sea (UNCLOS, 1982) declares that 'the seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction' (Article 1 (1(1))) is the 'common heritage of mankind' (Article 136). This means that it is not subject to appropriation by any state or individual, and its resources should be exploited for the benefit of all humanity. The phrase 'common heritage of mankind' is also used and defined in the Moon Agreement, but in negotiations for that treaty it was opposed by actors such as the USA who believed the

concept could be harmful to their own interests. Without international support for the Moon Agreement, it makes sense to explore other forms of governance compatible with non-appropriation.

Articles 149 and 303 of UNCLOS establish a duty of states to protect 'objects of an archaeological and historical nature found at sea', and to cooperate for that purpose (UNCLOS 1982: Article 303(1)). This principle was expanded in the 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage, a treaty that covers 'all traces of human existence having a cultural, historical or archaeological character' that have been submerged for at least 100 years (UNESCO 2001: Article 1.1). While this 100-year rule would not be applicable to outer space given how recent the sector's technological advancements are, best-practice principles are useful prompts in thinking of space heritage. For example, the treaty emphasises in situ preservation over salvage and demands that states avoid and prevent commercial exploitation of heritage sites and incidental damage (Perez-Alvaro 2024). Finally, it states that 'responsible non-intrusive access to observe or document in situ underwater cultural heritage shall be encouraged to create public awareness, appreciation, and protection of the heritage except where such access is incompatible with its protection and management' (Article 2(10)). It is worth noting that the issue of the education of wider publics, already touched upon in relation to geoheritage, re-emerges in the context of underwater heritage, where (as in outer space) objects are often far removed from view. The invisibility of these sites can translate into disaffection and lack of care for them, while education can 'contribute to awareness, appreciation and protection of that heritage' (UNESCO 2001, Preamble). For an equitable future of humankind in space, such opening to a wide variety of publics is fundamental.

Conclusion

This paper has reviewed literature from geography, planetary science, astronomy, astrobiology, and law to consider proposals for the environmental protection of the Moon, to protect the Moon as shared heritage (in environmental and cultural senses), and to safeguard it from potential harm. It has argued for the necessity of integrating different values and knowledge systems (beyond siloed scientific communities) when identifying sites of interest on the Moon. Moreover, it has cautioned that, although proposals that rely on zoning the environment of the Moon may help protect tangible heritage, they will not protect from other forms of contamination, such as the spread of volatiles from exhausts.

Therefore, multiple mechanisms for protecting lunar sites will likely be necessary, together with the establishment of robust processes for the environmental protection of the Moon as a whole and assessments of potentially harmful activities. The application of the precautionary principles to lunar activities may be used to halt or limit harmful activities or where existing knowledge is insufficient to exclude the possibility of major or irreparable harm.

Future work and suggestions for sustainable lunar governance

Building on this paper's analysis, governance of sustainable lunar activities and the protection of heritage will require:

1. An interdisciplinary definition of the kinds of objects and sites, including innovative scientific instruments, that are eligible for protection. This definition needs to account for

the plurality of lunar natural and cultural histories that make the Moon shared heritage as per Article 13 (co-existence of cultural values) of the Burra Charter (2013).

2. Intersectoral and community representation in space decision-making. Space stakeholdership should be understood to extend beyond actors directly involved in outer space exploration and exploitation activities. Representation of underrepresented groups, including Indigenous communities, could be encouraged, for example by inviting Indigenous organisations to have a permanent observer status at UN COPUOS.

3. Endorsing the proposed extended Principle 5 of the Draft Set of Recommended Principles for Space Resource Activities on the Sustainability and Protection of the Environment of Earth and Outer Space (h, g). These proposed additions are to 'protect [specific] areas that may have special scientific, environmental, historical, or cultural heritage interest or special significance for indigenous peoples' and to 'avoid depletion of space resources … or the destruction of a celestial body in which space resources are located.' (COPUOS, 2025).

4. Equitable distribution of the benefits of space. This can be defined once participation in space-related decision-making is widened. Discussions of benefits of space activities need to extend beyond highlighting the availability of satellite data for sustainable development on Earth, and tackle how to support knowledge sharing, the construction and use of space infrastructure and policymaking in countries that are not traditional space powers.

5. Responsible observation and documentation of heritage. This could increase public awareness and appreciation for sites that are 'out of sight'.

6. Prioritising non-invasive activities for science and heritage sites. Wherever possible, non-invasive methods of research and in situ preservation of objects should be used.

7. Understanding harm in space as more than damage to life. The Moon's geological features and physical environment are worth protecting because they contain a record of a long cosmic history that enabled and still sustains life on Earth.

8. Using the precautionary principle to protect space environments and other celestial bodies from harm. EIAs should be devised for potentially polluting/harmful activities and, where necessary, temporary restrictions should be implemented around protected sites.

9. Establishing a variety of mechanisms for environmental protection. Territorially bounded areas where activities are prohibited can protect sites from some harms (for example, restricted access can protect from the destruction of geological features) but may leave other forms of (potential) environmental contamination unchecked (such as the spread of volatiles). More research and policy work should be funded and supported to encourage the development of strategies and mechanisms to protect the Moon and its sites of interest.

Annex

List of environmental protection mechanisms discussed:

- Antarctic Specially Protected Areas (ASPAs): areas in Antarctica of outstanding environmental, scientific, historic, aesthetic, or wilderness value, any combination of those values, or ongoing or planned scientific research.

- GeoParks: single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education, and sustainable development.
- Planetary parks: first proposed for Mars, protected zones to be established on other celestial bodies, conceptualised on the model of national parks on Earth.
- Sites of Extraordinary Scientific Importance (SESIs): locations on the lunar surface to be protected for and allocated to astronomical research.
- Special Regions: areas on Mars designated in the COSPAR PPP as areas that may support Earth microbes inadvertently introduced to Mars, or that may have a high probability of supporting indigenous martian life.

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Navigating the global politics of artificial intelligence and healthcare

Jason Tucker, Institute for Futures Studies
and AI Policy Lab Umeå University

Abstract

Policymakers face unprecedented challenges in navigating the global politics of artificial intelligence (AI) and healthcare. While AI offers transformative potential, it can exacerbate health inequities and contribute to negative health outcomes along its opaque, transnational value chain. This paper provides an overview of the most pressing global political concerns related to AI and healthcare that warrant policymakers' attention. These are 1. Defining artificial intelligence, 2. The scales of global political discourse on AI and healthcare, 3. AI and the global political economy of healthcare, 4. The emerging global governance landscape, 5. Security and conflict, 6. Global political risks and limitations of AI (mis)use, 7. The global politics of health data in the age of AI, and 8. The environmental impacts of AI. By doing so the paper offers a currently under-represented global political perspective on the responsible adoption of AI in healthcare, to support policy makers the responsible adoption of AI in healthcare.

Introduction

Technologies driven by artificial intelligence (AI) are transforming healthcare. Experts describe the technology as a game-changer in areas such as diagnosis, prevention, pharmacology, treatment, streamlining healthcare systems, patient management, and improving community care (Palaniappan et al. 2024; WHO 2021). Yet, AI adoption introduces risks and can worsen health outcomes. Policymakers increasingly face complex trade-offs around if, where, when, and – critically – who should develop and deploy AI in healthcare.

Responsible AI (RAI) offers one approach to help policymakers navigate these trade-offs. RAI is a set of principles that require AI systems to be developed and deployed in alignment with social, ethical, and legal principles and that contribute positively to the well-being of individuals and communities (Calegari & Dignum 2024). RAI aligns closely with the ideologies that drive public health, and we have increasingly seen decision-makers adopting it as a framework to guide AI's adoption in healthcare.

This uptake, however, tends to focus assessments on specific groups in narrowly construed local contexts. While this level of focus is essential, policymakers must also navigate a broader set of global political concerns. We must recognise that understanding the intersection of global politics, AI, and healthcare is vital if we are to realise the greatest societal benefits of the technology and mitigate its harms. Incorporating these trade-offs into the decision-making process is no easy feat given that opaque and fast-evolving transnational networks of traditional and new actors develop, deploy, and control AI technology. The lack of global governance to regulate these processes and the fierce competition between states to be leaders in the field further complicate matters.

The purpose of this discussion paper is to equip policymakers with the background knowledge to meet the global political challenges of adopting AI in healthcare responsibly. The paper does so by asking: What are the principal global political challenges policymakers face in adopting AI in healthcare?

The paper begins by defining AI, before exploring seven of the most pressing areas of global political concern related to AI and healthcare that demand policymakers' attention. These are 1. Defining artificial intelligence, 2. The scales of global political discourse on AI and healthcare, 3. AI and the global political economy of healthcare, 4. The emerging global governance

landscape, 5. Security and conflict, 6. Global political risks and limitations of AI (mis)use, 7. The global politics of health data in the age of AI, and 8. The environmental impacts of AI. In doing so, it offers a currently under-represented global political perspective on the responsible adoption of AI in healthcare. By shedding light on theses, it is hoped that this will empower policymakers to make more informed, just, and sustainable decisions about responsible AI in healthcare.

Defining artificial intelligence

The definition of AI is hotly contested. However, for our purposes here, the World Health Organization's definition (WHO 2023a: 74) provides a useful foundation given the organisation's focus on healthcare: 'AI is a branch of computer science, statistics and engineering that uses algorithms or models to perform tasks and exhibit behaviours such as learning, making decisions and making predictions.' Put more succinctly, AI refers to the 'computational capability of interpreting huge amounts of information in order to make a decision' (Dignum 2019: 3). Other definitions emphasise the autonomy of AI technology (European Parliament and Council 2024).

Part of the challenge of defining AI is that it serves as an umbrella term used to capture a range of ever-evolving technologies. Broadly speaking, AI encompasses the following fields: problem-solving, knowledge and reasoning, machine learning, interaction, natural language processing (NLP), and perception (Dignum 2019). Within these there are further subfields; for example, within machine learning there is deep learning (on which large language models (LLMs) such as ChatGPT primarily rely), neural networks, and reinforcement learning.

The above are all examples of 'narrow' AI – that is, AI technology that performs tasks in very specific areas that normally require human expertise, and in these areas AI can even outperform humans. At the other end of the scale is artificial general intelligence (AGI), which is a general-purpose AI that can outperform human capabilities across a broad range of domains. This does not exist, and there is fierce debate around whether this is even possible or desirable.

The scales of global political discourse on AI and healthcare

There is considerable hype surrounding AI in general and AI in healthcare in particular. When engaging in policymaking on AI in healthcare, it is useful to consider where it operates across various interconnected scales (Tucker 2025a). By identifying these scales and emphasising their interconnections, we can more effectively situate healthcare sector policymaking on AI within its broader global political context.

At the first level we observe the current uses of AI in healthcare, or those in development. A key feature of this scale is that one can examine the technical aspects of AI systems and the context of their deployment. The focus on both the development and deployment stages is important, because engaging with the process of designing and training AI models plays a central role in RAI deployment (Dignum 2020). The level above this represents technological promises. Here AI is positioned as a forthcoming revolutionary technology that is the best

or only means to address a broad range of healthcare issues: an ideology known as techno-solutionism. The increased scale and scope of AI, and increased reliance on it, are seen as inevitable, and something society should accelerate. Most state, key non-state, and international actors in healthcare advance this position, or a slightly nuanced version of it (Hoff 2023; Strange & Tucker 2023; 2024b). Doing so limits the possibility of discussing non-AI solutions to healthcare problems, as well as critical reflection on the limitations and risks of using AI in the sector.

Finally, at the highest level, AI in healthcare often serves to support broader political agendas – related either to AI itself or to wider ideological goals. States and other actors may strategically promote AI in healthcare to boost political credibility and make certain policies (such as increased digitalisation or investment in national AI industries) more publicly acceptable (Maggor & Tucker 2025). At the same time, dominant discourses around AI can conceal underlying motives, such as promoting neoliberal or libertarian agendas favoured by influential state and non-state actors (Schaake 2024). For example, by portraying AI as a tool that empowers individuals to manage their own health, it can justify shifting responsibility away from public healthcare systems, effectively paving the way for (further) healthcare privatisation (Strange & Tucker 2024a). Ideas like transhumanism and even eugenics also enter public and policy discussions around AI and healthcare at this level (Brusseau 2023). While all three levels of AI deployment are interconnected, this broader political framing shapes expectations of what AI can achieve and ultimately influences which AI applications receive the support needed for their realisation.

With the definition in place, along with an understanding of what level the discourse on AI is being held, as well as its interconnectedness to other scales, we now examine some of the key global political concerns that policymakers must consider when assessing the responsible adoption of AI in healthcare.

AI and the global political economy of healthcare

AI has greatly disrupted the global political economy of healthcare. It is big business: healthcare and medicine ranked as the third largest sector in AI in terms of receiving global private investment in 2023 and 2024 (Maslej et al. 2025). This has largely been driven by investors in the US and China (North 2025). While this investment and corporate interest are often framed as positive developments, they present new challenges for policymakers to navigate. Despite corporate actors playing an important role in healthcare, a few technology corporations (which have not traditionally been involved in healthcare) are now accumulating vast amounts of power in the sector.

Take the US big tech actors, for example. Alphabet, Microsoft, Meta, and Apple have invested heavily in the AI healthcare arena for some time (Thomason 2024). With their wealth of existing customer data, this positions them strongly in comparison to the traditional medical technology (MedTech) industry and public healthcare. They also expend considerable resources to lobby against attempts to regulate AI nationally and internationally (Politico 2025).

New corporate actors, such as OpenAI, with their highly popular ChatGPT-4 generative AI application,[1] now play an increasing role in healthcare systems and data management as healthcare staff adopt the tool, either as recommended by their organisations or on their own initiative. This raises serious concerns regarding transparency, accountability, and privacy – especially when these companies operate transnationally and face limited global regulation over their practices (Wei et al. 2024; Strange & Tucker 2023).

Other states must now navigate issues of regulatory capture and interdependence in this changing multipolar order.

While the US is still the dominant player in AI and healthcare, China, and to a lesser extent the EU, are challenging this position (Chornyy 2024). This new potential multipolarity disrupts the previous global political economy of healthcare. Other states must now navigate issues of regulatory capture and interdependence in this changing multipolar order. Such an undertaking is particularly problematic for low- and middle-income countries (LMICs), which often must rely on other states or international non-state actors to advance AI in their healthcare systems, perpetuating problematic power asymmetries and dependency. Similar concerns also emerge regarding transnational philanthropic organisations (e.g. the Gates Foundation) and their role in setting the global health agenda, given that they operate in a legal grey zone with limited accountability or transparency (Youde 2020).

The emerging global governance landscape

Global governance

Since around 2019, international organisations, as well as state and non-state actors, have increasingly exercised various levels of normative leadership on AI governance (HealthAI 2024). These regulatory efforts broadly fall into three categories: industry self-governance; soft law and standards, which currently dominate; and hard law and regulatory sandboxes, which are now growing in favour (World Bank Group 2024).

In terms of the global regulatory landscape specific to AI and healthcare, WHO has developed a range of soft law and sector-specific guidelines (Kijewski et al. 2024). These have focused on AI and healthcare from the perspective of ethics (WHO 2022), regulatory considerations (WHO 2023a), sexual and reproductive rights (WHO 2024b), ethics and governance for large multi-modal models (LMMs) (WHO 2024a) and AI in traditional medicine (WHO and ITU 2025). WHO and the International Telecommunication Union (ITU) have also established benchmarks to compare the current standard of care against AI-based methods for diagnosis, triage, or treatment decisions, as well as monitoring AI applications after their deployment (Wiegand et al.2018). Other international organisations have acknowledged the importance of healthcare-specific governance of AI. For example, the Organisation for Economic Co-operation and Development (OECD) published guidelines on AI in healthcare in 2021 (Hashiguchi et al. 2021).

WHO has made progress in advocating for health equity to be a guiding principle in the development of AI governance. Unlike many other international actors working on AI governance, WHO has provided practical guidance that is tailored to specific stakeholders and supported them to implement both soft and hard law governance mechanisms (Kijewski et al. 2024). This adoption has been facilitated by actors in the healthcare sector being accustomed

1 Updated versions of Chat-GPT 4and new modes have been released while this paper has been in press. Yet, Chat-GPT 4 remains a pivotal moment where we saw popular adoption of LLMs.

to (and benefiting from) clear regulation and strict standards, in contrast to some other sectors where AI is being applied. Further to this, while most states do not have specific regulations on AI in healthcare in place, AI development and use typically fall under other national and international legislation, for example on medical devices, medical software, or data protection (HealthAI 2024).

The development of international technical standards for AI in healthcare also plays a critical role. These standards, with their focus on technical and procedural aspects, enable the implementation of principles and strategies and remain the most common form of AI governance to date (ibid). Technical experts often develop these rules behind closed doors, despite calls for greater civil society participation in this process (Ada Lovelace Institute 2023). These experts define standardised methods and terms to assess the quality of AI models, such as accuracy, interpretability, robustness, fairness, privacy, or security. Key organisations in this space include the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) and the Institute of Electrical and Electronics Engineers (IEEE) (HealthAI 2024).[2]

WHO continues to play a central role in addressing the fragmented national and global governance landscape.

Significant gaps persist in the global governance of AI and healthcare. WHO continues to play a central role in addressing the fragmented national and global governance landscape. The global community stands at a critical moment in shaping the global governance framework for AI in the sector. As such, the US's repeated withdrawals from WHO are deeply concerning, as is the broader crisis in multilateralism.

Regional governance

A major shift in the landscape of global AI governance in healthcare occurred with the adoption of the European Union AI Act (EU AI Act) in 2024 (Schmidt et al. 2024). This horizontal regulation covers AI more broadly and applies a risk-based approach to specific areas of application. The EU AI Act classifies healthcare as a high-risk area, although standards are still being developed to clarify its interpretation. This classification means that AI applications in the sector must meet more stringent demands. These include requirements for higher-quality data, more representative datasets, detailed risk management, clear human oversight, and robust documentation (European Parliament and Commission 2024).

From a governance perspective, it is important to note that the EU AI Act did not emerge in isolation. It builds on previous EU efforts, such as the Ethics Guidelines for Trustworthy AI (European Commission 2019), the Medical Device Regulation (European Parliament and Council 2017), the In Vitro Diagnostics Regulation (European Parliament and Council 2021), and the General Data Protection Regulation (GDPR) (European Parliament and Council 2016).

The extraterritorial reach of the EU AI Act means it regulates not only actors within the EU but also those intending to use their AI systems in the EU market. Thus, similar to the Brussels effect following the adoption of the GDPR, and with no clear alternatives on the horizon, the EU AI Act may become the de facto global AI regulation (Minssen et al. 2024). Not only will this enable the EU to protect its own market, but the standards around the high-risk area of health under the act will, in part, shape the future direction of AI and healthcare globally.

2 These are closely related to national efforts to set standards, for example the UK Medicines and Healthcare Products Regulatory Agency's 'Impact of AI on the regulation of medical products: Implementing the AI White Paper principles' (MHRA 2024).

National and other actors in global governance

Powerful nation-states and blocs – notably China, the US, the UK, and the EU – have also pioneered efforts regulating AI and healthcare, shaping regulation to align with their various socio-political and economic agendas (HealthAI 2024). Other states such as Brazil, Singapore, India, Kenya, Rwanda, and Indonesia have also implemented a range of health-specific AI legislation (HealthAI 2024, 2025; Palaniappan et al. 2024). We are also witnessing a surge of national horizontal legislative endeavours on AI, as recently occurred in South Korea (Choi 2025). This will add national-level regulation to the global governance landscape of AI in healthcare. Finally, researchers and clinicians are forming international consortia to establish and propagate principles for trustworthy and responsible AI in healthcare to address the current governance gap (Lekadir et al. 2025).

The path forward

AI is often perceived as a challenge to traditional multilateral regulatory mechanisms. Its rapid development and diffusion frequently outpace the capacity of these frameworks to respond effectively. Compounding this, powerful states and corporate actors are actively working to obstruct efforts toward establishing national, regional and international regulation. However, one should remember that considerable friction slows the development and adoption of AI in healthcare. For example, legacy systems can be difficult and costly to upgrade, there may be a lack of financial and staffing resources, and existing regulation and norms often resist change before its potential harms can be assessed (McKinsey & Company 2024). WHO Europe (2025) have also highlighted that lack of regulatory certainty, limited strategic planning and oversight are barriers to further AI adoption in the region's healthcare sector. These factors all delay or limit the uptake of the technology, providing valuable time to implement both traditional and emerging forms of global governance of AI.

Considerable inequalities persist in the uptake of AI within and between countries, and global governance risks reinforcing and exacerbating existing power asymmetries. One way to address this could be through regionally harmonised initiatives that avoid assuming or enforcing universal uniformity (Dignum et al. 2025). This would include prioritising context-sensitive approaches, meaningful participation from local stakeholders, and bridging respect for local values and concerns with international cooperation. There is also a pressing need to confront the politics of data infrastructure and access to the data that trains AI in LMICs.

Security and conflict

The increasing role of, and dependency on, AI in healthcare raises concerns in relation to security and conflict. States face a trade-off between expanding the role of AI in the healthcare sector to benefit from the technology and risking exposure to new threats as healthcare becomes increasingly digitalised and reliant on AI systems to function.

This is no marginal issue: AI in healthcare features prominently in many states' national and regional AI geopolitical agendas. Thus, it is no surprise that healthcare has become a focus for hybrid forms of conflict. At state level, we saw this during the Covid-19 pandemic. Nefarious actors used AI-generated deepfakes and other content, disseminated with the assistance of AI to spread mis-/disinformation, significantly complicating states' ability to manage the pandemic and maintain social stability (UNICRI 2020). The expanded use of AI also increases the reliance on critical infrastructure, such as subsea data cables, data centres, and the electricity network

(Crichton et al. 2024). Defending these can be challenging for even the most well-resourced states (Trakimavičius 2021). Sustained cyber-attacks have also targeted critical infrastructure supporting AI adoption in LMICs, particularly those seeking to leap-frog technologically (Sukumar 2023).

Healthcare facilities also face a barrage of AI-supported attacks. In 2021 a global survey found that more than one-third of responding health institutions experienced at least one ransomware attack in the preceding year and of all respondents, one third paid a ransom (Mishra 2024). In 2023, the healthcare sector suffered more cybersecurity incidents than any other critical sector in the EU (European Commission 2025). This risk intensifies as many systems designed to support AI in healthcare are connected to others, creating third-party vulnerabilities. Given all this, WHO considers cyber-attacks in healthcare a considerable threat to international security and global health (UN2024). The coordinated cyber-attacks on healthcare before and following the Russian invasion of Ukraine highlight how digitalisation of healthcare can make it a vulnerable and high-impact target in war (Samarasekera 2022).

AI has been successfully used to enhance the cybersecurity of health data and services. However, ensuring this security is becoming increasingly problematic as transnational, opaque, and fragmented AI systems are embedded in healthcare at multiple levels by various national and international actors.

Global political risks and limitations of AI (mis)use

Considerable care is needed to design and monitor AI systems to avoid bias and discrimination. This is especially problematic where the decision-making process of some AI systems is not understandable or explainable.

Despite the hype, AI in healthcare carries significant risks and limitations. These include algorithmic and data bias (Aliferis & Simon 2024), inaccuracy (Perez 2019), hallucinations (Kim et al. 2025), and lack of transparency and accountability (Fehr et al. 2024). There are also the dangers of the use of AI in contexts and on populations for which it was not designed, as well as the dangers of data leaks and misuse (Buolamwini 2024; OECD 2024). These risks do not affect all communities and states equally. For example, while AI can be used to identify and address racial bias in healthcare, it can also reproduce and worsen existing structural discrimination through algorithmic and data bias (Brunel University London & Health Action International 2023). Considerable care is needed to design and monitor AI systems to avoid bias and discrimination. This is especially problematic where the decision-making process of some AI systems is not understandable or explainable. This is referred to as the 'black box problem', a significant concern in the high-stakes world of healthcare (Rudin 2019).

A Western biomedical reductionist position also dominates in AI model development. This approach treats the body as quantifiable, sidelining cultural and contextual factors as unimportant (Shipton & Vitale 2024). This is highly problematic given the need to consider the local context for AI systems to deliver the most beneficial health outcomes. Further to this, there is a tendency toward the 'politics of avoidance' in AI health, whereby the root causes of healthcare challenges and the social determinants of health are ignored, or seen as inconsequential, in light of AI's perceived potential (Shipton & Vitale 2024).

One of the most worrying trends is that the hype around AI and healthcare is being used to justify reductions in vital healthcare spending (Davies 2019). Indeed, WHO emphasises that broad public healthcare provision is essential if AI's future benefits are to be realised (Tucker 2025b; WHO 2023b).

While we have seen significant friction in implementing AI in healthcare in high-income countries (HICs), this is even more pronounced in LMICs. Adoption is constrained by limitations such as poor-quality electronic health records; the high cost of data annotation, model development, hardware acquisition, and maintenance; and shortages of skills, resources, and infrastructure (López et al. 2022). As a result, in Latin America and the Caribbean, for example, AI use in the healthcare sector remains fragmented and mainly appears at the meso and macro levels of healthcare management (Saban et al. 2023). Yet, AI in healthcare holds enormous potential in LMICs. We are already seeing considerable efforts to realise this – for example, the largest number of AI start-ups in Africa operates in the health sector (Global Center on AI Governance 2025). However, these initiatives face considerable challenges as the global political economy of AI development and health data has concentrated power and resources in the hands of a few key actors in the US and China.

The global politics of health data in the age of AI

The governance of health data has emerged as a central concern in the global political economy of AI, with data sovereignty becoming a critical axis of contestation.

Data is the lifeblood of AI, playing a critical role in its training. Health data is highly sought after, with massive growth in the global market for big data in healthcare (Precedence Research 2025). The governance of health data has emerged as a central concern in the global political economy of AI, with data sovereignty becoming a critical axis of contestation. Data sovereignty refers to the principle that digital data is subject to the legal jurisdiction of the state in which it is collected. As AI-enabled healthcare systems increasingly depend on transnational data flows, tensions have intensified between protecting national interests and enabling cross-border innovation. A lack of harmonised regulation, asymmetrical geopolitical power relations, and harm caused by data extraction from LMICs further exacerbate these tensions.

The EU has sought to address concerns over data sovereignty (for its member states at least) and to capitalise on its wealth of public health data by establishing the European Health Data Space in 2025 (European Parliament and Council 2025). The EHDS will facilitate data sharing across the region while also strengthening European data sovereignty around health by limiting access for non-member states. Other regions have signalled that they also wish to undertake similar initiatives (AI Expo Africa 2025). At a global level, WHO advocates for the greater collection and sharing of global digital health data, in part to allow for AI-powered insights to tackle global health challenges (Shaffer 2020).

However, these national and regional legislative frameworks and calls for collaboration risk reproducing structural inequalities by excluding LMICs from access to health data. Without adequate investment in data governance infrastructure and equitable access provisions for LMICs, data sovereignty risks becoming a mechanism of digital enclosure. This is because access to health data serves as a foundational resource for AI innovation in healthcare. The global distribution of this access remains deeply uneven, in favour of HICs and a small group of big tech companies largely based in the US (Roberts 2024). It is not only access to data that is of concern. The extraction of health (and other) data from LMICs can be seen as a compromising these LMICs' digital sovereignty, an area of increasing prominence for LMICs.

The lack of quantity and quality of health data is often framed as a bottleneck in the potential advancements that AI can facilitate (Benke & Benke 2018). However, to meet this need we are witnessing the extraction and exploitation of health data from LMICs, as well as from

marginalised populations in HICs. This practice has drawn extensive critique for replicating and exacerbating existing power asymmetries, a phenomenon described as 'data colonialism' (Ferryman 2021). There are also challenges in preserving the health data sovereignty of LMICs and Indigenous communities (Cordes et al., 2024).

The environmental impacts of AI

Policymakers often underestimate these environmental costs in debates on AI.

Environmental sustainability in the context of AI use in healthcare presents a double-edged sword. On the one hand, for example, AI-assisted medical drones in Ghana have reduced the carbon emissions of traditional methods of delivering emergency medical supplies (Damoah et al. 2021). On the other hand, AI in healthcare often relies on large datasets, with complex algorithms and frequent model updates, all of which generate considerable environmental impacts (Ueda et al. 2024). These impacts include significant electricity and water usage, e-waste, and the extraction of rare earth minerals (Lucivero 2024). For example, water-thirsty data centres, which are essential to train the currently favoured branch of AI, have intensified droughts in areas of Chile, leading to negative health outcomes for the local population (Ren & Wierman 2024). This environmental cost is not evenly distributed. The uneven regional distribution of AI's environmental costs mirrors historical practices of settler colonialism and racial capitalism (AINOW 2023). At the local level, the negative environmental impact of AI disproportionately affects marginalised groups (Crawford 2021; Lucivero 2024). Policymakers often underestimate these environmental costs in debates on AI. There is a great deal of variation in terms of the environmental impacts depending on the type of AI application.

Summary: policymaking and responsible AI

This paper sought to support policymakers in how to navigate the global politics of AI in healthcare. It has done so by providing a background on some key global political forces impacting AI in healthcare of which policy makers should be aware. Navigating these is a daunting challenge for policymakers. Yet, failure to do so risks causing more harm than good. This can include negative health outcomes for individuals and populations, weakening healthcare systems, increased conflict, and environmental degradation.

While RAI is gaining traction in healthcare, it often overlooks the global political realities that influence how AI is developed, deployed, and governed. Rather than treating AI as a neutral tool, this paper urges policymakers to interrogate who benefits, who controls the infrastructure, and who bears the risks. It highlights how current practices risk deepening inequalities, especially for LMICs and marginalised communities, and calls for more inclusive, transparent, and context-aware governance. It offers an overview to help decision-makers assess global political risks, ask critical questions, and design policies that align with public health values and global equity goals. By foregrounding power, politics, and global interdependence, the paper reframes RAI as a strategic tool for navigating complexity. It is hoped that this will empower policymakers to make more informed, just, and sustainable decisions about responsible AI in healthcare.

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The new international politics of decarbonisation and climate preservation

Federica Genovese, University of Oxford

Abstract

This paper explores evolving international climate politics from a historical and comparative perspective. It argues that a core challenge in the new era of uncertain climate relations lies not in technical solutions but in the politicisation of climate policy coordination. The paper traces assumptions and limitations of international cooperation until the mid-2010s and the shift towards the more flexible Paris Agreement framework in 2015. It argues that this shift led countries to confront their political economies of climate action, with associated opportunities but also perils that have led to heightening politics against the Paris Agreement. To counter this backlash and support decarbonisation and adaptation efforts, the paper advocates for investing in state capacity to manage the social and economic disruption that the lack of climate policy – or, alternatively, an unregulated type of energy transition – will cause. The paper concludes by noting that the future of climate cooperation depends on navigating national political battles, which are unlikely to dissipate, and further linking the climate agenda with justice, growth, and democratic renewal.

Introduction

The largest and most existential issue confronting society today is climate change. The implications of excessive greenhouse gas emissions on the stability of the global climate have been known since the early 20th century, and the scientific literature agrees that climate change today is a direct consequence of the anthropogenic accumulation of these gases in the atmosphere. Indeed, climate change is a problem that stems from centuries of industrialised growth (notably in the Global North) and is boosted by sustained global fossil fuel production and consumption. As predicted by 20th-century scientists, accumulation of emissions has accelerated the occurrence of extreme natural events that affect ecological welfare, and thus generated what some now refer to as a climate crisis.

While the historical responsibility for climate change is not equally distributed among countries, the emergency is now so advanced that climate action requires increasingly coordinated institutional responses from all nations. According to the International Panel for Climate Change, these responses broadly fall into two categories: mitigation of climate change by reducing greenhouse emissions, and adaptation to climatic disasters by building ecological resilience.

Thankfully, technical solutions to climate change mitigation and adaptation have existed for a while. Mitigation requires decarbonisation, and at this point in history, this can be amply facilitated by large-scale electrification and renewable energy adoption, in addition to technologies currently in R&D and early implementation (e.g. hydrogen production). Adaptation requires large investments in infrastructure projects, such as smart irrigation systems and sea walls, which can help prevent the most dangerous aspects of climatic volatility.

But if the technical fixes exist, a significant problem remains: political capture – that is, the disproportionate influence that some interests exert against the fair distribution of responsibilities and gains from climate action.[1] Indeed, the trickiness of climate change is that no country will be able to lead climate solutions all alone, as the causes that magnify the

1 In this paper the concept of political capture is purposefully broad and includes various forms of decisions that steer gains towards private benefit at the expense of democratic accountability, including, for example, regulatory capture.

issue are rooted in the fossil fuel-driven world economy. Notably, the costs of action are very concentrated among fossil fuel producers, which further distribute them across consumption chains (Bechtel et al. 2019; Cory et al. 2021; Hovi et al. 2019). Fossil fuel producers either pass down the costs of a green transition to individual consumers or prevent it a priori by lobbying against policy action (Mildenberger 2020; Stokes 2020). In essence, this makes climate change a global collective-action problem dominated by what game theorists call a defection outcome (Barrett 2016).

Additionally, even among the countries that credibly want to act on climate change – namely, states that lack significant indigenous fossil fuel production (such as many parts of Europe, various small nations in the Pacific, and most of the Caribbean islands) or that have started the derisking from fossil fuels (such as other European nations and increasingly China) – there is a significant level of cross-national disagreement on how to act, when to act, and for what purpose.

Countries in Europe started experimenting with incremental market policies in the form of carbon pricing in the 1990s, and the European Union tried to consolidate those in the 2000s. Following Europe, other parts of the world attempted similar policies in the past decades (Lerner et al. 2024). However, the results have been only marginally meaningful to the extent that even European countries are now pushing for alternatives. For example, the European Commission is now spearheading trade-oriented climate policy instruments such as the European Carbon Border Market Adjustment (an import tax on carbon-intensive goods from abroad). And in the wake of China's 'big green state' in the 2010s, the EU and, during the Biden administration, the United States (US) oversaw new forms of green industrial policy. Helas, as of 2025 these approaches are increasingly braking. The cost-of-living crisis, new trade wars, and financial competition with other areas of technological investments such as artificial intelligence are challenging climate policy. In the meantime, most countries are still pursuing extraction and refining of fossil fuels, and the timelines of disinvestment from these sources of energy are, in many cases, highly uncertain. Moreover and critically, very few countries are properly investing in the level of adaptation planning that the state of the crisis requires.

Until the mid-2010s, the politics of climate change were siloed to international cooperation debates with technocratic language and little public appeal. By contrast, in the past decade climate politics has entered mass politics, taking on a new shape and becoming a manifestation of domestic political battles.

This paper takes stock of history and present of global climate politics in order to point at its systematic weaknesses and opportunities. It claims that vague and unclear national commitments have plagued international climate change agreements for decades, and this obfuscation has always been the product of political processes. Indeed, it is not that domestic politics did not play a fundamental role in international climate politics until recently – of course they have. Yet, until the mid-2010s, the politics of climate change were siloed to international cooperation debates with technocratic language and little public appeal. By contrast, in the past decade climate politics has entered mass politics, taking on a new shape and becoming a manifestation of domestic political battles. Consequently, this paper maintains that we must figure out the roots of the increasing disenchantment with international climate agreements and the past decade's domestic politicisation of climate change if global climate action is to have a serious chance in an emerging era of global disorder.

In sum, this paper argues that, to credibly prepare for future political battles around climate change, proponents of climate cooperation need to first recognise the past problems of climate multilateralism and then recognise the new premises (and promises) of politicised domestic climate action going forward. The paper unpacks these steps in order. It first examines the history of international climate cooperation, highlighting the shift from top-down enforcement (the Kyoto Protocol) to the more flexible but universally binding Paris Agreement. The next section focuses on national-level climate policies, especially the political obstacles and failures of carbon pricing, and the emerging emphasis on compensatory, state-led green

industrial policies. The final section concludes by assessing the challenges of climate policy as of 2025 and evaluating how to make climate policy more resilient in the years to come. Specifically, I emphasize the need for democratic states to build the administrative and legal capacity to act effectively on climate issues, and democratic governance to sustain credible, equitable climate action in a politically fragmented global landscape.

Promises and pitfalls of international cooperation: from Kyoto to Paris

As a global public good problem, climate change is a direct externality of collective human behaviour. Because fossil fuels are embedded in many interconnected aspects of human society, as are the ecological externalities of climate change, unilateral climate action by single countries is unlikely to meaningfully dent the problem. Against this light, international cooperation – the coordination of carbon regulations and environmental safety standards through international organisation – is considered the most efficient way to tackle the causes and consequences of climate change.

International lawyers and economists have long acclaimed the potential benefits of international cooperation. The argument goes that cooperation in international institutions (most notably the United Nations Framework Convention on Climate Change, UNFCCC) can significantly cut countries' transaction costs and welfare losses when dealing with climate change. For example, international programmes can break technological barriers and decrease the costs of policy adoption and diffusion across countries. Similarly, through the trust that comes with repeated meetings and negotiations, countries may initiate productive exchanges. For example, through international agreements wealthy countries are more likely to distribute funds for effective infrastructural protection and investments to developing countries, which may then reciprocate by changing their development paths towards cleaner technologies (Aldy and Stavins 2009; Gaikwad et al. 2025).

From this perspective, international cooperation can fruitfully provide successful coordinated climate action. At the same time, it demands some necessary conditions that could lead to self-enforcing cooperation and high potential gains (Keohane & Victor 2016). Notably, policymakers spent most of the early years of international climate politics paying attention to the legal facets of sustained enforcement of international agreements. The first years of international negotiations on climate change, from the 1992 Rio Convention to the adoption of the Kyoto Protocol (signed in 1997, enforced in 2005), were based on this premise; the entire goal was to strike agreements that would stabilise emissions by the 2010s. The anchoring paradigm for this approach was basic collective action theory: because free riding in international relations is overpowering and uncertainty is deep, international institutions must increase the power of their mandates. In a similar vein, several scientists advocated for agreements in the form of 'clubs' that could demand more loyalty and compliance from their member countries (Hovi et al. 2019).

This emphasis on the sustained enforcement of international cooperation motivated the outlook of international climate politics from the 1990s until the 2010s. Effectively, this paradigm generated an expectation that international institutions would pursue a top-down approach to climate lawmaking. However, the results of this approach have been disappointing. Binding countries and setting abatement targets for developed countries (as enshrined in the Kyoto Protocol) generated a deep division between Global North and

South that intoxicated the meetings of the UNFCCC's Conference of the Parties (COPs). The emphasis on participation and membership rather than genuine commitments also diluted the meaningfulness of the COP negotiations. Unanimity-based voting further complicated the effectiveness of the UNFCCC to get at bold action points, since consensus procedures tended to complicate and slow down negotiations (Genovese 2020; Genovese et al. 2023).

These pitfalls and failed promises of international cooperation terribly affected the credibility of the UNFCCC process in the eyes of the public. It seeded the mood that later led to the rise of various civil movements, such as Fridays for Future and the Sunrise Movement. Following these waves of civil action, the negotiations from 2008–12 were meant to define the post-Kyoto Protocol framework but resulted in various failures (Green 2025). It was only in 2015 that international climate politics found breakthrough. At the Paris COP, diplomats finally decided to try a new approach and formulate a different design of climate policy coordination.

The agreement struck in Paris (the so-called Paris Agreement) was different from anything else in the international climate politics domain because it focused less on prescribing top-down targets and more on mobilising national coalitions of climate policy winners. Essentially, the agreement proposed an international law framework explicitly designed to allow nations to choose their bottom-up approach to climate mitigation and adaptation. Through the initiatives of nationally-determined pledges (NDPs), it moves away from the system established in the 1990s in which countries were either legally bound or not. It reinvents the duties of decarbonisation and climate adaptation by universally giving weight to domestic commitments and recognising national capabilities. Importantly, it instates the political needs of countries as the starting point for designing their actions on the climate crisis. Many agree that this has constituted a paradigm shift in climate cooperation (Hale 2016; Hermwille 2016).[2]

It is up to national governments to identify and appease the domestic actors who oppose ambitious action and champion those who support it.

Implicitly, this paradigm shift means that, today, international climate policy is intrinsically embedded in the domestic political economy of every single country. It is up to national governments to identify and appease the domestic actors who oppose ambitious action and champion those who support it. In the eyes of several scholars (Aklin & Mildenberger, 2020; Colgan, Green, & Hale, 2021), the international community has effectively transitioned towards a new logic of policymaking that is less driven by seeking solutions to the global collective action problem and truer to the political root of the problem: distributive conflict. Zooming in on distributive conflict implies focusing on the material winners and losers of the climate transition. It means shifting attention to the domestic political economy of each country to assess which actors will accept the dramatic renegotiation of institutions required by climate action and which will push back – and how they can be appeased.[3]

As of 2025, it is still up for debate whether the paradigm of international coordination crystallised by the Paris Agreement, so reliant on the domestic political mobilisation of the 'will' for climate policy, is working and will indeed work in the long run. In 2015 diplomats effectively designed an international framework that, on the one hand, gives more flexibility to national plans but, on the other hand, puts a lot of trust in societies to identify and support their

2 The paradigm shift in Paris was less technical than substantive. Technically, the Paris Agreement still relies on implementation of international agreement into domestic law and domestic compliance with the terms of agreement. Also, as scholars of the UNFCCC have pointed out, the agreement still technically relies on types of incrementalism seen in other climate agreements (Allan 2019). However, substantively the Paris Agreement changed climate action into a transformative process led by coalitions of the willing within the agreeing countries. Changing the spotlight from top-down international targets to domestic targets generated through internal coalition-building processes was unprecedented and spurred a new momentum for climate civil movements.

3 Domestic political economies are of course nested in international ones, but they have different effects. Domestic political economies can be appeased, muted, or catalysed to swing voters before an election, while international political economies are much harder to reign in as they operate across national borders and legislations. Importantly, countries can have different geographic constituencies with different political economies. Aligning these may be key for climate advocates who seek to have climate champions win elections.

climate 'champions'. By reframing climate action as an economic transformation project and providing a reference point of ambition, the Paris Agreement bet on coalitions of climate-policy supporters to emerge within many countries. This was effectively a new avenue for progress by accommodating - rather than ignoring - hard domestic political realities.

But there are, of course, reasons to worry about the Paris model and the resilience of its approach in the future. Since 2016, we have seen significant pushback from interest groups, institutional actors, and the public to the idea of climate policy progress. Fossil fuel producers have notably mobilised against climate ambition (Baehr et al. 2025), systematically trying to dilute climate agreements and avoid commitments to limiting warming to 1.5°C (Genovese 2019), especially when confronted with higher regulatory costs than their competitors (Kennard 2020). Voters in vulnerable economic regions have shown increasing unease with the terms of international cooperation for climate change (Bayer & Genovese 2025). Similarly, populist leaders have attempted to sabotage the entire negotiation effort with threatened or effective withdrawals (Urpelainen & Van de Graaf 2018). These threats to the international climate order have accelerated especially with the return of President Trump at the White House and the various anti-climate decisions that the administration has unleashed, not least the (second) withdrawal from the Paris Agreement (Colgan & Genovese 2025).

That said, the recent period has also shown significant international participation and, overall, some sustained salience of multilateralism. The 2022 deal on a 'Loss and Damage Fund' struck by alliances of Global North and Global South countries (Vanhala & Calliari 2025) and the COP30 agreement to strengthen adaptation finance are noteworthy examples of international policy progress. And on a more basic political level, various constituencies have manifested their belief that the Paris Agreement is worth fighting for, in part because of its economic efficiency and not least because there is no other framework on the horizon (Gaikwad et al. 2025).

But if the Paris Agreement remains a significant toolkit for managing climate change in the next decade, we should better understand what climate agendas within countries can look like, and what reasons there are for concern and hope in handing the responsibility for international climate action to domestic stakeholders. The rest of the paper unpacks these questions.

The rise of nationally driven climate agendas and the mass politicisation of climate action

National policies focused on mitigation (emissions abatement) and, to a lesser extent, adaptation (protection of people, ecosystems, and infrastructure) have existed for about three decades. In the late 1990s, in part because of the UNFCCC goals and in part due to the strong leadership of the European Union (EU), some Northern European countries (Denmark, Finland, Sweden, the Netherlands, and Norway) became early adopters of forms of carbon pricing aimed first and foremost at greenhouse gas emissions.

During this period, the most dominant form of policy in this realm was (gas/petrol-related) carbon taxation. Additionally, some countries started experimenting with the idea of emissions trading (cap-and-trade), compatible with an expanded liberal market ideology. The early attempts at these instruments were credible and, in many ways, courageous. However, there is now abundant evidence showing that none of these mechanisms provided the promised policy

outputs due to political infeasibility (Finnegan 2023). In fact, many carbon pricing targets have repeatedly become vulnerable to changes, exceptions, and, effectively, political U-turns.

Notably, gasoline-based taxes in Europe are higher than in other developed countries but rarely above levels able to make a meaningful impact (e.g. 0.6 EUR of duties per litre). Similarly, carbon taxes exist in only a few European countries, and proposals have been dismantled at various stages in states such as Italy and Switzerland. As for emissions trading, the EU established its emissions trading scheme (the EU ETS) in 2005, against the backdrop of high expectations for the Kyoto Protocol's emissions market. However, until recent reforms, the system was flawed with an oversupply of offset credits and links to non-verified projects in developing countries (Genovese and Tvinnereim 2019; Green 2021).

Despite these concerns and the volatilities of carbon pricing, until the 2010s most economists argued that these tools were necessary and sufficient to combat climate change. After all, economic textbooks teach that taxes (including carbon pricing regulations) can effectively let people internalise externalities and efficiently change polluting behaviour. However, this view disregards once again the political capture behind carbon pricing and its implications. As many political scientists agree, abstracting these policy tools from the distributional conflict between carbon-producing actors (e.g. fossil fuel producers) and climate-vulnerable actors (e.g. wildfire and flooding exposed communities) is a recipe for failure, not success (Colgan et al. 2021; Ross 2025). This point is especially important in view of the new inward look that international climate action is going through after the return of President Trump at the White House. While carbon pricing (carbon taxes and cap-and-trade) should remain in the toolkit of instruments to fight climate change, it is crucial to assess their political perils and pitfalls in an era of democratic and geopolitical change.

To start off, carbon taxation has the advantage of generating immediate welfare benefits. It creates government revenues that can be further distributed and invested for climate protection purposes. It is also beneficially straightforward (at least nominally, notwithstanding the complications of tax collection). However, the intrinsically political problem with carbon taxes is that new taxes are never seen favourably, either by companies or the public. Consequently, carbon taxation is likely to threaten governments, regardless of ideological orientation and institutional make-up. Perhaps paradoxically, it is especially unlikely to manifest in electorally competitive democracies, where voters tend to be more myopic and less interested in the intertemporal payoffs of high carbon taxes (Finnegan 2023). Not surprisingly, the few recorded attempts to ramp up carbon taxation in the past decade have caused significant backlash, as evidenced by major demonstrations in France and protests in Latin America (Lerner et al. 2024).

However, history shows that emissions trading, like taxes, is also likely to become a victim of political capture.

As for emissions trading, capping carbon and trading pollution credits has the advantage of being a more flexible system that relies on market signals. This allows the emission producers (i.e. companies) to more smoothly adjust to the associated costs of regulation. Cap-and-trade can also be an economic 'leveller' as it may reward first-movers and small companies (Bayer & Aklin 2020). However, history shows that emissions trading like taxes, is likely to become a victim of political capture. The EU ETS, for example, was quickly the target of industrial lobbying and, at least in its first two regulatory phases (2005–07 and 2008–12), its scope was heavily diluted by the massive number of cheap credits allocated among the regulated companies (Genovese 2021).

Against this background, the reason why carbon pricing – in Europe, North America, Australia, and many other continents – has not been able to deliver its ambitious promises is simple: these policies were designed without consideration of the political implications of their cost

distributions. The policymakers chose not to consider the inevitable political fight that would occur in response, by companies as well as the public. Arguably, carbon pricing's implicit emphasis on constraints, which reinforce the incapacity of politicians to redress distributional concerns, constitutes a major peril for climate action, at home and internationally.

Thanks to the mobilisation of various groups in civil society and the political contention around carbon pricing, the policy agenda of the past ten years has started to change. Crucially, it has become evident that the climate crisis requires building larger coalitions of supporters than previously envisaged (Bergquist et al. 2020). In policy terms, this means that the 'stick and carrot' sides of regulations, which have heavily been focused on the stick part, need to be rebalanced. Essentially, policymakers need to find new carrots for people and companies to buy in to climate action.

Political scientists have stepped up to this task, trying to elaborate what climate-policy carrots can look like. It turns out that they can take different forms to appeal to different sections of society. These include, for example: income compensation and retraining of individuals employed in carbon sectors; targeted investments to protect vulnerable ecosystems; and investments to scale up renewable energy. All these instruments can be embedded in climate policy and can effectively address some of the distributional aspects of climate action.

This is not to say that agreement is impossible: American and Indian citizens are on average more willing to support climate policy if any form of compensation is included.

It has also been shown that the public is more likely to support climate policy that explicitly highlights such compensatory mechanisms, although some divergence remains. For example, Gaikwad, Genovese & Tingley (2022) illustrate through original surveys in the US and India that many voters are willing to raise national contributions for climate change actions if broad-scale investments are included in a policy; alternatively, voters living near coal mines and oil drilling stations are more supportive of such a policy if it embeds cash transfers to fossil-fuel communities. This is not to say that agreement is impossible: American and Indian citizens are on average more willing to support climate policy if any form of compensation is included. Nevertheless, striking the exact balance of compensatory goals within a climate policy package is a challenge for future policymakers.

More broadly, social science research is increasingly indicating that people in Global North and Global South countries are willing to act on climate change and are ready for new forms of climate policy focused on incentives. This implies, inevitably, more public spending and a bigger role for the state, either as a central catalyst of the energy transition or a broker of the private capital that needs to shift towards greener assets. But this is not easy politics. Voters are concerned with debt and fiscal prudency, and while it is increasingly recognised that the costs of climate change will outweigh the solutions and that therefore investments in this area are highly needed, it is unclear how much appetite there is for decoupling economies from greenhouse gas emissions vis-à-vis a derisking model in which private interests are given more and more carrots.

In a nutshell, electoral polls and public opinion studies– through certainly not conclusive – tend to support the logic of climate policy attempts across various countries between the COVID-19 pandemic and the Russian attack of Ukraine. These policy attempts included green industrial projects and just-energy-transition experiments such as the Inflation Reduction Act (under the US Biden administration, later dismantled by the Trump administration) and the Green New Deal (especially during the first von der Leyen EU Commission), in addition to the large-scale renewable energy planning that countries such as China have spearheaded for 20 years.

These political projects, which explicitly focused on a new phase of 'large government' action, are at least partly in tension with the neoliberal order upon which climate policy was founded in

the 1990s and fine-tuned in the 2000s. Yet, this policy shift promised a more successful path for the credible advancement of mitigation and adaptation, because climate policy is doomed to fail unless authorities and big capital get involved to guarantee a redistribution of costs. However, this would have inevitably required a willingness to actively and explicitly fight for climate agendas that is regressing as of 2025, to which the paper turns in the next and last section.

Climate change and the political battles we will fight

Catastrophic climate change is not inevitable, and the technologies to fight climate change are known and increasingly accessible. What stands between the causes of and solutions to the climate crisis is a new wave of disintegration politics, of which the return of President Trump and the rise of far-rights in Europe are most prominent examples. On the climate issue, this politics is manifesting as a populist backlash against recent climate actions; however, the spirit of this backlash is essentially rooted in the old political problem of 'carbon capture' (Mildenberger 2020), which takes issue with various aspects of public good provision, including the progressive incrementalism of international climate cooperation. Giving in to this new political mindset, politicians risk short-changing the domestic political economies that the Paris Agreement has sought to champion, i.e. groups that boost growth based on green assets instead of fossil fuels.

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Against this background, domestic coalitions of resilient supporters of climate policy are struggling to solidify, in part because coalition-making processes require time but also because institutions and stakeholders have not ambitiously internalised the benefits of international climate cooperation. With the aggressiveness shown by the 2025 Trump administration and the potential onset of new trade and technology wars, the international community may be lured into setting aside climate change priorities. Indeed, in a world with increased global economic uncertainty, we may be facing a dire future for climate politics for the immediate future.[4]

Yet it is worth remembering that relatively recent policy turns – internationally, the adoption of the more flexible Paris Agreement; domestically, the new emphasis on compensatory national policies and investments in green industrial policies – may well offer a less pessimistic outlook of climate politics than if we had continued with the paradigm of the past century. This is not to say that the climate problem will be easier to solve now that climate change has reached mass politicisation; the 'losers' of climate action – or rather, their appointed political entrepreneurs –will continue putting up a strong fight. But the salience of climate change in this moment does point to the fact that choosing to fight a political battle for climate change is possible. Its success will depend closely on two factors.

First, society will only have a chance at battling climate change if we rethink the role of the state and the importance of state capacity to take decisive action in the global economy (Meckling & Nahm 2021). Without a strategic rethinking of states' roles, there is no accountable actor that can push forward the battles against climate change. The state needs to step in to

4 According to some observers, this moment can only be met with so-called 'climate realism', which some proponents are championing as a sober way to keep the idea of climate action alive during the second Trump administration (Council on Foreign Relations 2025). But as many have pointed out (Colgan and Genovese 2025), climate realism is incompatible with multilateralism as it is predicated on the assumption that countries will first and foremost pursue their own self-interest and so climate action can only work to the extent that it protects this self-interest – even if at the expense of the global public good.

reassure citizens for any welfare loss caused by climate action. Similarly, the state will need to domesticate private interests for the public good. This will bring up conversations about the position of the state in people's lives, the implications of green fiscal reach, and the importance of devolution and federalism to enhance just, place-based climate policies (Bayer & Genovese 2025). It will also require interrogation of how states relate to their own pasts. For Global North countries currently struggling with the unpreparedness to the challenges of the 21st century (from energy scarcity to technology disruption to a second "China shock"), institutions will need to find willing to seek internal reforms that make the state more lean, flexible, and adaptable. The current discrediting of the neoliberal economic model by populist movements could interact with a demand for a stronger role of the state. For Global South countries, the effort of building state capacity will also include reflecting upon the legacies of colonial states and unpacking questions around climate (neo)colonialism and intergenerational justice (Dolšak & Prakash 2022).

Second, fighting climate change will require a renewed commitment to democracy. Some commentary suggests the opposite, pointing to the current US quest for rare materials despite the step-back on climate policy and China's current energy leadership. This view confounds energy politics with climate politics, which have clear overlaps but also separate logics. For example, while the Chinese case shows that autocracies can lead the race-to-the-top in mitigation efforts, there are reasons to doubt China's genuine investment to the global public good (Wallace 2025). This is evidenced by the continued amounts of fossil fuel consumption in Chinese territory (with significant electricity generation in China still based on coal) and its limited ambition in international climate finance and aid to date (making less of a contribution than smaller economies such as France and Japan). A more systematic and fairer transition towards a more stable climate needs to be centred on democracy (Lazar & Wallace 2025) because this is the only political system that gets close to guaranteeing the needs of the people rather than a small circle of powerful interests.

But for democracies to take the lead on climate action and for the battle against climate change to be purposeful, citizens must have renewed faith in the basic elements of democratic life, in both the short and the long run.

In the short run, as far-right climate-delay movements rise across the world, it is sensible to ask how realistic the global commitment to democracy will be in the years to come. Far-right political parties may come to power by democratic means (i.e. free and fair elections), but there is consensus in the political science community that they tend to be harmful to public good provision if they excessively concentrate political powers in the ruling party at the advantage of a small elite (Przeworski 2024). Will far-right movements halt climate policy progress by eroding democratic norms and goals?

The evidence from 2025 suggests far-right parties are not invincible, as shown by recent electoral victories of moderate parties in Australia, Canada, and Romania, among others. This suggests that there is a significant part of the global electorate still willing to vote for democratic forces instead of choosing to slide into authoritarianism. Feeding the climate policy aspirations of moderate voters is possible and, indeed, requires the opposite of dismantling climate action. Concrete short-term policy actions that can help boost climate policy appetite include better regulating the media environment that steers public discussion and feeds climate change perceptions, and more forcefully regulating some external communications, such as those of publicly-owned energy companies. At the same time, this vision of public policy will require balancing climate ambition with efficient regulation, considering the significant amount of red tape that democracies often entail (Klein & Thompson 2025).

In the long run, meaningful climate action will rely on accurate media reporting and verified information. It will also require a renewed belief in political and institutional representation, and for elites to be accountable to the people. Climate inaction is ultimately fuelled by misinformation, mistrust, disenfranchisement, and inequality, and action will require a critical analysis of the types of power politics that have led us here and the sort of political economies we want to design going forward.

In sum, the future battle for the preservation of the planet is intrinsically tied to democratic leaders willing to link the energy transition to political redistribution, social justice, and human rights, and to put this vision at the forefront of a credible political agenda that can gain coalitions of voters among citizens, interest groups, and civil society organizations. Other evolving crises will threaten to divert attention away from the climate battle over time. However, this will not make climate change go away – if anything, it will amplify its effects. A visible and bold agenda that is based on a strong (and just) state and that finds complementarities between climate action, on the one hand, and short-term economic interests, on the other, is more likely to not only be resilient to the new political cleavages that have emerged in recent crises, but also to draw from the distributional solutions that the management of the other crises will potentially unveil, strengthening itself.

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Towards an orderly and just global energy transition

Peter Newell, University of Sussex

Abstract

It is ever more apparent that ambitious climate goals cannot be met without orchestrated efforts to support a fair phase out of fossil fuels. This paper explores both mini-lateral 'club' and multilateral approaches to a global transition away from fossil fuels amid the challenge of both providing an ordered and just transition while disrupting the power and control that incumbent fossil interests wield over energy and political systems to inhibit such transitions. It explores the potential and limits of phase out clubs and the growing momentum behind calls for a new international treaty to regulate and limit the production of fossil fuels in order to support such a transition.

Introduction

The world's energy system is in crisis. Heavily dependent on climate change-inducing fossil fuels, characterised by vast inequalities in production and consumption within and between countries, and closely linked to war and economic turbulence, energy is at the heart of many of the most pressing challenges the world faces. Yet the global governance of a transition to a more secure, accessible, and sustainable energy order is under-developed and understudied (Newell et al. 2023). For the purposes of this paper, a just transition is one that attends to the procedural and distributional elements of justice affected by efforts to steer society towards a lower carbon future, especially with regard to those living in energy poverty, those whose livelihoods are affected by and dependent on a fossil fuel economy, and the ways that potential tensions between simultaneously pursuing energy and climate justice are addressed (Newell & Mulvaney 2013). An assessment of the prospects for a just transition is critical to move beyond the status quo default of crisis-induced policy responses followed by backlash from excluded groups and largely unco-ordinated national responses to what is a quintessentially global challenge. The purpose of this paper is, therefore, to explore mini-lateral and multilateral political and institutional pathways towards the required exit from fossil fuels.

A just transition will require disrupting incumbent control over energy and governance systems while building governance processes supportive of globally just transitions.

Such pathways have to navigate a series of key tensions. Firstly, the tension between order and disruption. Traditionally, transitions are neither just nor orderly; indeed, to succeed they depend on the disruption and destabilisation of dominant sociotechnical regimes (Turnheim & Geels 2012). A just transition will require disrupting incumbent control over energy and governance systems while building governance processes supportive of globally just transitions. The need to address historical inequities and current injustices regarding differing contributions to the problem of climate change and uneven capacity to address it means this transition cannot be left to the disruptions brought about by shifts in the market alone, but rather requires action by states and international institutions to address the procedural and distributional dimensions of a just transition. Secondly, thus far major energy transitions have spanned decades or centuries (Smil 2016), yet these now need to be accelerated and scaled over a much shorter time frame to avoid surpassing critical climate thresholds. This presents novel governance challenges. Thirdly, this imperative of acceleration also produces potential tensions between the need for inclusive and deliberate public engagements to build ownership and social acceptance, which take time, and the need for speed (Newell et al. 2022). Acceleration without attention to justice is unlikely to get very far, as we have seen in orchestrated backlash from incumbent business actors and their allies in the media to measures imposed from above and in resistance by poorer developing countries to demands that they increase their climate ambitions in the absence of adequate finance that reflects differentiated historical responsibilities and vulnerabilities to climate change.

The paper seeks to furnish a foundational diagnosis of the sources of the current disorderly energy transition, provide an analysis of current trajectories and initiatives, and propose alternative policy pathways which would build concretely on the limitations of the current landscape of energy governance.

The geopolitical landscape of energy transition

This is not a conducive moment for strengthened multilateralism, increased aid, or confronting inequalities, and systems of global energy governance, such as they exist, are considered weak and under-developed (Florini & Sovacool 2009). This unfolds against a wider context of rising populism, regional wars, trade wars, and the expansion of new frontiers of mineral exploitation that is required for the drive towards global electrification.

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At the same time, it is now widely acknowledged by all major international institutions and most governments that unless the world accelerates its transition away from fossil fuels, the ambition of the Paris Agreement will not be realised. It was only in 2023 at the UN Framework Convention on Climate Change (UNFCCC) COP28, after 30 years of negotiations, that the treaty body explicitly acknowledged the role of fossil fuels in the climate crisis. Countries were called upon to transition away from fossil fuels in a 'just, orderly and equitable manner, accelerating action in this critical decade', marking the 'beginning of the end' of the fossil fuels era (COP28 2023). This was based on clear evidence of not only an emissions gap (between the commitments governments have made and the scale of action required to deliver the Paris Agreement) but also a production gap (between planned fossil fuel extraction and production and what is compatible with remaining carbon budgets in line with a 1.5 or 2 degrees Celsius trajectory) (SEI et al. 2024). In other words, the goals of the Paris Agreement cannot be achieved amid the expanded production of fossil fuels.

The need to rapidly increase global ambition to tackle the climate crisis is not the only driver accelerating the transition from fossil fuels. Other key drivers include: (i) **Economic costs**, including concerns about stranded assets and systemic risks to financial stability, the costs of importing fossil fuels, price volatilities, and the cost of fossil fuel subsidies, which for G7 members reached a record high of USD 282 billion in 2023 (the last year for which estimates are available) (IISD 2025). Recent estimates predict a US$ 17 trillion loss of revenue to the forty identified petrostates globally with a 'slow transition' and US$ 8 trillion with a 'moderate transition' between 2023 and 2040 (Manley et al. 2023; Prince 2023, 18–19), which omits the substantially higher cost of not transitioning at all. The International Energy Agency (IEA) forecasts that demand for fossil fuels will peak this decade and begin to wane thereafter, meaning that supply may well exceed demand (IEA 2023). (ii) **Economic opportunities** associated with clean energy. 'Global energy transformation: A roadmap to 2050 by the International Renewable Energy Agency' (IRENA) finds that such a transformation would boost gross domestic product (GDP) by 2.5 per cent and total employment will peak at 0.2 per cent globally in 2035 and stabilise at 0.16% by 2050 and that health, subsidy, and climate-related savings would be worth up to USD 160 trillion cumulatively over a 30-year period. Hence, every dollar spent on transforming the global energy system provides a pay-off of at least USD 3 and potentially more than USD 7, depending on how externalities are valued (IRENA 2019). (iii) **Geopolitical drivers**, including the desires to reduce energy-system disruption, exposure to shocks, and dependence on volatile fossil fuel-producing nations. For example, Europe spent

an extra €517–831 billion in excess market costs on fossil fuels due to higher prices throughout 2021–2022 in the wake of Russia's invasion of Ukraine (Colgan et al. 2023). (iv) **Health impacts**. For example, the energy sector is the primary cause of the polluted air that more than 90 per cent of the world's population breathes, linked to more than 6 million premature deaths per year (IEA 2023). (v) **Environmental impacts** on energy systems. Impacts on energy sources and infrastructures are expected to 'multiply six-fold by mid-century and amount to more than 10 times the present damage of €3.4 billion per year by the end of the century due to climate change' (Forzieri et al. 2018). There are therefore multiple drivers converging around the need for an orderly and just exit from fossil fuels.

Future scenarios anticipate the loss of fossil fuel-related jobs will be more than compensated by the increase in transition-related employment.

Of course, the scale of the challenge of transitioning away from fossil fuels should not be underestimated. The IEA anticipates the share of coal, oil, and natural gas in the global energy supply will still be at 73 per cent by 2030 (IEA 2023). Investment in oil and gas today is almost double the level compatible with a net-zero emissions scenario in 2030, putting the 1.5 degrees Celsius goal out of reach. But change in the energy transition is underway – and accelerating. Renewables are set to contribute 80 per cent of new power capacity in 2030 according to the IEA's Stated Policies Scenario (STEPS), though there is scope for this to be surpassed (IEA 2023a). Future scenarios anticipate the loss of fossil fuel-related jobs will be more than compensated by the increase in transition-related employment. 'For every USD 1 spent on fossil fuels, USD 1.7 is now spent on clean energy. Five years ago, this ratio was 1:1' (IEA 2023a website). However, 'the increase in clean energy spending in recent years is … heavily concentrated in a handful of countries' (China, EU, and the US in particular) (IEA 2023a website). In addition, 'competition for clean energy manufacturing and for supplies of critical minerals and metals is a major issue for the resilience of energy transitions' (IEA 2023a website).

The challenge for governments is to keep pace with these developments and manage them effectively. Fossil fuels are being increasingly out-competed by the declining costs of renewable alternatives or subject to global and regional pressures to reduce and eliminate their use. Yet many producer and consumer states feel ill-equipped to navigate the speed and scale of this shift, for which few precedents exist. Proactive planning and societal engagement are critical to anticipate and avoid significant economic and social disruption. In this regard, governments can benefit from support, capacity-building, and policy learning through multilateral institutions such as through the World Bank's 'Just Transition for All' initiative and the Climate Investment Fund's Just Transition Planning Toolbox as well as regionally through the EU's Just Transition Platform. International institutions such as the World Bank, International Monetary Fund, IEA, International Labour Organization, United Nations Conference on Trade and Development (UNCTAD), and IRENA have an important role to play in financing, co-ordinating, and building capacity for just transitions and enabling lesson learning among countries regarding strategies to support just transitions (Newell et al. 2023). But navigating these competing trends and ensuring that transitions are just will require greatly strengthened systems of energy governance. What form could such systems take?

The minilateral governance of energy transitions

There are a number of emerging initiatives and proposals to accelerate and co-ordinate transitions away from fossil fuels. The most prominent of these include Just Energy Transition Partnerships (JETPs) and 'climate clubs' such as the Powering Past Coal Alliance (PPCA) and the Beyond Oil and Gas Alliance (BOGA). Many are consistent with the philosophy and approach which Naim (2009) and others call minilateralism, which suggests the ideal starting point for a collective response is the smallest number of countries with the greatest scope to make an impact. In the context of climate change, for example, the G20 account for over 75 per cent of greenhouse gas emissions. The Major Economies Forum on Energy and Climate brings many of those actors together (CCPI 2025).

Robyn Eckersley (2012: 24) agrees that inclusive multilateralism' is unlikely to produce a timely climate treaty, but warns that 'exclusive minilateralism' is 'elitist, procedurally unjust, self-serving, and likely to thwart the justice principles of the UNFCCC' (26). Instead, she advocates for 'inclusive minilateralism, based on 'common but differentiated representation', that is, representation by the most capable, the most responsible, and the most vulnerable' (26). Framed that way, however, the number of countries to which those criteria apply would make for a more multilateral than minilateral approach to a just energy transition.

It is worth recalling that amid all the diagnoses of the novel nature of contemporary disorder, plurality, hybridity, and fragmentation in global governance – including that which exists at the interface of energy and climate change, one subsection of the broader regime complex on climate change (Keohane & Victor 2011) – there are precedents both for such challenges and for governance innovations that have sought to address them. Indeed, there is a rich history of attempts to complement, strengthen, or otherwise bypass the slow pace of international climate negotiations to accelerate progress on financing and technology diffusion of lower-carbon energy alternatives through public private partnerships and forms of transnational governance from the Asia Pacific Partnership on Clean Development and Climate to REEEP (Renewable Energy and Energy Efficiency Partnership) and REN21 (Bulkeley et al. 2014). Even 15 years ago, Szulecki et al. (2011) found more than 46 dedicated transnational multi-stakeholder partnerships on sustainable energy working across different scales to enable knowledge dissemination and technology transfer, the building of institutional capacity and training, and technical implementation and innovation, with a few seeking to create new energy infrastructures on the ground.

Following in this vein at the UNFCCC COP26 in 2021, several national and subnational governments launched BOGA with the central aim of promoting a managed phaseout of fossil fuels to align with the Paris Agreement (BOGA, 2021). Moreover, 39 countries and financial institutions also pledged at COP26 to phase out public finance and investment for coal, oil, and gas by the of 2022, with other nations and institutions joining the initiative at COP27 in Egypt. Since its inception, the Clean Energy Transition Partnership has expanded to around 40 signatories, including major fossil fuel-financing countries such as Australia, the USA, and Canada. The example of the PPCA also shows how a few countries, in this case the United Kingdom and Canada, can rapidly 'internationalise' a new idea, in this case phasing out unabated coal-fired power. The Alliance grew from 27 members at its beginning in 2017 to 165 members by late 2021 and has come to attract members from important coal regions such as Germany and North Macedonia. That said, with certain notable exceptions (e.g. Germany),

'countries pledge to phase out coal only when potential stranded assets, employment losses, regional impacts and other costs are low' (Jewell et al. 2019: 596). Moreover, a phaseout is 'more likely to be pursued by independent and transparent governments in wealthy countries, which have the capacity to bear substantial political, social and economic costs' (596). PPCA also 'excludes coal mining from its scope, focusing solely on coal-fired power production, which enables countries willing to phase out the latter, but not the former, to join' (van Asselt et al. 2022: 35).

There have also been bilateral and trilateral approaches to phasing out fossil fuels at the international level in the form of JETPs that have been negotiated by a series of donor countries, such as the UK, US, and Japan, with mainly coal-dependent nations to date (Indonesia, South Africa, Senegal, and Vietnam). But civil society groups have expressed concerns about the financing model the partnerships promote (concessional finance and majority private rather than public finance), the lack of consultation with societal actors beyond business about how the funding will be allocated, conditionalities and who imposes them (since they are often tied to neoliberal policy reforms and requirements), and continued fossil fuel lock-in. Indonesia's JETP, for example, comes with a requirement to purchase carbon capture and storage technology from Japan, one of the key donors in the partnership. Moreover, though the partnerships were designed to support countries to reduce coal use and Indonesia has committed to stop developing new coal plants, plants built to power strategic industrial projects are exempted so long as the plants reduce their emissions 35 per cent in 10 years and shut down by 2050 (Farand 2023).

Taken together, these initiatives are best thought of as helping to tackle distinct aspects of the sprawling and complex challenge of accelerating just transitions in different ways across diverse sectors and regions – plugging gaps and creating momentum but clearly not proportionate to the scale of the challenge. So, what would a more effective or alternative multilateral response look like?

The multilateral governance of just transition

Given the fragmented bi- and minilateral structure of many of the initiatives described in the previous section and their voluntary and non-binding nature, we will now turn our attention to what sorts of multilateral mechanisms could support a just transition away from fossil fuels. This section of the paper explores proposals for new multilateral arrangements, such as a Coal Elimination Treaty or a Fossil Fuel Non-Proliferation Treaty (Burke & Fishel 2020; Newell & Simms 2020).

Proposals for a coal convention have been made before by academics (Burke & Fishel 2020) and leaders such as former President Tong of Kiribati. In 2015, in the Suva Declaration on Climate Change issued from the Pacific Islands Development Forum Third Annual Summit held in Suva, Fiji, decision-makers called for: 'a new global dialogue on the implementation of an international moratorium on the development and expansion of fossil fuel extracting industries, particularly the construction of new coal mines, as an urgent step towards decarbonising the global economy' (Suva declaration 2015: 8). In 2016, 14 Pacific Island nations discussed a treaty that would ban new coal mining and embrace the 1.5 degrees Celsius goal set at the Paris climate talks (Brittlebank 2016).

Given the need to address not just coal but also gas and oil, a proposal then emerged for a Fossil Fuel Non-proliferation Treaty (Simms & Newell 2018). As a complementary approach to the climate regime – which for thirty years did not name fossil fuels as the number one source of the climate problem –this proposal seeks a fair exit from fossil fuels. Organised around three key pillars which mirror the Treaty on the Non-Proliferation of Nuclear Weapons, it would seek to: prevent the expansion of new extraction of coal, oil, and gas (non-proliferation); support the early retirement of many existing fossil fuel infrastructures (fair phaseout); and finance non-fossil energy pathways in poorer countries and those reliant on fossil fuels (just transition) (Newell & Simms 2020; Newell et al. 2022). To date, the proposal has been endorsed by 18 governments (including Colombia, Cambodia, Pakistan, and small island and Pacific states), international organisations (such as the WHO and European Parliament), 10 Indigenous nations, 700 elected officials from 85 countries, 131 cities and subnational governments, 1 million individuals, 3,500 civil society institutions, and faith institutions representing more than 1.5 billion people (Fossil Fuel Non-Proliferation Treaty 2025). Assuming the campaign can succeed in persuading 20 countries to endorse it, negotiations towards such a treaty could potentially commence in 2026 following the world's first summit on the elimination of fossil fuels to be hosted by Colombia and the Netherlands in April 2026.

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Though I have discussed them separately here, minilateral and multilateral pathways are not necessarily mutually exclusive, but rather can be sequenced and exist on a spectrum of more legal and institutional pathways to a managed exit from fossil fuels. van Asselt and Newell (2022) explore two idealised forms of international cooperation on the supply-side, aimed at regulating the supply of fossil fuels: a 'club' model based on non-legally binding principles and a multilateral environmental agreement (MEA) based on legally binding principles and institutional architecture. A supply-side club comprised of like-minded states provides a greater degree of flexibility than an MEA in terms of procedures, legal forms, and sequencing. A club model could also incorporate non-state and subnational actors, which has been central to the implementation of supply-side policies to date through clubs such as BOGA and the PPCA. An approach based on an MEA, on the other hand, would formally engage a larger number of participants and have a legally binding agreement as its basis that could explicitly address fossil fuel production. An MEA would create a high degree of institutionalisation, signal a strong commitment from parties, have a decision-making body or fora as well as a dedicated secretariat, and would usually require ratification and therefore the engagement of national parliaments and legislatures.

Both models have benefits and costs. The club approach is inherently dynamic, which means it can be set up and scaled at a speed commensurate to the urgent need to address fossil fuel production. MEAs can take longer to create and formalise, although there are exceptions such as the Nuclear Non-Proliferation Treaty which was concluded in under three years and the Treaty on the Prohibition of Nuclear Weapons which was negotiated in two years. A club arrangement with non-binding commitments may be more effective at bringing fossil fuel majors into the fold. However, a club arrangement can suffer from issues of free-riding, leakages, weak levels of institutionalisation, and backsliding from members. At the moment, both mini-lateral climate 'phase-out' clubs (Koppenberg 2025) are expanding and momentum is gathering behind the proposal for a Fossil Fuel Non-Proliferation Treaty with the former very much preparing the ground and compatible with the latter.

Future pathways to an orderly and just energy transition

So, what would be required for these proposals for minilateral and multilateral governance arrangements to extend their ambition and inclusion in terms of reach, membership, sectoral, and geographic coverage in order to provide a more effective basis for an orderly energy transition away from fossil fuels? Given the multilevel governance dynamics at play here, it is important to explore scenarios in national, regional, and global settings involving key actors. My reflections on this build on three experiences in particular. Firstly, I served as research lead on a global policy dialogue on the theme of 'Prosperity post fossil fuels' conducted over several days with government representatives from oil- and gas-dependent economies (Azerbaijan, Brazil, Ghana, Nigeria, and Trinidad and Tobago); a range of multilateral actors from IRENA, the EU, and the World Bank; and representatives from the US and Australian governments. Secondly, I co-organised a regionally focused workshop with activists and researchers from key 'first mover' countries in Latin America that, in different ways, have put policies in place to leave reserves of fossil fuels in the ground (Chile, Colombia, Costa Rica, and Ecuador). Thirdly, I co-organised an event convened in the UK with former government advisors and civil society organisations on ways to strengthen UK leadership on climate and energy, particularly in relation to the initiatives it is leading to mobilise finance for renewable energy and phase out support for fossil fuels.

A key issue that emerged in the policy dialogue with major oil and gas producers was economic diversification and which internal policy tools and forms of economic support might be required to support an economy-wide transition away from fossil fuels, not just in the energy sector (Peszko et al. 2020). This is crucial where fossil fuel revenues are central to the tax base of an economy or to supporting welfare provision, such as in Norway and Nigeria. This suggests that entry points for more co-ordinated international support to just transitions need to bring in key international economic institutions such as the World Bank, WTO, and UNCTAD to a far greater degree. The workshop in Latin America, meanwhile, underscored the need for regional cooperation and engagement to help build alternative regional energy pathways based on renewables, regional grids, and power pools as well as measures to address the fiscal and debt crises faced by many countries in the region, without which it be impossible to persuade policy elites and voters to forego exploiting their fossil fuel reserves. Co-ordinated civil society campaigns will also be vital to strengthen and maintain support for the 'first movers' that have agreed to not issue licenses for oil and gas and to accelerate the exit from coal in the face of significant countervailing pressure domestically (CFAL 2025).

The context for the third scenario exercise was the new Labour government in the UK seeking to position itself as a global leader of efforts to boost a transition to clean power, having undergone its own transition away from coal and led initiatives to accelerate the phaseout of finance for fossil fuels (SUS POL 2025). Home of the first industrial revolution and one of the world's major financial hubs for oil majors such as BP and Shell and a new GB Energy company, the UK might be well placed to take up this mantle. But this is a crowded space with many initiatives already in existence, as we have seen in the previous sections. In November 2024, UK Prime Minister Keir Starmer launched the Global Clean Power Alliance (GCPA) at the G20 meeting in Rio de Janeiro. Touted as a way to position the UK 'at the very heart of the single most significant technological challenge and opportunity of this century' (Lammy 2023), the GCPA's main foci are to accelerate the mobilisation of private finance and create country partnerships to build capacity and overcome barriers to deploying that finance. The alliance

is currently comprised of the UK, Brazil, Australia, Barbados, Canada, Chile, Colombia, France, Germany, Morocco, Norway, Tanzania, and the African Union, with the European Union and US (for the time being) also partnering with the UK.

It has several key missions, the first and most developed of which is on finance. Though it is yet to be decided, a second mission of the GCPA could be energy security and supply chains. Here the alliance could operate as a 'reverse OPEC' to a 'buyers' club' for critical minerals. How much power and influence the GCPA could wield in such a role would depend on how many other key economies could be persuaded to join the alliance. To do so, those economies will want to know the value added of this new initiative. We know from previous experience that successful initiatives are those which respond to a clear demand, do something different, operate an effective partnership model, and set clear deadlines and milestones around which finance is mobilised (E3G and Chatham House 2024). The true test of leadership, however, is whether the fine words expressed in international fora are matched by deeds at home. Having undergone a public consultation, the UK government has reaffirmed its commitment to end new oil and gas licenses in the North Sea despite ongoing uncertainty around the approval of the Rosebank oilfield in the North Sea (UK Government 2025).

Though the focus of this paper has been on supply (fairly cutting the production of fossil fuels), it is inevitably also the case that efforts to drastically reduce demand are vital to global efforts to address the climate crisis. Global levels of demand for critical minerals for electrification – even with new innovations to prolong the life of batteries and reduce the resource intensity of their production – are likely to reach unsustainable levels, putting pressure on communities the world over. We need to cut supply and demand with 'both arms of the scissors' (Green & Denniss 2018). Renewable energy adds to the energy mix but does not enable a shift away from fossil fuels so long as levels of demand continue to increase, ensuring that a transition does not take place (Fressoz 2024).

Given the interrelated nature of energy transitions, a globally just transition cannot be one in which richer countries source the materials they need for their national transitions by externalising and imposing social and environmental costs on poorer countries and communities.

Given the interrelated nature of energy transitions, a globally just transition cannot be one in which richer countries source the materials they need for their national transitions by externalising and imposing social and environmental costs on poorer countries and communities. This is also where the prospects of a globally just transition intersect with the global politics of trade, finance, and investment. For example, launched in 2019 at the initiative of New Zealand, the Agreement on Climate Change, Trade and Sustainability aims to use trade rules to phase out fossil fuel subsidies among its parties. It complements an earlier initiative launched by New Zealand to establish an informal 'Friends' group of non-G20 countries to encourage G20 and APEC (Asia-Pacific Economic Cooperation) leaders to act on their commitments to phase out inefficient fossil fuel subsidies as soon as possible. To address concerns that treaties with investor-state dispute settlement (ISDS) mechanisms can be used to frustrate and challenge transitions away from fossil fuels, recent studies have pointed to the potential for climate clubs to develop responses such as providing a waiver agreement for ISDS related to fossil fuel assets, a more general ISDS waiver agreement, or even a mutual agreement to terminate investment treaties (Tienhaara et al. 2025). Hence, enabling a globally just transition will not only derive from bespoke arenas and club arrangements targeting climate and energy questions, but also from efforts to reform trade and investment agreements.

There is a task here to sequence and seek openings and intervention points to nurture more ambitious and socially just global energy transition strategies. Seeking to simultaneously address all the dimensions and sources of injustice in the international system will inevitably result in deadlock, loss of political momentum, and failure. But concerted action from a few

states could build significant momentum. Just five wealthy producer states from the Global North are responsible for 51 per cent of the planned expansion of oil and gas production by 2050, underscoring the importance of historical responsibility and capacity to transition in discussions of supply-side policies (OCI, 2023). Those states that bear the most historical responsibility for climate change, have the greatest resources, and hold the most capacity to diversify their economies away from fossil fuels must lead global efforts and support others to do the same. Such countries must show national, regional, and global leadership even while major economies such as the US refuse to engage. Countries from the Global South whose own contributions to climate change are increasing – such as China, India, South Africa, and Indonesia – will expect these countries from the Global North to lead as a condition to enhancing their own ambitions.

At the same time, this means being willing to broaden the discussion of 'just transitions' beyond questions of (private) finance, (Northern) technology, and retraining of (unionised) workers to address bigger questions of economic justice such as debt, taxation, and unfair terms of trade. Commitment to work on these broader issues over the medium term could be a quid pro quo for short-term cooperation and collaboration to decarbonise the global energy system. Scenarios and models are often imagined to be technical exercises focused on technological uptake and the costs of technologies and their deployment. But whether different pathways are possible depends on building support, trust, and coalitions; partnering with different actors; forming international alliances; and thinking creatively and innovatively about how to overcome obstacles. Though they do not have to be sequential, I have argued here that minilateralism supporting the transition away from fossil fuels may provide the means to do this. If it can ride trends towards the falling price of renewables and the increasing geopolitical and economic costs of dependence on fossil fuels, this may lay the foundation for the multilateral response ultimately needed to ensure the transition is both fair and effective. The fact that 83 countries supported the call for a roadmap to move away from fossil fuels and that the world's first ever summit on a just transition away from fossil fuels will be hosted in April 2026 by Colombia and the Netherlands provides a hopeful indication that momentum is building to address this critical issue even as petro-states continue to veto progress within the climate negotiations.

Acronyms

BOGA – Beyond Oil and Gas Alliance

COP – Conference of the Parties

JETP – Just Energy Transition Partnerships

GCPA – Global Clean Power Alliance

IEA – International Energy Agency

IRENA – International Renewable Energy Agency

ISDS – investor-state dispute settlement

MEA – multilateral environmental agreement

PPCA – Powering Past Coal Alliance

REEEP – Renewable Energy and Energy Efficiency Partnership

STEPS – Stated Policies Scenario

UNCTAD – United Nations Conference on Trade and Development

UNFCCC – United Nations Framework Convention on Climate Change

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Can we sustain progress and convergence in an ageing world?

Charles Kenny, Centre for Global Development

Abstract

Globally, we are past 'peak baby', and many countries are past peak working-age population. Richer economies are seeing plateauing education rates and rising demand for services. All these factors suggest slower growth in richer countries, combined with fewer export opportunities for poorer countries. We could still sustain global growth and convergence over the next 50 years through greater movement of people, but that makes the political economy of migration of central importance to the prospects of global prosperity over the next half century.

The demographic challenge

We are past 'peak baby'. In 2012, 144 million children were born worldwide. By 2020, that figure had dropped to 134 million. Richer countries are already shrinking and ageing (Spencer, Warner & Bastian 2019; United Nations 2022). The knock-on effects, in terms of economic dynamism and global progress, could be considerable but are far from inevitable (at least for the next few decades). The most powerful tool to mitigate and delay the effects of global demographic change is migration.

Peak baby hit in the United States around 2007, with just over 4 million children born that year, and it occurred far earlier in most other richer economies – as early as 1959 in Europe as a whole, for example.[1] While the global population continues to increase thanks to rising life expectancy, in many high-income economies total populations are starting to fall. The United Nations estimates that European population peaked in 2020.[2]

By 2050, there will be one retirement age person for every two people of working age in high-income countries, compared with one for every five as recently as 1990.

Most significant for economic outcomes, the UN suggests that peak working-age population (20–64) for high-income countries as a whole was reached in 2023, at 740 million people. For Europe, the percentage decline in workers over the next few decades will be similar to that which occurred in the aftermath of the Black Death (Kenny 2023). By 2050, there will be 209 million fewer working-age people in high- and middle-income countries than at the 2027 peak, a decline of more than 9% in just 23 years (United Nations 2022).

But the number of retirees will continue to climb for many decades to come. By 2050, there will be one retirement age person for every two people of working age in high-income countries, compared with one for every five as recently as 1990. That means not only will there be fewer workers, but they will be a smaller part of the overall population. In 2050, in countries such as Italy, Japan, and South Korea, there will be fewer workers than old and young dependents combined (National Institute on Aging et al. 2007; United Nations 2022).

There are partial domestic solutions to the looming shortage of workers, but they face challenges. The differential between female and male labour force participation in high-income countries could be closed – although, because the gender differential is already considerably smaller than it was in the past, this would be insufficient to fill the worker gap (Toossi, & Morisi,

1 Our World in Data using UN World Population Prospects (2024) https://ourworldindata.org/grapher/births-and-deaths-projected-to-2100?country=~Europe+%28UN%29

2 Our World in Data using UN World Population Prospects (2024) https://ourworldindata.org/grapher/population-with-un-projections?country=~Europe+%28UN%29

2017).[3] While rising longevity and healthy years of life might call for longer working lives, official attempts to increase retirement ages are immensely politically unpopular (Kalenkoski & Oumtrakool 2017).

The limits to automation

As a cautionary tale regarding current forecasts of robots and AI taking over jobs, US data on automation trends between 2000 and 2020 has ill matched prior expert predictions of automation risk. Furthermore, there is little evidence of an acceleration or change in the number or types of jobs being automated, nor in the pay or number of employees in jobs seeing more automation (Deming, Ong & Summers 2025; Scholl and Hanson 2020). To date, there is also little evidence that this time is different with AI, for all of the plausible reasons as to why it might be. In Europe between 2011 and 2019, occupations such as finance and software development, most exposed to AI, saw rising employment shares (Albanesi et al. 2023).

It is not hard to see why a smaller workforce could be a drag on growth. Between 1989 and 2019, Japan and the US saw a very similar increase in GDP per hour worked – but, thanks to Japan's far more rapidly ageing and retiring population, GDP per person increased 35% in Japan compared with 56% in the US, for example. High-income countries where the working-age population was expanding saw 2% GDP per capita growth in the last few decades. During periods when the working-age population was shrinking, however, that declined to 0.9% (Cooley, Henriksen & Nusbaum 2024; Kenny & Yang 2021, 2024).

The plateauing of human capital

Meanwhile, plateauing education rates mean the stock of human capital in richer countries is increasing more slowly than in the past. We are still in a period of massive global growth in educated workers: in 1980, more than 70% of the working-age population of the world had only primary school education or less; by 2020, 70% of the world's working-age population had secondary education or more.[4] University enrolments worldwide have climbed from 10% to 40% over the past half century.[5] Once again, however, high-income countries are ahead on a flattening curve. We appear to be approaching peak years of education across rich countries (Barro &Lee 2013; Kenny &Gehan 2023).

US undergraduate enrolment fell from 18 million in 2010 to 16 million in 2020, and the number of Ph.D. degrees awarded has flatlined.[6] The stock of education as a whole (measured as years of schooling in the adult population) was rising at an annualised rate of 2.7% between 1950 and 1980 and 1.4% between 1980 and 2010. This is a widespread phenomenon: for China the same numbers are 6.0% for the earlier period and 3.1% for the later period.[7] Education efficiency is also flatlining: the literacy scores of adults with more than a high school education in the US actually fell between 1994 and 2014 (Helland & Tabarrok 2019). Analysis of standardised tests

3 See also Federal Reserve Bank of St Louis 'FRED' LNS11300002.
4 See World Bank 'Databank' SE.TER.ENRL https://data.worldbank.org/indicator/SE.TER.ENRR
5 See Wittgenstein Center 'Data Explorer' https://dataexplorer.wittgensteincentre.org/wcde-v1/; World Bank 'Databank' SE.TER.ENRR.
6 Data from NCES https://nces.ed.gov/programs/coe/indicator/cha https://ncses.nsf.gov/pubs/nsf22300/report/u-sdoctorate-awards accessed 28 October 2022.
7 Author's calculation from Barro and Lee (2013) dataset available at http://www.barrolee.com/ accessed 28 October 2022.

over the last two decades in the OECD club of rich countries suggests no significant trend in average performance.[8]

Reaching the peak in human capital stocks will be a second drag on growth in wealthy countries. Differences in average years of education among and within countries can explain a considerable proportion of income differences (Deming 2022). 'Growth accounting' estimates suggest that rising education rates may be responsible for as much as half of global growth over the past few decades (Gethin 2023). This suggests that the stagnation of human capital stocks will be a significant cause of broader economic stagnation.

The service economy challenge

A further concern is that the combination of past income gains and continued ageing are pushing the world economy further toward the production of services. In the US, households headed by those over 80 years old have a 27 percentage points higher share of services spending than households headed by someone in their early 30s, as expenditure on things like cars gives way to spending on care. Across countries, an increase of one percentage point in the share of the population aged 65 and over is linked to a 1.3–1.5 percentage point increase in the service share of value-added and employment (Cravino, Levchenko & Rojas 2019). In 1970, agriculture and industry accounted for 46% of the global economy. Today, that figure is down to 30%, with the other 70% accounted for by services, reaching toward 80% in the US (Herrendorf, Rogerson & Valentinyi 2021).

Over time, we have not proven nearly as good at improving learning per teacher as we have at improving car production per factory worker or corn production per farmer.

The problem with that change is that services see lower productivity growth than manufacturing or agriculture. Over time, we have not proven nearly as good at improving learning per teacher as we have at improving car production per factory worker or corn production per farmer. Innovation is concentrated in material production: for example, more than 70% of US corporate patents are in manufacturing, a sector that accounts for just 10% of GDP (Jones 2022). The sectoral shift to services can account for more than half a percentage point of the recent slowdown in GDP growth in rich countries (Cravino, Levchenko & Rojas 2022).

Innovation and entrepreneurship in decline

The greater complexity of productivity growth in services illustrates a broader problem: that global innovation and entrepreneurship are declining, in part (once again) thanks to ageing and shrinking populations in the countries where innovation is concentrated.

Between 1980 and 2010, ageing accounted for a 0.3 percentage point decrease in the annual rate of growth across US states. But only a third of that decline was due to reduced labour force growth. The rest reflected lower labour productivity growth (Maestas, Mullen & Powell 2023). The main impact of ageing was not fewer workers but less productive ones. That may be linked in part to declining entrepreneurship and innovation as populations age. Looking at the share of

8 OECD 'PISA 2018 Results' https://www.oecd.org/en/publications/2019/12/pisa-2018-results-volume-i_947e3529.html

the population that runs a wage-paying business across countries, a 3.5 year rise in the median age leads to a 2.5 percentage point decline in this entrepreneurship rate countries (Liang, Wang & Lazear 2018, 31).

Or look at the rate of invention: in 2020, China, the US, Japan, South Korea, and Germany accounted for 93% of resident patent applications worldwide.[9] The scope for greater research effort in these countries is limited, given their combined population aged 20–64 will be 184 million smaller in 2050 than it was in 2020.[10] But there is already a problem: despite rising numbers of researchers in these countries previously, it is taking ever larger teams to deliver innovation (Ahmadpoor & Jones 2019; Boeing, P., & Hünermund 2020;Miyagawa and Ilshikawa 2019).

There are numerous examples of more researchers producing less in the way of productivity gains, from computing to agriculture to pharmaceuticals. R&D budgets of US pharmaceutical firms increased ninefold 1970–2014, but the return on that spending fell by a factor of five, as measured by the return in new molecular entities approved as drugs (Bloom et al. 2020:1123). More broadly, long-term patterns of total factor productivity change suggest slower growth rates over time (Philippon 2022).

In part this may be simply that ideas are becoming harder to find, requiring teams of researchers and all the associated costs of large-scale collaboration. But it may also reflect that research is increasingly dominated by older, less productive researchers. Studies of research and innovation output point to productivity peaks in the 30s and 40s. For example, a dataset of the ages of 1.2 million US resident inventors patenting between 1976 and 2017 suggests that patenting rates peak around the early 40s (Jones, Reedy & Weinberg 2014). And yet, looking at the US National Institutes of Health research grants budget of about $30 billion annually, the average age at first grant award increased from 34 to 44 years old between 1970 and 2014 (Faherty 2022).

There are certainly domestic fixes that can improve levels of both entrepreneurship and innovation – not least equalising the opportunities to participate. The proportion of US patents including at least one woman inventor was still only 19% in 2020 (Toole et. al. 2020). Race and class are also very significant factors. Children from high-income (top 1%) families are 10 times as likely to become inventors as those from below median income families, and the gap is not explained by test scores (Bell et al. 2019; Cook 2019). But with stagnating populations and human capital, these fixes will be temporary in terms of extending productivity growth.

Implications for global trade and development

The trends in relation to ageing, peak education, services, and declining innovation are all most advanced in richer countries, but they have significant implications for global trade and development, perhaps especially in relation to the dominant historical model for rapid income convergence with industrialised countries. Across developing countries, manufacturing

9 World Bank World Development Indicators Patent Applications, Residents (IP.PAT.RESD) https://data.worldbank.org/indicator/IP.PAT.RESD. Patenting is a problematic measure of innovation activity, especially because it is easier to patent in manufacturing than in services, as a rule. However, as noted in the text, other measures, including total factor productivity, point in a similar direction.

10 Author's calculation from 2022 UN population projections, medium variant, accessed 19 July 2022 https://population.un.org/wpp/Download/Standard/Population/

employment climbed from below 10% to closer to 15% between 1970 and 2020, recently driven by employment growth in China. And manufacturing export–led growth was the secret to many 'East Asian miracle' countries reaching high-income status. But even in China, manufacturing employment has peaked. Although automation is not associated with job losses in rich countries, it may be acting as a substitute for labour-intensive offshored production in lower-wage economies (Artuc, Christiaensen & Winkler 2019). And declining demand for manufactures in ageing countries will exacerbate that impact. If current trends continue in the forces determining manufacturing employment, there might be about 65 million fewer people working in manufacturing worldwide in 2050 than today (Webster, Kenny & Dissanayake 2023).

Meanwhile, services trade is growing worldwide, climbing from 10% to 14% of global GDP in the years 2003–23.[11] Furthermore, the population of developing countries is far more educated than in the past (and far more educated than was the population of now-rich countries when they had a similar income per capita), suggesting a considerable stock of human capital to fuel services exports. And there are cases where this has translated into significant trade flows: Bangalore is a major centre for IT services exports, for example.

But while services' exports are growing, the sector remains significantly less traded than agriculture and industry, and we should be cautious in expecting revolutionary change. A widely cited 2007 estimate suggested that more than a quarter of US jobs could be offshored. Ten years later, there was no relationship between estimated offshoring risk at the occupation level and US domestic job growth in those occupations. Although more jobs were done at a distance, they were still overwhelmingly done within the US (Ozimek 2019). In addition, forecasts for job growth in rich countries are in sectors such as healthcare, home care, education, construction, cleaning, and food preparation. These jobs are very difficult to outsource.[12] As much to the point, the trade balance in services sees rich countries in surplus: developing countries are net importers.[13]

Future scenarios and the role of migration

There could be as many as 30 million additional working-age migrants from sub-Saharan Africa to high-income countries between now and 2050 under a business-as-usual scenario...

Overall, there are considerable headwinds for global growth and development over the next 30 years. Using demographic, climate, and education forecasts to predict economic growth, based on the past relationship between these variables, suggests slowing growth especially in rich countries (potentially below 1% a year for the US) and potentially weakened rates of convergence worldwide to 2050 (Kenny & Gehan 2023).

But these are forecasts based on business as usual, and global policy change could significantly alter these outcomes. This is because still-expanding working-age populations in low-income and lower middle-income countries where education rates are rising could fill the jobs that need doing in richer countries. In South Korea, for example, the forecast decline in the working-age population could reduce per capita income growth over the next half century by 1% per annum, suggesting negative rates of GDP growth by 2050. Yet an increase in the migrant worker population from about 3% of workers to about 15% over the next 40 years would offset most of that growth impact (Clemens 2024). In addition, young, increasingly

11 Our World in Data 'Trade in Services' https://ourworldindata.org/grapher/service-exports-and-imports-gdp
12 US BLS Occupational Outlook Handbook https://www.bls.gov/ooh/ (2020 edition).
13 World Bank 'Databank' https://data.worldbank.org/indicator/TG.VAL.TOTL.GD.ZS, BG.GSR.NFSV.GD.ZS

educated immigrants could sustain growth in the stock of human capital, as well as leading on continued innovation and entrepreneurship. In the 2000s, a 35-year-old educated Nigerian with a job in the US was paid 15 times as much as a similarly educated Nigerian working in Nigeria (Clemens 2011). There could be as many as 30 million additional working-age migrants from sub-Saharan Africa to high-income countries between now and 2050 under a business-as-usual scenario, with opportunities for as many as three times that number in a world seeking more migration (Kenny & Yang 2021). Remittances to sub-Saharan Africa under that second scenario might equal nearly half a trillion dollars per year (Budiman & Connor 2019).

Global remittances were already worth US$839 billion in 2023, and remittance payments doubled their share of global GDP in the first two decades of the 21st century.[14] But evidence from sending countries suggests this is a significant undercount of the total benefit of emigration for those left behind – perhaps as little as a fifth of the total. Much of the rest is accounted for by the increases in education that migration options encourage and support (Khanna et al. 2022). Migration, then, will help ensure the continued increase of global human capital stocks – and it is also associated with significantly stronger trade, investment, and knowledge flows between countries.[15]

In addition, reducing inequality in the opportunity to innovate across countries could help sustain productivity growth. Poor children from low-income countries are many orders of magnitude less likely to become inventors or global entrepreneurs than rich children in high-income countries, and emigration can help reduce that gap (Kenny & O'Donnell 2017). Migrant inventors account for more than 10% of inventors worldwide, and they are about a third more productive after migrating. Immigrants represent less than 14 per cent of the US population, 16 per cent of all US inventors, and 23 per cent of innovation output as measured by patents and patent citations (Bernstein et al. 2022). Between 1995 and 2005, more than half of Silicon Valley's technology and engineering companies were founded by immigrants (Azoulay et al. 2022; Kerr & Kerr 2020).

Estimates of the global efficiency gains of removing barriers to the international movement of people range from 67% to 148% of global GDP (Clemens 2011). This alone would be significant enough to sustain strong global growth and convergence for decades, and that does not account for impacts on innovation.

The migration challenge

This makes support for ramping up the movement of people an important global priority. But under UN business-as-usual scenarios, there is insufficient movement. Immigration is predicted to add about 27 million to the working-age population of the US between 2020 and 2050 – compared with the need for 42 million more workers to keep the dependency ratio in the US the same as it is today. For the European Union, the numbers are 17 million working-age migrants compared with a need for 61 million (Kenny & Yang 2021).

This is not simply a case of opening borders. Free movement of people within the EU, for example, increased the stock of migrants in the region by only 0.5% of the total population. It

14 World Bank 'Databank' https://data.worldbank.org/indicator/BX.TRF.PWKR.CD.DT; https://data.worldbank.org/indicator/BX.TRF.PWKR.DT.GD.ZS

15 Migration may be a force for greater global equality, but what about within countries? The evidence is mixed, but the usual short-term impact on wages for those born in destination countries is around zero. The impact on inequality in origin countries tends to be negative in the case of small emigration flows and positive in the case of larger emigration flows (Koczan et al. 2021).

appears that movers needed an average of about US$30,000 more a year in pay to make it worthwhile (Rodríguez-Puello et al. 2024).

Worldwide, the relationship between emigrants as a percentage of sending country populations and GNI per capita is positive at low incomes but reverses at about US$10,000. Well over half the world's population lives in countries with a GDP per capita over $10,000 – and that may exceed three quarters in the next 20 years. In the absence of active pro-migration policies, we may be approaching the global peak emigration rate (Kenny & Yang 2021).

This suggests the need for global agreements that ensure a triple win – for sending countries, recipient countries, and migrants themselves. Luckily, this has already begun. There were more than 1,219 separate bilateral labour agreements signed between 1945 and 2020, with about half of these signed since 2000. Germany and Kenya recently signed an agreement around skilled migration in areas including information technology. In 2024, Germany also offered tax breaks to select skilled migrants. Countries are allowing foreign students and family members of visa holders to work, providing more support for language and skills training and help with housing. Some host countries are paying for flights and relocation costs, or simply paying people cash on arrival. The mayor of Helsinki proposed making English the official language of the city to attract immigrants (Chilton & Woda 2022; Kenny 2023).

Countries are allowing foreign students and family members of visa holders to work, providing more support for language and skills training and help with housing.

The political economy of migration

That said, the last few years have demonstrated that immigration can be used as an issue to rally support behind populists and the far right. Fears of irregular migration – by small boats or smuggling across the Rio Grande, for example – raise demands for 'taking back control' and can delegitimise the concept of 'refugee' or 'asylum seeker' as deserving of assistance (Findor et al. 2021).

Nonetheless, this is not a necessary consequence of increased immigration: indeed, the average relationship across countries suggests the link between local immigration flows and the vote share of anti-immigrant parties is zero (Cools, Finseraas & Rogeberg 2021). Meanwhile, attitudes towards accepting particular classes of migrant workers (e.g., nurses, agricultural workers) tend to be considerably more positive than towards migration in general (Kustov 2025). And immigration reforms towards more open borders (which tend to focus on legal migration to fill recognised gaps in local labour markets) do not create increased support for populist parties (Kustov 2023). There is political space for increased legal migration even in times of populism.

To reduce any risk of backlash and ensure local communities benefit from hosting new arrivals, immigration flows should be accompanied by additional support for housing and services provision, as well as reskilling opportunities. All else being equal, migration arrivals are associated with rental and housing price increases (Gonzalez & Ortega 2013; Saiz 2007). That said, other factors dominate in determining long-term trends in housing costs, including regulation of density and multi-family dwellings (Molloy 2020). Regulatory reform alongside public investment in new housing should allow housing markets to adapt to larger migration inflows, especially in periods of flat or declining demand for housing from those born in the country, related to slow or negative population growth.

With regard to public provision of services, including health and education, if these are provided by local governments there is a role for central government to assist with adaptation to demand – given national demographic and migration trends, as well as the arrival of

international migrants. In the case of health, migrants themselves are an increasingly important part of service provision in many wealthy countries, suggesting that greater flows should reduce supply constraints, all else being equal (Lafortune et al 2019). And, although overall demand for health services continues to rise in richer countries as populations age, the same is not true of demand for education services, which is peaking in line with child populations. In the US, for example, total undergraduate enrolment in degree-granting post-secondary institutions fell from 18.1 million in 2010 to 15.8 million in 2023. At primary and secondary level, enrolments peaked in 2017.[16] Migrant families might help fill this gap, rather than creating competition for places.

Turning to reskilling, while migrants should primarily be filling worker shortages (on a net basis), this does not mean that immigration will not lead to changing employment opportunities for non-migrants. The overall picture tends to be that immigration (especially unskilled immigration) is usually accompanied by non-migrant workers moving into jobs that require less manual labour and more communication, often with better pay (Sebastian & Ulceluse 2019). While this is broadly beneficial, greater support for training programmes that help workers respond to employment shifts caused by technological, demographic, or other trends may additionally ease the transition for workers in areas seeing an immigration inflow.

...if education systems can respond to growing opportunities for skilled workers to emigrate, the result can be a greater domestic skills base along with a growing diaspora providing remittances.

On the sending side, fears of brain drain are common, but actual evidence of harm is less so (Clemens 2016). In particular, if education systems can respond to growing opportunities for skilled workers to emigrate, the result can be a greater domestic skills base along with a growing diaspora providing remittances. The Philippines provides a case study in the area of healthcare professionals: there are 300,000 Philippine registered nurses working abroad. But the Philippines still has a lot more nurses working domestically than would be expected given its income. The option to migrate has encouraged more people to go to nursing school (Kenny 2023).

To help ensure the triple win of migration – to migrants, receiving countries, and sending countries – global skills partnerships are designed to increase skills availability in both origin and destination countries, by sharing the costs of training and skills development between governments and firms in receiving countries and sending countries, and by guaranteeing more people are trained by such programmes than ultimately migrate under the scheme. The Philippines has set up such a programme with Germany to cover nursing migration.

In short, the economic challenges presented by migration to subsets of the population in both receiving and sending countries can be addressed through policies that allow markets, communities, and individuals to respond flexibly to shifting opportunities of whatever kind – including technological and demographic shifts. And the overall economic and fiscal benefits of migration are considerably larger than any costs incurred through those adaptation policies applying to migration-related challenges (Clemens 2022).

Peak education and peak working-age population will likely be global phenomena by century's end. The global shift to services and a declining desire to migrate will slow growth everywhere. But the world can see decades more rapid progress if people continue to move, and move in greater numbers. The real and growing migration crisis is that there are not enough migrants. Fixing the political economy of migration will be the central determinant of the course of the global economy over the next half century.

16 National Center for Education Statistics Digest of Education Statistics Table 303.70 and Table 105.30 https://nces.ed.gov/fastfacts/display.asp?id=98 https://nces.ed.gov/programs/digest/d22/tables/dt22_105.30.asp

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The EU's new industrial strategy and global disorder

Scott Lavery, University of Glasgow

Abstract

The fear that Europe might 'fall behind' rival economic powers has long shaped European integration. In the present phase of global disorder, this fear has intensified. Policymakers warn that the EU, pincered between an interventionist US and China, risks losing ground in the race for technological leadership. A new EU industrial strategy – marked by relaxed competition rules and targeted subsidies – has taken shape in this context. This paper focuses on how four historical factors – the aftermath of the 2008 financial crisis, the rise of China, the Covid-19 pandemic, and successive protectionist US interventions – combined to generate a break with past economic policy practice in Europe. However, as the case of semiconductors shows, attempts by EU policymakers to shore up European 'strategic autonomy' also generate new internal dilemmas, deepening existing tensions within Europe's political economy.

Introduction

In his landmark 2024 report, The Future of European Competitiveness, Mario Draghi, former president of the European Central Bank, sounded the alarm. Due to its 'static industrial structure', Draghi warned, the European economy faces a formidable 'existential challenge' (Draghi 2024: 5-6). Since 2000, real disposable income has grown by almost twice as much in the US as compared to Europe. While US firms dominate the high end of the technological frontier, 'only four of the world's top 50 tech companies are European' (ibid). At the same time, 'China's state-sponsored competition … represents a threat to our productive clean tech and automotive industries' (Draghi 2024: 7). In 2002, China competed directly with euro-area exporters in 25 per cent of sectors, yet today that figure has reached 40 per cent. Draghi warned that, caught between the US and China, 'the EU's competitiveness is currently being squeezed from two sides' (Draghi 2024: 5).

The themes highlighted by the Draghi report – of a Europe caught between two economic great powers and in need of fundamental reform – are not new. Throughout the post-war era, the 'fear of falling behind' was a key motivating factor driving further European integration (Seidl & Schmitz 2024). In the 1960s, rising levels of US Foreign Direct Investment (FDI) sparked fears of a US takeover of European industry, resulting in a range of economic reforms designed to shore up European leadership in key industrial sectors (Warlouzet 2017). In the 1980s, increasing competition from Japanese manufacturers and an appreciating US dollar motivated moves towards the formation of the single market, designed to create a new platform through which European firms could compete on the world stage (Sandholtz & Zysman 1989). During the high tide of globalisation in the 1990s and 2000s, European elites, including political leaders at the member-state and Commission levels, warned that the EU would only catch up with other powers at the leading edge of the 'knowledge economy' – most notably the United States – if it embarked on a programme of far-reaching labour market reform outlined in the Lisbon agenda (Solbes 2003).

The context within which the EU finds itself today differs in important respects from these past episodes. These previous initiatives took shape in the context of a deeper, structural framework of global order underpinned by the geopolitical and economic power of the US (Panitch & Gindin, 2013). European leaders engaged constructively in US attempts to contain the Soviet Union and opened their economies to US exports and investments. EU elites wagered that this 'alignment' to the geopolitical and economic power of Washington would

The ongoing rise of China and other middle powers, coupled with the withdrawal of the US from its traditional leadership role, have eroded the foundations of the global order within which earlier phases of European integration took shape.

serve to carve out a sphere of relative European autonomy on the world stage (Lavery & Schmid 2021). In the present context, this framework has been thrown into disarray (Thompson 2022). The ongoing rise of China and other middle powers, coupled with the withdrawal of the US from its traditional leadership role, have eroded the foundations of the global order within which earlier phases of European integration took shape.

What do the uncertainties generated by this new global disorder mean for the future of the European economy? The stock answer from European Commission officials and other elites is that the EU needs to enhance its 'strategic autonomy' on the world stage. Originating in the defence sector in the 2010s, this concept has spilled over to encompass a wide range of domains, including trade policy, energy, external relations, law, and industrial strategy (Lavery, McDaniel & Schmid 2022). As the European Commission's New Industrial Strategy for Europe (2020) puts it:

> Europe's strategic autonomy is about reducing dependence on others for things we need the most: critical materials and technologies, food, infrastructure, security and other strategic areas … [which] provide Europe's industry with an opportunity to develop its own markets, products and services which boost competitiveness (European Commission 2020: 13).

This 'strategic autonomy' agenda crystallises most strongly in the sphere of industrial strategy. In the European Industrial Renaissance (2014), the European Commission declared that it would aim to effectively end the deindustrialisation of the EU, seeking to increase the share of the manufacturing sector as a proportion of EU GDP to 20 per cent by 2020 (European Commission 2014). This ambition has been followed by a series of concrete policy initiatives aimed at supporting key strategic sectors – in particular, hydrogen, electric vehicles, semiconductors, cloud computing, and batteries. A wide range of tools has been deployed in pursuit of this objective, including the targeted expansion of subsidies, the relaxation of key elements of EU competition law, and the creation of new funds designed to 'crowd in' private investment into key strategic sectors (Wigger 2023). While these 'new industrial strategy' instruments are complex and multifaceted, at their core lies an underlying logic that marks a break from recent economic policymaking orthodoxy (McNamara 2024). Reshoring manufacturing capacity, minimising strategic dependencies on third countries, bolstering state support for key strategic sectors, securing operational autonomy from Washington – a little over a decade ago these ambitions would have been dismissed as relics of a bygone era. Now, they are mainstream.

What have been the main drivers of these changes? To answer this question, we need to contextualise the relationship between European integration and global order historically. The first section of this discussion paper shows that the 'fear of falling behind' rival economic blocs has been a consistent driver of European integration throughout the post-war era. However, the contemporary emergence of a new EU industrial policy is taking shape under a novel set of international conditions. The second section of this paper outlines how a number of shifts over the past decade – the legacies of the 2008 crash and the eurozone crisis, the ongoing rise of China, the Covid-19 pandemic, and the interventionism of successive US administrations – have combined to generate momentum towards a new EU industrial policy. In this novel context of global disorder, EU elites are being driven to embrace a plethora of instruments that ostensibly break from the market-oriented strategies that dominated since the end of the Cold War. However, whether this new industrial strategy will address the EU's 'fear of falling behind' rival economic blocs remains unclear. The third section of the paper engages with one sector where the new EU industrial policy has taken shape concretely – the semiconductor sector –

and argues that the new EU interventionism in this sphere generates a series of novel dilemmas from an EU policymaking perspective.

Fear of falling behind: European industry and changing patterns of global order

The fear that European industry might 'fall behind' rival power blocs was a recurrent theme of European integration throughout the post-war era (Seidl & Schmitz 2024). These fears were famously expressed in the 1960s, at the height of the Fordist 'boom', as outlined in Jean-Jacques Servan-Schreiber's The American Challenge (1967). Servan-Schreiber – editor of Le Monde, associate of Jean Monnet and Konrad Adenauer, and minister within the first Chirac government – noted that US monopolies, with greater access to capital, superior management techniques, and access to a large home market, systematically outperformed their European counterparts (Servan-Schreiber 1967). The problem was that these US giants now threatened to take over strategically significant elements of the European industrial base, transferring control of the commanding heights of the European economy across the Atlantic. While, in 1950, one seventh of total US investments abroad went to Europe, by 1970 this had grown to over a third (Lundestad 1998: 113). US dollars flooded into technologically sophisticated and high-productivity sectors, including electrical goods, automotives, petrochemicals, and computing (Poulantzas 1974: 152). While increased FDI from US firms appeared to bolster efforts at Western European reconstruction, critics such as Servan-Schreiber warned that this process was effectively handing control of European industry to American boardrooms. Three giant American firms together accounted for 40 per cent of direct investment in Germany, France, and Britain (Servan-Schreiber 1967: 51). For Servan-Schreiber, what was needed was a sustained pan-European effort to 'catch up' with the US, coordinated at the supranational level. In a US-led global order, enhanced European integration would be critical to carving out a degree of relative European autonomy on the world stage (Lavery & Schmid 2021).

The problem was that these US giants now threatened to take over strategically significant elements of the European industrial base, transferring control of the commanding heights of the European economy across the Atlantic.

The fear of falling behind emerged again in the 1970s and 1980s, as the US-led global order underwent new transformations (Coates 2018). The oil crises of the 1970s and the US abandonment of the Bretton Woods system threatened to undermine the delicate social contract upon which post-war European reconstruction had been established. In a system of floating exchange rates, new patterns of turbulence gripped European monetary and financial markets, as European leaders sought to shore up their ailing economies with reflationary fiscal policies and successive devaluations (Warlouzet 2017). The result was the generation of new barriers to trade within and outside Europe and the proliferation of 'new protectionist' instruments by key European states. At the same time, the rise of Japan as a manufacturing powerhouse threatened to displace European firms as leaders in key technologies, particularly in the sphere of microelectronics (Sandholtz & Zysman 1989). In response, European elites advanced a new programme to unify Europe into a single market, committing all member states to the removal of tariff and non-tariff barriers. The single market programme, culminating in the 1992 Maastricht Treaty, increased cross-border trade and financial integration within the EU and exposed EU producers to intensified patterns of international competition (Jabko 2017). EU elites hoped that this new, enhanced framework of European integration would force European firms to become more competitive, providing a launchpad upon which future European champions could compete on the world stage.

For EU elites, the challenge was to ensure that EU economic governance equipped member states to compete within this globalised economic context.

By the 1990s and 2000s, the launch and development of the single market took shape in a global order in a period of transition. The collapse of the Soviet Union had given rise to a new system, with the US as the undisputed unipolar power at its heart. It was in this context that a high tide of 'globalisation theory' took shape (Rosenberg 2002). For globalisation theorists, the rise of an increasingly interconnected world economy – characterised by integrated supply chains and footloose, mobile capital – fundamentally challenged the sovereignty of national governments. As the world economy globalised, the governance of that economy would increasingly be transferred to the transnational scale. In this sense, the postnational character of the EU seemed to anticipate the future of global capitalism (Habermas 2012). For EU elites, the challenge was to ensure that EU economic governance equipped member states to compete within this globalised economic context. The strict debt and deficit rules of the Maastricht criteria would guard the fiscal credibility of the eurozone; supply-side investments in R&D and labour market reforms (as promised by the Lisbon agenda) would underpin Europe's 'knowledge economy'; and continued removal of non-tariff barriers within Europe and a steady liberalisation of trade internationally would further underpin the competitiveness of EU firms. By the mid-2000s, the prevailing wisdom of EU elites was that the EU was well equipped to deal with the challenges of a globalising world. In the following years, however, this sanguine assessment would come under immense pressure.

The EU's new industrial strategy in an age of global disorder

Over the past 15 years, the EU's 'fear of falling behind' rival economic blocs has re-emerged, but in a new form and under new international conditions. A number of external structural shifts within the world economy – the legacies of 2008, the ongoing rise of China, the impact of the Covid-19 pandemic, and the interventionism of successive US administrations – have fundamentally reconfigured the context within which European integration takes place (Lavery 2024). As Barry Buzan and George Lawson argue, global order since the 19th century had been fundamentally 'centred' around a core nexus of Western states – particularly the US and Western Europe (Buzan & Lawson 2015). However, over recent years, this framework has been increasingly 'decentred' by the rapid ascent of non-Western states such as China and Japan, as well as the increasing withdrawal of the US from its traditional role of international leadership (Hopewell 2025). These dual processes underpin the contemporary period of global disorder, and the emergence of the EU's new industrial strategy has taken place against this wider backdrop. To account for the interactions between these 'external' shifts and 'internal' reconfigurations, it is necessary to identify how key moments in the development of the current global disorder were mediated by the EU institutions, laying the foundations for the new EU industrial strategy that has taken form today.

The pivotal moment in the emergence of the new global disorder was the 2008 global financial crisis, which embodied the greatest shock to the world economy since the Great Depression. In the immediate aftermath of the crash, EU leaders were quick to blame the crisis on 'Anglo-American' excess (Tooze 2018). Nicolas Sarkozy (then French President) proclaimed that the crisis spelled the end for untrammelled laissez-faire capitalism (MercoPress 2008), while José Manuel Barroso claimed that 'the crisis was not originated [sic] in Europe … this crisis originated in North America and much of our financial sector was contaminated by… unorthodox practices' (BBC 2012). These assertions conveniently ignored the deep entanglements between European and US banking systems which had taken shape during the globalisation

of the 1990s and 2000s (Tooze 2018). By 2008, domestically owned European banks had $5 trillion of claims on US assets (Thompson 2016: 221). As a result, European financial institutions were highly exposed to the dollar liquidity shortage that took root in the aftermath of the crash (Tooze 2018). Fearing a global crisis of the financial system, the Federal Reserve stepped in as a lender of last resort, extending up to $310 billion in 'swap lines' to the European Central Bank and the Bank of England (Helleiner 2015).

The 2008 crisis and its aftermath form the critical background conditions which drove the shift towards a new EU industrial strategy. In the 1990s and 2000s, EU officials had argued that the formation of the euro, backed by an independent central bank and tight fiscal rules, would support the development of a more autonomous European economic model capable of challenging the US dollar. However, 2008 revealed that the European banking system remained structurally subordinate to oscillations on Wall Street and highly dependent on the Federal Reserve as a lender of last resort.

Crucially, the long tail of 2008 generated an extended deflationary period which, in the context of the eurozone crisis, bolstered calls for a new EU industrial strategy. Tight fiscal constraints – entrenched by the European Semester process – sapped demand from the EU economy and compounded low levels of private and public investment. Countries on the eurozone's southern periphery experienced falling industrial output and a shedding of manufacturing employment. It was in this context that the European Commission launched the European Industrial Renaissance paper (2014), which sought to respond to the deflationary context of the eurozone crisis via a blueprint for a new EU industrial strategy. As the Commission noted at the time, 'the legacy of the crisis is severe: since 2008, 3.5 million jobs have been lost in manufacturing; the share of manufacturing in GDP has fallen … and the EU's productivity performance continues deteriorating in comparison to that of our competitors' (European Commission 2014: 2). In this context, the European Commission, under president Jean-Claude Juncker, launched the European Fund for Strategic Investments (EFSI), which deployed the EU budget as a guarantee to 'de-risk' private investments in key strategic sectors. The 'Juncker fund' formula of derisking private finance would form a key plank of the EU's industrial strategy over the following decade (Gabor 2023).

China surpassed the US as the world's leading recipient of FDI, became the leading source of merchandise trade, and accounted for over a third of global growth in the wake of the crash.

The second driver of the new EU industrial strategy was the ongoing rise of China, and its rapid penetration, throughout the post-crisis period, of global export markets for higher value-added products. In solar photovoltaic technology, for example, China moved from zero production capacity in the early 2000s to dominating over 70 per cent of the global production market by 2017 (Wen et al., 2021). In the wake of the 2008 crash, Beijing implemented a gargantuan $600 billion post-crisis stimulus package, which consolidated China's position as a key reservoir of global demand (Tooze 2018). China surpassed the US as the world's leading recipient of FDI, became the leading source of merchandise trade, and accounted for over a third of global growth in the wake of the crash. China's rapid ascent had significant implications for the EU. The $4.5 billion acquisition of Kuka – a German-based robotics firm – in 2016, by the Chinese firm Midea, came to symbolise the increased presence of Chinese investments in Germany. Concern intensified when China invested $70 billion in high-tech European firms in the first six months of 2016, more than in the previous three years combined. This led to rising concerns that Chinese firms were engaged in processes of hostile technology transfer from Germany's nascent technological leaders. Faced with an influx of Chinese investment into its key innovative sectors, German industry broke with its traditionally accommodative stance to Beijing. In 2019 the Federation of German Industries (BDI), erstwhile advocate of openness to Asia, described China's state-dominated economy as a 'systemic rival' to German and European industry.

The pivot from an accommodative to a more defensive China strategy crystallised over the subsequent years. In 2017, the German, French, and Italian governments called for action at the EU level to limit hostile foreign investments from non-EU countries, culminating in the FDI screening mechanism which sought to limit hostile takeovers of critical infrastructure. In 2019, Peter Altmaier, then Germany's minister for economic affairs and energy, signed a Franco-German manifesto on industrial policy with Bruno Le Maire, then French finance minister (BMWI and MEF 2019). The manifesto noted that European firms were competing with international rivals that were often heavily state subsidised, recommending an overhaul of European competition law to facilitate larger mergers and acquisitions between European firms. Screening 'hostile' foreign investments, relaxing the EU's erstwhile robust competition law whilst promoting the development of 'pan-European industrial champions' now took shape as further elements in the EU's new industrial strategy (Lavery 2024).

Shortages of critical inputs and inflationary spikes that took place during Covid-19 revealed the extent to which EU industry was vulnerable to supply chain disruptions, particularly in key strategic segments such as critical raw materials, lithium-ion batteries, semiconductors, hydrogen, and cloud computing.

The third driver of the new EU industrial strategy formed in the context of the Covid-19 pandemic. Shortages of critical inputs and inflationary spikes that took place during Covid-19 revealed the extent to which EU industry was vulnerable to supply chain disruptions, particularly in key strategic segments such as critical raw materials, lithium-ion batteries, semiconductors, hydrogen, and cloud computing. In the 1990s and 2000s, prevailing policymaking wisdom held that globalised supply chains would reduce costs and maximise efficiencies; yet, by the 2020s, the vulnerabilities that this might introduce had taken centre stage. In terms of the new EU industrial strategy, this prompted the European Commission to initiate an extensive report into 137 products that embodied 'strategic dependencies' for European industry (European Commission 2022a). A range of related initiatives aimed to bolster the resilience of EU supply chains, including the Action Plan on Critical Raw Materials (European Commissio, 2020b), the European Battery Alliance (European Commission 2025), and ongoing support for Important Projects of Common European Interest (IPCEIs) in key sectors, including hydrogen, semiconductors, cloud computing, and batteries.

The fourth driver of the new EU industrial strategy was the proactive industrial policy pursued by the Biden administration. The $370 billion Inflation Reduction Act (IRA) and the $57 billion Chips and Sciences Act together utilised a range of mechanisms – including subsidies, local content requirements, and additional support for R&D – which aimed to crowd in private investment into key US sectors and thereby 'reshore' manufacturing jobs. The EU felt compelled to react, with President Ursula von der Leyen stating the European Commission's intention in 2021 to develop an equivalent EU Chips Act, which came into force in September 2023. Other initiatives from this period, including the Net Zero Industry Act (NZIA), aimed to bolster European competitiveness in clean technology, directly in response to the subsidies that Biden channelled to the renewable energy sector in the US. In this sense, a key strand of the new EU industrial strategy – the drive to support strategic, green technologies – developed in combination with equivalent interventions on the other side of the Atlantic.

The EU's semiconductor sector: drivers and limits of the EU's new industrial strategy

The new EU industrial strategy encompasses a wide range of sectors, legislative instruments, and policy priorities. Despite this complexity, it is possible to identify a consistent set of

principles that underpin this new paradigm in EU economic policymaking. These include: (i) bolstering state support for key strategic sectors; (ii) minimising dependencies on third countries for key critical raw materials and technologies; and (iii) reshoring manufacturing capacity. Taken together, the EU hopes that these new policy orientations can propel Europe into a new phase of 'strategic autonomy', preventing the EU from 'falling behind' other economic blocs, particularly the US and China.

To what extent has this new approach been successful? The semiconductor or 'chips' sector has been a central focus of new EU industrial strategy. The following section traces the development of the EU's semiconductor strategy, identifying the ways in which the principles of state support for strategic sectors, supply chain resilience, and reshoring have been articulated in this policy area. The analysis suggests that, while the EU's semiconductor strategy ostensibly attempts to shore up key segments of EU industry within global supply chains, its current form generates new dilemmas from an EU policymaking perspective.

The EU's entanglement in the 'chip wars'

Since 2016, the semiconductor industry has become a key site of conflict between states and a prominent symptom of emerging patterns of global disorder (Miller 2023). Semiconductors – tiny microelectronic chips – form the material infrastructure that underpins all modern forms of digitalisation and computing. Smartphones, cars, artificial intelligence, data centres, modern weapons systems, home appliances, and telecommunications networks are all reliant upon this technology. In the 1990s and 2000s, semiconductors were viewed as a globalised industry par excellence, drawing together intellectual property in Silicon Valley, chip design in the UK, chemical processing in Japan and Germany, machine tool manufacture in the Netherlands, high-end chip fabrication in Taiwan, and the back-end integration of components in Vietnam and Malaysia. However, over the past decade, this industry has become increasingly 'weaponised' in the context of the US–China conflict over technological supremacy (Farrell & Newman 2019).

There are two principal ways in which the EU has become entangled in the battle over semiconductors. The first relates to the question of export controls. In July 2018, during his first term as US president, Donald Trump announced a 25 per cent tariff on Chinese chip imports (Bown 2020). The Biden administration subsequently strengthened export controls that aimed to prevent US firms and third countries such as Taiwan and Korea from exporting critical components to China (Allen 2024). US export controls under both administrations fed through directly to European firms and the EU more widely. The Netherlands is the base of ASML, a machine tools company that specialises in extreme and deep ultra-lithography equipment, which is critical to the manufacture of high-end semiconductors. In 2018, the Dutch government approved an export licence for ASML to sell extreme ultra-violet (EUV) lithography machines to Beijing. In response, the US authorities opened bilateral meetings and exerted extreme diplomatic pressure on the Dutch government. By July 2020, the Dutch government complied with US demands, revoking ASML's China export licence. In January 2023, the Dutch government signed a further agreement with the US to curb the Dutch export of key semiconductor manufacturing technologies to Beijing.

The second source of EU entanglement in the wider 'chip wars' took shape in 2021, in the wake of Covid-19. During the pandemic, demand for semiconductors shifted (Miller 2023). Industrial

firms such as automotive producers cut back on orders, while there was a surge of demand from the ICT sector as firms and households shifted towards remote working. As lockdown restrictions eased in mid-2021, and in a context of pent-up demand, automotive and other sectors began to place high levels of chip orders. At the same time, US export controls had led China to stockpile large numbers of chips. The result was a 'chip choke' – a severe constraint on semiconductor supply to the world economy, contributing to wider supply shortages and generating further inflationary pressure.

The semiconductor shortage severely affected the EU economy. High demand for chips led to a doubling of order times from 10 to 20 weeks. This had a spillover effect on key EU sectors where demand for semiconductors is highest, including automotives, communications, healthcare, and consumer electronics. Automotive production fell amidst supply chain shortages (European Commission 2021: 9). Eric-Mark Huitema, director general of the European Automobile Manufacturers' Association, reflected his industry's concerns about the 'chip choke' when he stated that the EU faces 'an acute supply chain issue with severe and immediate consequences for the European auto sector', advocating for a 'strategic plan to increase the production of semiconductors in the EU' (ACEA 2020). The spillover of semiconductor shortages into automotives and other key sectors presented a key challenge for EU policymakers, such that establishing 'security of supply' by reshoring productive capacity became a key focus for EU officials in the subsequent period.

The EU's semiconductor strategy

The EU's headline response to US–China semiconductor rivalry culminated in the 2022 'A Chips Act for Europe' (European Commission 2022b). Guided by the ambition to achieve a 20 per cent share of global semiconductor production, this communication aimed to shore up the EU's strong R&D capacities while also, crucially, developing the EU's manufacturing capacity in this sector. Specifically, the strategy aimed to build up production of the most advanced chips (not currently manufactured in Europe at all) and thus turn the EU into an 'industrial leader' in this sector (European Commission 2022b: 3). To reshore chip manufacture, additional public support – from the EU budget and national budgets – is pledged to investments in manufacturing capacity.

In addition, the Chips Act offers a new legal basis on which subsidies awarded by member states to the construction of 'first-of-a-kind' production facilities in Europe may be deemed compatible with rules limiting state aid within the EU internal market. So far, under the aegis of the Chips Act, Italy has awarded €292.5 million to the construction of an industrial plant by STMicroelectronics (European Commission 2022c), France has awarded €7.4 billion to the construction of a joint mass production facility by STMicroelectronics and GlobalFoundries (European Commission 2023a), and Germany has channelled almost €10 billion in subsidies to Intel and €5 billion to TSMC for the construction of new chip manufacturing plants in the country (China Finance, 2024; Germany Trade & Invest, 2024). Moreover, these new individual state aid measures take place in conjunction with the development of an Important Project of Common European Interest in the field of microelectronics, involving €8.1 billion in state aid from 14 EU member states (Lavery & Lopes-Valenca 2025).

External convergence and internal divergence

The EU's industrial strategy in the sphere of semiconductors embodies a convergence with a wider global trend. However, this new industrial policy constellation produces new fissures within the fabric of the European economy. The various strands of the EU's semiconductor strategy – the creation of pan-European industrial clusters, the extension of state aid exemptions for member states, and the wider impetus of the Chips for EU Act to engender a reshoring of semiconductor production – compound pre-existing divergences at the heart of the European political economy. Firms and states with pre-existing advantages in the semiconductor supply chain and with fiscal resources at their disposal are well positioned to capitalise on this supranational policy shift, while firms and states that are not integrated into the supply chain find themselves potentially locked out from accessing new funding streams and state aid support.

As related research shows (Lavery & Lopes-Valenca 2025), the Important Project of Common European Interest on Microelectronics (IPCEI-ME) – one of the key components of the EU's subsidy regime for semiconductors, accounting for €30 billion total investment – has been characterised by a highly uneven distribution across EU member states. Germany alone accounts for 53.4 per cent of the total subsidies granted under this regime (ibid). Firms operating in other member states, such as Slovakia, Romania, and Malta, have also received disproportionately high levels of state aid when we adjust for the size of their economies. However, the national-level state aid data can obscure the direction of the state aid that is being granted. The firms participating in the Romanian IPCEI-ME, for example, are in fact domestic subsidiaries of foreign multinational corporations: Bosch (German), Continental (German), and NXP Semiconductors (Dutch). This suggests that the EU's new industrial policy in the sphere of semiconductors introduces new dilemmas for economic policymakers. As the EU mobilises to support its own industrial base, it does so at the risk of distorting the single market and reinforcing pre-existing divergences between Europe's export-led core and its southern and eastern periphery.

Conclusion: EU industrial strategy in a new global context

Over the past decade a new industrial strategy has taken shape across Europe. In one sense, this repeats patterns from the past. Throughout the post-war era, a 'fear of falling behind' rival economic blocs recurrently motivated European elites to embrace new forms of integration. However, the current context of global disorder is also distinct from past episodes. The legacies of the 2008 financial and eurozone crises, the ongoing rise of China, the aftermath of the Covid-19 pandemic, and the protectionism of successive US administrations embody a unique set of circumstances unparalleled during earlier phases of integration. Enhanced state support for strategic industries, minimising supply chain dependencies, and reshoring key strategic productive activities have returned to EU policymaking agendas but in a new form and under a novel set of international conditions.

The legacies of the 2008 financial and eurozone crises, the ongoing rise of China, the aftermath of the Covid-19 pandemic, and the protectionism of successive US administrations embody a unique set of circumstances unparalleled during earlier phases of integration.

What might this new era of global disorder and the return of EU industrial strategy mean from a policymaking perspective? Leaders at the EU and member-state levels must begin by

acknowledging the unprecedented character of the present moment and the novel challenges that it generates. Throughout its post-war history, European integration was profoundly shaped by the wider framework of US-led global order. Since the 1980s, EU policymakers wagered that liberalisation under the auspices of the single market would be enough to prevent the EU 'falling behind' the US and other major powers. The past decade of global disorder has shown that this approach is now failing. In place of a US-led liberal order, a more de-centred and multi-polar world has taken shape, marked by the proliferation of protectionist economic strategies between rival regional and economic blocs. The EU's long-standing commitment to liberal economic integration is now an outlier relative to the more muscular interventionist economic strategies pursued in the US, China and by other rising powers in the global south. The choice for Europe today is whether to embrace this new world of economic interventionism or to cleave to the EU's historic and fundamentally liberal international orientation.

The rise of the new EU industrial strategy is an important aspect of the EU's contemporary response to this challenge, but in its current form it is incomplete and riven with tensions. As we saw in relation to the case of semiconductors, EU policymakers have significantly relaxed competition policy to shore-up fabrication capacity and the resilience of European supply chains. However, as we have seen, this potentially threatens the integrity of the single market, as export-led member-states at the 'core' of the European economy disproportionately benefit from new subsidy regimes and consolidate their position at the heart of the EU economy. Balancing expanded support for the EU's industrial base whilst maintaining the cohesion and integrity of the single market is likely to form an enduring dilemma for EU policymakers over the coming decades. The stakes of getting the balance right between an embrace of the new protectionism and the continued economic integration of Europe could not be higher. 'Falling behind' may be one very real fear in an age of global disorder; the 'breaking apart' of the EU and its single market is quite another.

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