SEF DIALOGUES 2022

RETHINKING BOUNDARIES AND REVISITING BORDERS

CONDITIONS FOR INNOVATION, ENTREPRENEURSHIP AND ECONOMIC INTEGRATION IN AN INTERCONNECTED WORLD

Enrico Deiaco and Joakim Wernberg (Editors)

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Swedish Entrepreneurship Forum is an independent foundation and the leading network organization for initiating and communicating policy-relevant research on entrepreneurship, innovations and small businesses.

The foundation's activities are financed with public funds as well as by private research foundations, business and other interest organizations, companies and individual philanthropists.

Participating authors are responsible for problem formulation, choice of analysis model and conclusions in each chapter.

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PREFACE

Since 2009 Swedish Entrepreneurship Forum has arranged the annual meeting SEF - the Swedish Economic Forum. The purpose of SEF is to initiate and renew dialogue on important current policy issues that are critical to innovation, entrepreneurship and structural change. As basis for such dialogue, each year's meeting is accompanied by a novel research anthology.

This year SEF Dialogues examines how the conditions for future innovation, entrepreneurship and economic integration are being shaped by geopolitical power tensions. The struggles are spanning across the regulation of digital markets, rising cyber security threats, technical standardization as well as the transition towards sustainable energy sources.

The world today is characterized by increased global economic integration and digital interconnectivity which pave the way for geoeconomic shifts. Both actions of foreign states and the changing nature of international markets have brought new challenges to national sovereignty. Thus, we have seen legislators and policymakers push for the strengthening of borders as well as regulatory initiatives aimed at digital crossborder markets. However, disconnecting, disintegrating and decoupling undermine the foundations of innovation, entrepreneurship and structural change enabled by digital interconnectivity. This volume examines and provides several starting points for continued dialogues about how to move forward in an interconnected world.

Each contributing author in this volume provides a unique perspective but they all shed light on some aspect of how the balance between digital interconnectivity, boundaries for economic and social exchanges, and national borders is changing.

The contributing authors are Enrico Deiaco and Joakim Wernberg, Swedish Entrepreneurship Forum (editors), Richard Allan, House of Lords UK; Maryann P. Feldman, Arizona State University; Thijs Van de Graaf, Ghent University; Hal Varian, Google; Tim Rühlig, German Council on Foreign Relations; and Jacquelyn Schneider, Stanford University. The authors take full responsibility for the analysis and recommendations in their respective chapters.

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Anders Broström, PhD
Managing Director Swedish Entrepreneurship Forum

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ABOUT THE AUTHORS

This collection of essays is not intended to provide all the answers, but to raise issues and frame problems that deserve and require further elaboration and debate. We are excited and humbled to have gathered a group of leading thinkers from the intersection between academia, business and politics. Each of the authors shed light on issues they hold key insights into, and together they provide an intriguing entry to further discussions about connectivity, shifting boundaries, and the new role of borders in the 21st century.

RICHARD ALLAN

Richard Allan has spent one half of his career in politics and the other half working in internet businesses. He reached senior positions in both fields becoming a national legislator in the UK and a senior executive at Facebook. He regularly speaks and writes on a wide range of technology policy issues through his regulate.tech blog and podcast. He explores how the balance between economic and political forces shaped the internet's growth but may also come to splinter it in the future in his chapter titled *Gearing up for the Splinternet*.

MARYANN P. FELDMAN

Maryann P. Feldman, PhD, is the Heninger Distinguished Professor in the Department of Public Policy at the University of North Carolina, an Adjunct Professor of Finance at Kenan-Flagler Business School and a Research Director at UNC Kenan Institute of Private Enterprise. Her research and teaching interests focus on the areas of innovation, the commercialization of academic research and the factors that promote technological change and economic growth. Dr. Feldman is an editor of the journal, Research Policy. She writes about how digitalization and globalization poses both opportunity and threat to small local economies and rural areas in her chapter titled *Local Knowledge spillovers in the Digital Economy*.

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Tim Nicholas Rühlig, PhD, is a research fellow at the German Council on Foreign Relations (DGAP) in Berlin and an associate research fellow of the Europe Program of Utrikespolitiska institutet (UI) in Sweden. His research focuses on China's foreign and technology policy, technical standardization, EU-China relations, and China's political economy. Among his recent publications are his monograph *China's Foreign Policy Contradictions* (2022, Oxford University Press), his edited volume *Assessing China's Digital Power and its Implications for the EU* (2022, Digital Power China), his articles *Chinese Influence through Technical Standardization Power* (2022, Journal of Contemporary China), and *A Sovereign Europe… and China* (2022, Internationale Politik Quarterly) as well as his report *The Shape of Things to Come. The Race to Control Technical Standardisation* (2021, European Union Chamber of Commerce in China and UI). He highlights the increasing politicization of technical standardization and political rivalry between the US, China, and the EU in his chapter titled *Technical Standardization and Innovation in a Changing Geopolitical Landscape*.

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Jacquelyn Schneider, PhD, is a Hoover Fellow at the Hoover Institution and an affiliate with the Center for International Security and Cooperation, both at Stanford University. Her scholarly work has appeared in a series of journals including *European Journal of International Relations*, *Security Studies*, and *Journal of Conflict Resolution*. In addition to her

scholarly publications, she is a frequent contributor to policy outlets, including *New York Times*, *Wall Street Journal*, *Foreign Affairs*, *CNN*, *NPR*, *BBC*, *MSNBC*, and *Washington Post*. Dr. Schneider is an active member of the defense policy community with previous positions at the Center for a New American Security, RAND Corporation, and the Cyberspace Solarium Commission. She has a BA from Columbia University, MA from Arizona State University, and PhD from George Washington University. She paints a geopolitical perspective of the balance between capabilities and vulnerabilities associated with new technology uptake in her chapter titled *Digital Dependencies, Pandemics and the Capability-Vulnerability Paradox*.

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Thijs Van de Graaf, PhD, is an Associate Professor of International Politics at Ghent University, Belgium. He is also a fellow with the Payne Institute at the Colorado School of Mines, the Initiative for Sustainable Energy Policy (ISEP) at Johns Hopkins University, and the United Nations University Institute for Comparative Regional Integration Studies (UNU-CRIS). He is the co-author of Global Energy Politics (Polity, 2020) and was the lead author of the IRENA report Geopolitics of the Energy Transformation: The Hydrogen Factor (2022). He writes about the geopolitical implications of the transition from fossil fuels to sustainable energy sources in his chapter titled *The geoeconomic of renewables - implications for innovation and entrepreneurship*.

HAL VARIAN

Hal Varian, PhD, is the Chief Economist at Google and professor emeritus at the University of California at Berkeley. Varian is known to many as the author of one of the main textbooks on intermediary economics used in university courses around the world, but he has also written extensively and oftentimes ahead of his time about the digital information economy. He gives a long-term perspective on technological shifts, regulation and digital markets in an interview by Joakim Wernberg titled *An Optimistic Outlook on Troubled Times*.

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CHAPTER 1

INTRODUCTION:

CONNECTIVITY, BOUNDARIES AND BORDERS

ENRICO DEIACO AND JOAKIM WERNBERG (EDITORS)

Trade, globalization and economic integration have historically been associated with peace, economic growth and prosperity. Policies to promote cross-border economic exchange and the spread of internet access and digitalization reinforced each other at the end of the 20th century and the beginning of the 21st. Yet, with this inreased interconnectivity, new political tensions and conflict have followed.

The same ties that bind people, businesses and nations closer together are increasingly also being utilized for criminal activities, cyberattacks and geopolitical power struggles. That increased economic integration and digital interconnectivity is accompanied by a geoeconomic shift in which both the actions of foreign states and the functioning of international markets bring new challenges to individual countries' territorial sovereignty. Consequently, legislators and policymakers have been increasingly prone to strengthening borders rather than diminishing them. There is also a surge in regulatory initiatives aimed at digital cross-border markets. However, disconnection, disintegration, and decoupling undermine the foundations of innovation, entrepreneurship and structural change enabled by digital interconnectivity. So what are the alternatives?

This year's SEF Dialogues is dedicated to exploring these issues. On the one hand, there are rising tensions between increased economic integration and national sovereignty. On the other hand, there is also considerable friction between economic disintegration and economic progress. While considerable attention has been directed towards the geopolitical implications of this geoeconomic shift, the chapters in this volume are concerned with the other side of that discussion. How are the conditions for future innovation, entrepreneurship and economic integration being shaped by geopolitical power struggles that span across the regulation of digital markets, rising cyber security threats, technical standardization and the transition

towards sustainable energy sources with its subsequent shift in the demand for resources? Each author provides a unique perspective on these issues, but they all shed light on some aspect of how the balance between digital interconnectivity, boundaries for economic and social exchanges, and national borders is changing.

CONNECTIVITY: EXTENSIVE AND INTENSIVE

With globalization follows connectivity and economic interdependence. During the second half of the 20th century, the annual growth in exports outpaced the total production of industrialized countries. The annual growth in international borrowing and lending nearly doubled compared to that of exports (Ostry and Nelson, 1995). This wave of globalization mainly concentrated economic, political, military and cultural power in a few countries. In 1990, the trend shifted; in two decades, the seven richest countries' (G7) share of global income was rapidly reduced, primarily due to the growth of six industrializing countries, with China in the lead (Baldwin, 2016). Consequently, connectivity increased, and international economic interdependencies expanded.

As the internet was privatized and access spread globally in the second half of the 1990s, it did so in a world that was already interconnected; now, the connectivity manifests differently than before. An estimated 63.5 percent of the world's population has access to the internet. Digital communication did for the cost of moving ideas what steam power did for the cost of moving physical goods. It became increasingly possible to outsource activities outside the firm and to offshore manufacturing to other countries to leverage differences in wages. Between 1990 and 2020, trade in goods grew fivefold, while trade in knowledge-intensive services increased by more than an order of magnitude, measured as the ratio of world trade in goods and services to the world GDP (Baldwin, 2022).

Digital networks do not just grow at their extensive margins by adding new users. They also grow significantly at their intensive margins by deepening the use of established connectivity, resulting in growing digital interconnectivity.

First, internet access lowered the threshold for leveraging connectivity both locally and internationally. The internet is available to individual households just as much as it is to industry. It is available to small businesses just as much as it is to large corporations.

Second, falling costs for computation and data storage combined with increasing bandwidth made it possible to develop software as a service (SaaS) and cloud computing, allowing firms to buy the capacity of physical capital at a variable rather than a fixed cost (Varian, 2018). This paved the way for a wide variety of new innovations, entrepreneurial ventures and tech startups offering digital services ranging from games to healthcare in a way The Economist (2014) likened

to the Cambrian explosion in evolution when life emerged from the sea onto land and ignited a cascade of mutations.

Third, as internet use increased, there was both an opportunity and a need for intermediation to allow users to further benefit from their access without succumbing to transaction costs and noise. Digital platforms such as Altavista, Amazon, Yahoo!, eBay, MySpace, Google and Facebook have since become an integral part of the digital landscape. These platforms are matchmakers (Evans and Schmalensee, 2016; Wernberg, 2021). Multi-sided platform economies are not unique to the digital era, but platforms can combine reach across large populations with instant matching between supply and demand in digital markets (Wernberg, 2018). This allows platforms to lower transaction costs both on geographically large international markets and small but very dense markets, such as large cities. Empirical studies suggest that small and medium-sized companies benefit disproportionately from using digital platforms to boost their productivity, effectively allowing them to leverage digital tools by proxy (Kergroach and Bianchini, 2021). They also enable startups that develop digital services to scale them quicker through app stores and other types of platform infrastructure.

All of these developments contribute to compounding the impact of connectivity. Small businesses leverage cloud computing and software-based services provided by large tech companies to reach customers; they sometimes do so by expanding their business to new geographical markets but more often by attracting or retaining customers in their existing market. Individuals use digital applications to reach out to others across the world. They also use them to pay their bills, call a doctor when their children are sick, order takeout from a restaurant around the corner or stay in touch with friends and family. Digitalization has not only accelerated connectivity but also made it, as well as the interdependencies that follow with it, more granular.

Along with the virtual nature of many interactions, digital interconnectivity also leaves a tangible footprint in the physical economic geography. The increased use of digital technologies has increased the demand for rare-earth minerals, which affects the balance regarding natural resources in the geopolitical landscape. Digitization requires considerable amounts of energy but also plays a crucial role in the transition from fossil fuels to more sustainable energy systems.

The potential advantages of increased digital interconnectivity outweigh the disadvantages by far, but increased digital connectivity and economic integration also imply a growing complexity in terms of mutual interdependencies between individuals, firms, industries and governments that span across national borders. These interdependencies break existing boundaries for social, economic and political interactions but also create new ones. There is a growing need to understand how this affects economies and society at large.

RETHINKING BOUNDARIES

Growing digital interconnectivity has contributed to lowering thresholds for interactions and exchanges regardless of distance. For this reason, it has challenged established boundaries in the economic, political, military and cultural domains. Prior to the internet, international commerce came at considerable cost and effort, which implicitly reinforced national borders. Reaching consumers in other countries was hard. Usually, only firms that were already large enough to afford setting up shop in another country could expand their business. Similarly, most consumers were limited to their local and domestic markets to satisfy their demand, unless they traveled.

With digitalization, national borders become increasingly more permeable to social and economic interactions (Reidenberg, 1996). Consumers can buy books or clothes just as easily online as at their local store. Small firms can address demand in niche markets and reach a critical mass of international customers to sustain their business without physically expanding it. This challenges the boundaries between the local and the global, between small and big cities, but also between local businesses and international competition.

In her chapter, Maryann P. Feldman (Chapter 2) discusses how internet access and digitalization may have a negative effect on the local knowledge spillovers that define many small and rural economies and keep them together. In the past, the competitiveness of places was determined by factors such as natural resources, accessibility, local know-how or anchor firms. The local market was once insulated from outside competition by geographical distance. Now, small local economies must combine local connections with digital interconnectivity to the rest of the world; one cannot replace the other. Policymakers, locally and nationally, must address the overhanging threat of places being left behind in the digital shift to avoid further domestic geopolitical imbalances, inequality and polarization.

As industry increasingly leverages the benefits of software-based services, digital platforms and cloud computing, new types of technological and economic interdependencies contribute to a significant shift in supply and value chains as well as industrial organization. The boundary between the organization and its surroundings is shifting. Individual firms are increasingly dependent on other actors to run their core businesses. As businesses, individuals or public authorities connect to the internet or to others outside the organization, they are also exposed to new risks in the guise of cyberattacks and cyberespionage designed to leverage this new industrial organization.

Jacquelyn Schneider (Chapter 5) emphasizes the trade-off between the capabilities enabled by new technologies and the vulnerabilities that accompany them in her chapter. She starts with the rapid digital transformation induced by the pandemic. Video conferences, apps for food delivery and digital tools for education allowed

people to isolate themselves to decrease the spread of the virus, but also exposed households, firms and public authorities to a new range of risks and threats. Schneider outlines two ways in which this capability-vulnerability paradox can act as a tinderbox for geopolitical conflict. First, emerging technologies shift winners and losers, both within economies and interstate relations. This contributes to increased incentives to strike first and adds to uncertainties about state intentions, especially for states that fear losing power and falling behind. Because of this, countries may find themselves spiraling towards otherwise undesired conflict. Second, technology shifts change the demand for resources and the geography of dependencies both on technology development and the resources it requires. In an increasingly digitally interconnected world, this translates to conflicts about information— for example cyber attacks, misinformation and election manipulation.

The relationship between industry and geography is also challenged. Businesses can coordinate complex activities that previously needed to be geographically concentrated over large distances. They can offer digital services to virtually any market where there is a connected demand. Knowledge-intensive economic activities have become easier to relocate; as a result, policies for foreign direct investment increasingly shift from one-time investments to ongoing projects to retain increasingly mobile economic resources (Andersson et al., 2019). A growing number of businesses and individuals utilize digital services and platforms that are supplied from outside the region where the users themselves are located. In theory, data can be generated from users subject to one jurisdiction. The data can then be collected, structured and used for data-driven innovation by a business that acts out of another jurisdiction.

The rise and spread of professional user-generated content online challenges the boundary between producer and consumer, echoing futurist Alvin Toffler's prediction about "prosumers" from the 1980s (Toffler, 1980). This development has produced fantastic services. Two examples are Wikipedia and the operating system Linux, both built on collaboration and open source (Benkler, 2011). It has also challenged the established media landscape, first through grassroots journalism and later in the form of increasingly professionalized alternative media outlets and influencers (Gillmore, 2006; Benkler et al., 2018). Partially due to the rise of social media, the barrier to entry in the public debate has arguably been lowered, for better or for worse. The same digital technologies that can be used as tools for upholding democracy are also utilized to spread misinformation and propaganda.

While increased economic integration across national borders is traditionally associated with preventing war, digital interconnectivity also enables new conflicts and modes of conflict between states (Gartzke, 2006; Khanna, 2016). Digital interconnectivity and economic integration enable a type of geopolitical conflict targeting industry and the economy. National governments are increasingly harnessing the links between countries to exert control and gain advantages. For example, Leonard

(2021) argues that the US leverages the weight of its currency to control access to the global financial system, the EU uses its market size to develop and export regulation, and China invests in foreign infrastructure to connect itself to other countries.

High digital interconnectivity helps blur the boundaries of conflict between states. The blurred lines influence business, public debate and even national elections. Digital interconnectivity is granular and ubiquitous. The efforts needed to internationally target either one specific individual or business or a large population are at an all-time low. Cyberattacks, propaganda and fake news campaigns that target industries or civilians, sanctioned by a foreign government, can be scaled up and globally implemented in a manner similar to the efficiency of a tech startup scaling up its business.

With the increased importance of technological infrastructure, technical standards are also becoming an arena for increasingly antagonistic geopolitical maneuvering. China has adopted a strategy to dominate technical standards by 2035. Other countries have in turn blocked Chinese companies from competing for 5G licenses and infrastructure based on concerns that imply a blurred boundary between China as a state and Chinese industry.

The next generation of digital innovations is expected to be more systemic in nature, but they will also be subject to more regulated markets. This will be a major factor in a geopolitical tug-of-war between the US, China and the EU. In his chapter, Tim Rühlig (Chapter 6) extensively examines the rising tension between market and government with respect to the strategic importance and current power struggles related to technical standards. Standardization has always had a political dimension, but most emphasis throughout history has been on self-regulation led by market actors and broad consensus with governments and other stakeholders. The self-organization has been integral to the effectiveness of standardization; now the politicization of this process is growing. China has made it a political priority to influence and dominate standards in key areas, one of which are lithium batteries. This political aim has alerted policymakers in the EU and the US. It is also a potential catalyst for increased political intervention in the establishment of standards.

The increased use of digital connectivity not only challenges the restrictions of geographical distances but also shifts the boundaries of geopolitical advantages anchored in the physical geography. A significant increase in demand for rare earth minerals and digital components, along with increasing interest in a sustainable energy system that is not dependent on fossil fuels, leads to a shift in the value of these respective resources.

Consequently, the map of geopolitical advantages is being redrawn with this digital and green transition. In his chapter, Thjis Van de Graaf (Chapter 3) compares changes in boundaries between the old fossil system and the emerging renewable energy system, and the difference is significant. For instance, the conditions for ownership of assets are fundamentally changing. Fossil fuels were concentrated in a number of small nations, but the emerging energy system relies heavily on resources that are more evenly distributed across the globe. For example, solar and wind energy are available in most countries. They take the form of limitless but volatile flows of energy compared to finite stocks of the fossil era. This blurs the distinction between importers and exporters and creates a world of interconnected and interdependent prosumer countries that both consume and produce energy. This process is enabled by digital technologies, facilitating the integration of variable renewables into the energy system.

The aftermath of the internet's initial growth sparked debate about the distinction between "online" (in cyberspace) and "offline" (in the physical world). Retrospectively, the main concerns were not about setting up boundaries for cyberspace as an isolated place, but in understanding how digital connectivity challenges and shifts established boundaries in the physical world in profound ways (Barlow, 2019; Johnson and Post, 1999). As digital connectivity has intensified and enabled growing cross-border interdependencies, policymakers have more heavily considered the utility of borders.

REVISITING NATIONAL BORDERS

There is an inherent trade-off between increased cross-border economic integration and national political sovereignty. While the former is beneficial for generating growth and prosperity, it inevitably limits the extent of control national legislators and policymakers have over the geographical territory they govern.

Several factors contribute to political tensions between connectivity and national control (Ostry and Nelson, 1995). While cross-border economic integration is associated with considerable gains for all countries involved, it is frequently accompanied by potentially negative spillovers such as pollution or excessive migration flows that are enabled by cross-border integration but lie beyond the control of individual countries that are affected. Limitations on fiscal or monetary policy due to economic integration may diminish individual countries' autonomy. Foreign businesses offering services to a select geographic market while acting largely beyond the scope of that country's jurisdiction or ability to collect taxes could be interpreted as a challenge to that country's political sovereignty. Just as digital interconnectivity has the potential to boost the positive effects of economic integration, it also supercharges the political tensions that arise in the balance between connectivity and control (Leonard, 2021). Consequently, the impact of economic sanctions has changed significantly in the wake of economic integration and digital interconnectivity (Mulder, 2022).

The internet's network borders were designed with the explicit aim to not coincide with national borders. An adverse effect of the design is that digital connectivity challenges established perceptions of geopolitics.Historically, the study of geopolitics has primarily been concerned with how geography (distance, resources, terrain) conditions politics for international relations and conflicts. With growing economic integration, trade, financial transactions and supply chains have become increasingly more important in geopolitical considerations. Even so, geopolitics is still firmly rooted in geographical space. With digital interconnectivity, people are still anchored in physical places; legal entities depend on the jurisdictions they belong to; supply and demand can in some sense be traced and geographically determined; but interactions and exchanges can be conducted without traversing geographical distances. Trade in goods still results in shipping and transportation, but services, information and ideas are becoming increasingly difficult to link to geography within existing institutional and regulatory frameworks (Baldwin, 2022).

In the wake of combined globalization and digitalization, the last decade has seen a rise in nationalism and protectionism, accompanied by numerous political initiatives to regulate both digital markets and tech companies. In his chapter, Richard Allan (Chapter 4) explores how this shifting relationship between digital interconnectivity and national sovereignty has shaped and continues to shape the future of the internet. The centripetal, mainly economic, forces that push toward an expanding and coherent network are increasingly countered by centrifugal forces splintering it. As the internet's economic and political impact grows, both the advantages and the disadvantages it contributes to become more tangible, driving voters and industries to call for political action and legislators to call for control. This begs the question of whether a new balance between connectivity and control can be obtained with the internet intact or if we need to prepare for governing a splinternet and what that would mean for those depending on it. The key issue is not whether the internet should be regulated or not (it already is), but how to adequately regulate it.

On the surface, it might appear reasonable to reduce connectivity in response to blossoming tensions. Such sentiments currently fuel various developments in many nations. Yet, disintegration and decoupling may prove counterproductive by limiting the diffusion of new ideas and technology (Cerdeiro et al., 2021). While increased cross-border integration of social and economic interactions creates friction with national legislatures, disintegration and decoupling similarly stand in conflict with the innovation and entrepreneurship necessary for structural change, economic growth and prosperity.

The internet and digitalization have ushered in an explosion of entrepreneurship and innovative tech startups that rely on interconnectivity both locally and internationally. Due to digital platforms, cloud providers and software-based services, businesses outside the tech sector can leverage the benefits of digital interconnectivity

to reach both new and existing customers. Consequently, it may prove unfeasible to regain the same level and type of control as before because the economic and political climate is changing, becoming increasingly complex and shaped by interdependencies both within and across borders.

Stopping foreign digital platform companies at the border will not only block them from reaching users within the country, but also impede domestic small businesses from reaching customers in their own local markets via digital channels. Old geopolitical balances are shifting; there is a rising demand for rare-earth minerals and a declining demand for fossil fuels. The ongoing energy transition will be mineral- and metal-intensive, which creates new resource dependencies and vulnerabilities. There is a growing need to reevaluate policy measures and rethink the political use of borders in a new geopolitical landscape where local and global characteristics are becoming increasingly hard to disentangle.

What characterized the growing economic integration and interconnectivity leading up to and following the spread of the internet and digitalization in the 1990s and 2000s was that the effects of policy and technological innovation reinforced each other. With the rise in nationalism and protectionism in the 2010s, policymaking and technological innovation fell out of sync with each other. Growing regulatory pressures may drive market fragmentation, but the economic potential of the ongoing digitalization still pushes towards network expansion and market convergence.

Hal Varian, interviewed by Joakim Wernberg in this volume, notes that regulators have a larger role than before, and they oftentimes take a short-sighted perspective on innovation, progress, efficiency and other important economic factors. Excessive regulation will stifle innovation. Some of the regulations currently being put forward may even prove to be counterproductive with respect to the goals they are intended to realize. Even so, Varian remains optimistic about the future. He observes that we have survived previous technological disruptions and emerged stronger on the other side, despite concerns both about new technologies and how they should be regulated. That does not mean the choice of policy approach is unimportant. Political interventions to protect incumbents or play favorites may create adverse effects and conflicts that persist for decades, but policymakers can also play a key role in enabling new technologies; one example is the interoperability of cellular networks around the world. First, the technical system was built by engineers and then the institutional framework needed to scale it was developed by policymakers.

Politicians need to reorient themselves in this interconnected world and calibrate their political response to reflect the new trade-offs between open and closed economies. The proper answer is not to completely disconnect; it may even be to increase connectivity, but it most certainly requires structurally different interconnectivity to preserve the values of economic integration while circumventing its adverse effects.

POLICYMAKING IN AN INTERCONNECTED WORLD

Economic integration has historically contributed to progress, prosperity and the prevention of military conflicts, but there is growing evidence that connectivity also has its own risks, threats, vulnerabilities and conflicts. Mutual cross-border interdependencies challenge traditional means of territorial control and aid in increasing uncertainty. The spread of the financial collapse in 2007–2008 in global financial systems, the obstruction of the Suez Canal in 2021, the breakdown of global supply chains during the Covid pandemic in 2020–2021 and Russia's subsequent invasion of Ukraine all demonstrate how interconnectivity allows incidents to cascade beyond our control across the ties that bind us together in ways that can amplify macroeconomic shocks (Acemoglu et al., 2016). In many ways, functional infrastructure and networks (i.e., cities, transport networks, pipelines, and internet cables) provide more insight into the world than political borders (Kahin and Nesson, 1997; Khanna, 2016).

Policymakers are now at a crossroads. There is a question of whether we should disconnect or change the way we control and govern the networks that we are now part of. A surge in voters supporting nationalism and protectionism has made disconnection an attractive option to many politicians and policymakers, but this approach is short-sighted. As the authors in this volume have demonstrated in different ways, disconnecting in an interconnected world is not equivalent to dismantling networks and reverting to the condition of the world before the internet. It would put the disconnected country or countries at a considerable disadvantage.

The other option is to shift the means of political control to build and promote networks that prioritize robustness and resilience in combination with expansion, which we are already currently seeing across economies. It is essentially a question of spotting critical weak links. Relying on a single supply chain or pipeline may be economically favorable, but everyone in the network faces considerable harm if that link is broken. Many businesses are re-evaluating their supply chain strategies in the wake of the pandemic; rather than abandoning global networks, they appear to be reconfiguring them to be more robust to the breakdown of individual links (Endewick and Buckley, 2020; Kilic and Marin, 2020; Blomkvist et al., 2021). Just as we are unlikely to see a global disconnect, we are also unlikely to see a return to previous configurations of global networks. Instead, we will see more connectivity through different approaches.

Politicians cannot and should not determine the structure of economic networks, but they are essential in shaping the infrastructural networks and institutional frameworks that govern economic exchange. For policymakers, the ambition to build and promote robustness in economic networks translates into challenges that cut across different policy areas and sometimes require new approaches. In

the following section, we outline six broad categories of policy issues to address network robustness in an interconnected world.

First, there is a need for robustness in the physical networks that facilitate economic and social interactions. The cost of maintaining excess capacity in such network infrastructures is tantamount to buying insurance to prevent losses from network failures. If the expected cost of such losses is high, insurance is a worthwhile investment. This does not necessarily require parallel infrastructures, but if, for example, a critical network for transport, energy or communication is interrupted, alternatives must be utilized to avoid a network breakdown. This causes dependencies on any single actor or foreign state in a specific network to also be diluted.

Second, due to the combination of extensive and intensive growth in digital interconnectivity, people experience the effects of mutual cross-border dependencies in real time, for better or worse. For those who do not leverage the benefits of connectivity or see their local communities transformed as an effect of it, it may seem to lack signs of improvement even when the net effect on prosperity is positive. Structural change oftentimes catalyzes social conflict (Lande, 2003; Frey, 2019). This fuels polarization between socioeconomic groups, between urban and rural places, as well as between the local and the global. Policies must ease structural change and transition to prevent a domestic disconnection. The goal is not preservation but easier adaptation to help people and communities benefit from connectivity. On the one hand, these issues are addressed by transport and communications infrastructure to promote accessibility. On the other hand, they are addressed by measures to lower thresholds and increase incentives for education, job switching, entrepreneurship and overall social mobility.

Third, the boundary between domestic and foreign policy is blurred as foreign direct investments rely increasingly on mobile human capital rather than fixed natural resources. This implies not only that domestic innovation policy affects the ability to attract foreign investment but also that other countries' innovation policies contribute to that effect (Andersson et al., 2019).

Domestic policies to, for example, subsidize a specific industry have long been a threat to international trade relations. It gives the subsidizing country's industry an unfair advantage by closing off their domestic market to competition while also potentially boosting their competitiveness on an international market. With increased interconnectivity and mobility of knowledge-intensive activities and services, such domestic subsidies may also have the intended or unintended effect of attracting foreign direct investment and firm relocation, further adding to the risk of trade conflicts or a race to the bottom in subsidies, not unlike rising tariffs.

Consequently, there is an increased need for aligning initiatives and frameworks across different policy areas, including but not limited to education, labor market, innovation, industry, and science and technology, to establish a coherent policy approach to promoting innovation, entrepreneurship and foreign direct investment while maintaining international trade relations.

In a similar manner, the boundary between foreign and domestic policy is undermined in the domain of cyber defense. While profuse debate and effort have been utilized to prevent a cyber attack on the scale of 9/11 or Pearl Harbor, a rising tide of small-scale attacks is proving to be a sizable threat to trust in digital markets and, by extension, national security (Schneider, 2022). Meanwhile, there are empirical indications that cyber security investments are lagging considerably behind digital transformation (Franke and Wernberg, 2020). Cyber security policy needs to include stakeholders in industry and government not only as beneficiaries but as active participants (Franke, 2020).

Fourth, the scope of science and technology policy is increasingly shifting from the national to the international scale, especially for smaller nations. Regulation and governance need to be coordinated on an international scale, and the EU is currently working on establishing itself as a leader in this regard. As the economy is being digitalized, trade flows and tech policy will increasingly coincide, and trade flows will be associated with data flows. Therefore, there is also a growing need for finding functional and coherent regulatory frameworks for transfers of data and information between different jurisdictions, such as the US and the EU. Compliance costs and the risk of fragmentation between different jurisdictions accompany all regulation. Therefore, regulation of digital markets should be guided by the ambition to counter evidenced harms, not to choose winners, promote domestic industries or steer development in those markets.

In addition, as the political importance of technical standards appears to grow, there is a need to balance standardization against regulation as a means of governance. Efficient standards must enable and reinforce consensus in the market and provide a more lenient and more adaptable alternative to legislation. Perhaps most importantly, standards and legislation must be coordinated to avoid overlapping and conflicting regulatory frameworks that cause an undue regulatory burden for market actors.

All of this requires improved coordination nationally and internationally between stakeholders during the early phases of proposals for new legislation and standardization. If this is not done, Sweden and other similar countries with open economies and small domestic markets risk falling into a small country squeeze (Van Tulder, 2002). To address these issues, any existing gaps between domestic and foreign policy in the area of science and technology need to be closed.

Fifth, digital interconnectivity, as well as all other networks that are increasingly dependent on digital technologies, resultantly rely on an energy system that is transitioning away from fossil fuels. Traditional boundaries between different energy sectors, such as electricity, heat and transport, will become more ambiguous with the rise of electrical mobility and other renewable solutions. Along with shifting needs for natural resources, this provides a fundamental shift in the geopolitical power balance and casts uncertainty on the future. This twin transition in digitalization and sustainable energy is not merely concerned with setting up new infrastructure and establishing new connections but also with evolving old connections. The impact of the latter is often underestimated in the geopolitical debate. There should be a policy agenda that addresses issues related to economies that are losing their primary sources of economic growth.

Sixth, decoupling is becoming an important geopolitical tool in the competition between superpowers for geopolitical control in an increasingly digitalized world economy. It is notably comparable to sanctions. However, decoupling must be balanced against redundancy as a means of maintaining connectivity with reduced risk and harm. Foreign investments in infrastructure or foreign control of financial flows pose a lesser risk if they are not bottlenecks in the global economy. Decoupling tends to trigger increased use of protectionism and industrial policy that is oriented around national origin. Such policy measures have a questionable track record (Andersson et al., 2021). There are cases that merit decoupling, but as an occasional response with surgical precision rather than a sweeping measure.

The current geopolitical debate is overwhelmed by a pessimistic viewpoint on the emerging interconnected world order. There is a tendency to emphasize risks, vulnerabilities and uncertainties. However, it is evident that globalization, digitalization and interconnectivity have provided far more benefits than harms. This pessimistic bias causes many policymakers to resort to increased political intervention at the potential expense of market dynamics, innovation and entrepreneurship. This shift in balance between market and state may prove counterproductive, and old policy rationales are rarely compatible with new technologies (Foldvary and Klein, 2003). Historically, not only have we surpassed previous technological disruptions and benefited from them, but new technologies and entrepreneurship, backed up by innovative policy measures, have provided the solutions needed to counter the adverse effects of that disruption.

REFERENCES

Acemoglu, D., Akcigit, U., and Kerr, W. (2016). "Networks and the macroeconomy: An empirical exploration". *Nber macroeconomics annual*, 30(1), 273-335.

Andersson, M., Larsson, J., and Wernberg, J. (2019). "Stora kunskapsintensiva investeringar: Orsaker, verkan och den offentliga sektorns roll". Tillväxtanalys PM 2019:13.

Andersson, M., Deiaco, E., and Eklund, J. (Editors) (2021). "Swedish Perspectives on Industrial Policy - The Washington Consensus and Beyond". Swedish Entrepreneurship Forum. Swedish Economic Forum Report 2021. https://entreprenorskapsforum.se/wp-content/uploads/2021/11/SEF2021_Rapport_Web.pdf.

Baldwin, R. (2016). *The Great Convergence: Information Technology and the New Globalization*. Harvard University Press.

Baldwin, R. (2022). "Challenges for monetary policy in a rapidly changing world. Globotics and macroeconomics: Globalization and automation of the service sector". European Central Bank. https://www.ecb.europa.eu/pub/conferences/ecbforum/shared/pdf/2022/Baldwin.pdf.

Barlow, J. P. (2019). "A Declaration of the Independence of Cyberspace". *Duke Law & Technology Review*, 18(1), 5-7.

Benkler, Y. (2011). "The penguin and the leviathan: How cooperation triumphs over self-interest". Currency.

Benkler, Y., Faris, R., and Roberts, H. (2018). *Network propaganda: Manipulation, disinformation, and radicalization in American politics*. Oxford University Press.

Blomkvist, K., Kappen, P., Nilsson, F., Schmuck, A., and Tell, F. (2021). "Globalization Strategies : Strategic Adaptations and Pathways Ahead for Swedish Multinational Corporations", Uppsala University. Department of Business Studies. https://fek.uu.se/. ISBN: 978-91-506-2899-9.

Cerdeiro, D. A., Mano, R., Eugster, J., Muir, M. D. V., and Peiris, M. S. J. (2021). "Sizing up the effects of technological decoupling". International Monetary Fund.

Enderwick, P., and Buckley, P. J. (2020). "Rising regionalization: Will the post-Covid-19 world see a retreat from globalization?". *Transnational Corporations Journal*, 27(2).

Evans, D. S., and Schmalensee, R. (2016). *Matchmakers: The new economics of multisided platforms*. Harvard Business Review Press.

Foldvary, F. E., and Klein, D. B. (Eds.). (2003). *The half-life of policy rationales: How new technology affects old policy issues*. NYU Press.

Franke, U. (2020). "Cybersäkerhet för en uppkopplad ekonomi".

Franke, U., and Wernberg, J. (2020, June). "A survey of cyber security in the Swedish manufacturing industry". In "International Conference on Cyber Situational Awareness, Data Analytics and Assessment" (CyberSA) (pp. 1-8). IEEE.

Frey, C. B. (2019). *The technology trap. In The Technology Trap*. Princeton University Press.
Gartzke, E. (2006). “Interdependence really is complex”. Typescript. Columbia University.
Gillmor, D. (2006). *We the media: Grassroots journalism by the people, for the people*. O'Reilly Media, Inc.
Johnson, D. R., and Post, D. G. (1999). “The rise of law on the global network”. in Kahin, B. and Nesson, C., *Borders in cyberspace: Information policy and the global information infrastructur*e.
Kahin, B., and Nesson, C. (Eds.). (1997). *Borders in cyberspace: Information policy and the global information infrastructure*. MIT Press.
Khanna, P. (2016). *Connectography: Mapping the future of global civilization*. Random House.
Kergroach, S., and Bianchini, M. M. (2021). “The Digital Transformation of SMEs”. OECD Publishing.
Kilic, K., and Marin, D. (2020). “How Covid-19 is transforming the world economy”. VoxEU. org, 10.
Landes, D. S. (2003). *The Unbound Prometheus*. Cambridge Books.
Leonard, M. (2021). *The Age of Unpeace: How Connectivity Causes Conflict*. Random House.
Mulder, N. (2022). *The Economic Weapon: The Rise of Sanctions as a Tool of Modern War*. Yale University Press.
Ostry, S., and Nelson, R. R. (1995). T*echno-nationalism and techno-globalism: Conflict and cooperation*. Brookings Institution Press.
Reidenberg, J. R. (1996). “Governing networks and rule-making in cyberspace”. *Emory LJ*, 45, 911.
Schneider, J. (2022). “A World without Trust: The Insidious Cyberthreat”. Foreign Aff., 101, 22.
The Economist. (2014). “A Cambrian moment, Special report on tech startups”, (accessed 2022-11-30). https://www.economist.com/special-report/2014/01/16/a-cambrian-moment.
Toffler, A. (1980). *The Third Wave*, William Morrow.
van Tulder, R. (2002). “Small Industrialized Countries and the Global Innovation Race: The Role of the State in the Netherlands, Belgium and Switzerland”. In Hilpert, U. (Ed), *State Policies and Techno-Industrial Innovation*, pp 293-316, Routledge.
Wernberg, J. (2018). “Inside the black box: Platform economies and digitalization”. European Liberal Forum.
Wernberg, J. (2021). ”Innovation, Competition and Digital Platform Paradoxes”. Policy Papers on Technology, Ecnomics and Structural Change. Swedish Entrepreneurship Forum.

CHAPTER 2

LOCAL KNOWLEDGE SPILLOVERS IN THE DIGITAL ECONOMY

MARYANN P. FELDMAN

1. INTRODUCTION

Many places around the world attempt to build entrepreneurial ecosystems around advanced technologies but with disappointing results. Specialized concentrations of innovative firms, support services and productive workers – iconic places like California's Silicon Valley or the Route 128 halo around Boston – are often understood as virtuous circles in which localized rivalry between firms generates skills and innovation, raising productivity, wages, and profits, while making products that increase social welfare. The functioning of geographic concentrations of related firms have been analyzed extensively (c.f. Feldman and Storper, 2018). A theme through this research has been that agglomeration economies arise naturally and organically from the actions of entrepreneurs and firms as they strategically secure an advantage, benefiting from other local firms and building on skilled labor and supplies – all the factors that define local capabilities. In this manner, geography creates self-sustaining virtuous cycles of innovation that lead to greater productivity, wealth creation and shared prosperity. These patterns held through prior industrial revolutions, yet, increasing the results have been disappointing as new digital technologies are embedded in a system that acts to erode local advantage.

Knowledge spillovers are a key mechanism in industrial agglomerations that increase productivity by lowering the cost of accessing and using information. Such spillovers have been understood as a driving force for firms to cluster in space. Recent studies find that the magnitude of geographic localization of knowledge spillovers has become lower than prior estimates (Bikard and Marx, 2020). A few prominent universities in technology rich locations have come to dominate commercial inventive activity, rather than the prior pattern of industry relying on

a more diverse landscape of academic discoveries that favored local interactions. Even accounting for some differences in results due to improved estimation techniques, these results suggest the possibility of a new reality in the American economic landscape – the source of local knowledge spillovers has declined. Due to large systemic forces such as deindustrialization, many places have lost their industrial base and thus their ability to generate and absorb local knowledge spillovers. This loss of locality has intensified with the implementation of digital technologies.

Digitalization offers significant opportunities for firms, especially small and medium-sized companies, to expand and improve their business (OECD, 2021). At the same time, these digital technologies rely on algorithmic structures that shift how we search for, order, and manage information in ways that may also prove challenging to many small and local businesses. In particular, digitalization challenges the role of *local* information and knowledge spillovers that facilitates experimentation, improvisation and entrepreneurship. This essay will argue that many local places have found themselves left behind because of this shift in the role and structure of local knowledge that holds tangible consequences for the geography of innovation in an increasingly interconnected world.

This time of technological change is so profound it has been called an industrial revolution, changing the ways we work and live and interact. In the wake of this great opportunity, income inequality has increased, and prosperity is becoming regionally concentrated in a few locations in the United States. This trend is also considered in other countries under a literature that examines *places left behind* (Rodriguez-Pose, 2018). The next section (2) presents evidence about the geographic distribution of income in the US over the past 40 years. This reflects the changing landscape of opportunity within the United States and shows that large areas have suffered a loss of the resources required to restructure.

Regional prosperity increasingly depends on the capacity to produce and absorb ideas locally and these capacities have changed in significant ways. Section 3 examines the spatial dimension of digitalization digital economy in light of the decline of the factors and institutions conducive to creating and absorbing knowledge spillovers. This section considers the potential of digital technology as a general-purpose technology and highlight limitations in current implementation.

Section 4 examines how local knowledge spillovers as we used to know them have decreased and what it means for the local economic geography.

Section 5 sketches a policy approach to address the trade-off between local connection and global interconnectivity. To some degree local economies benefit from being connected to digital markets, but there is a case to be made for doing so while preserving their locality and ability to leverage local knowledge spillovers.

2. THE CHANGED GEOGRAPHY OF PROSPERITY

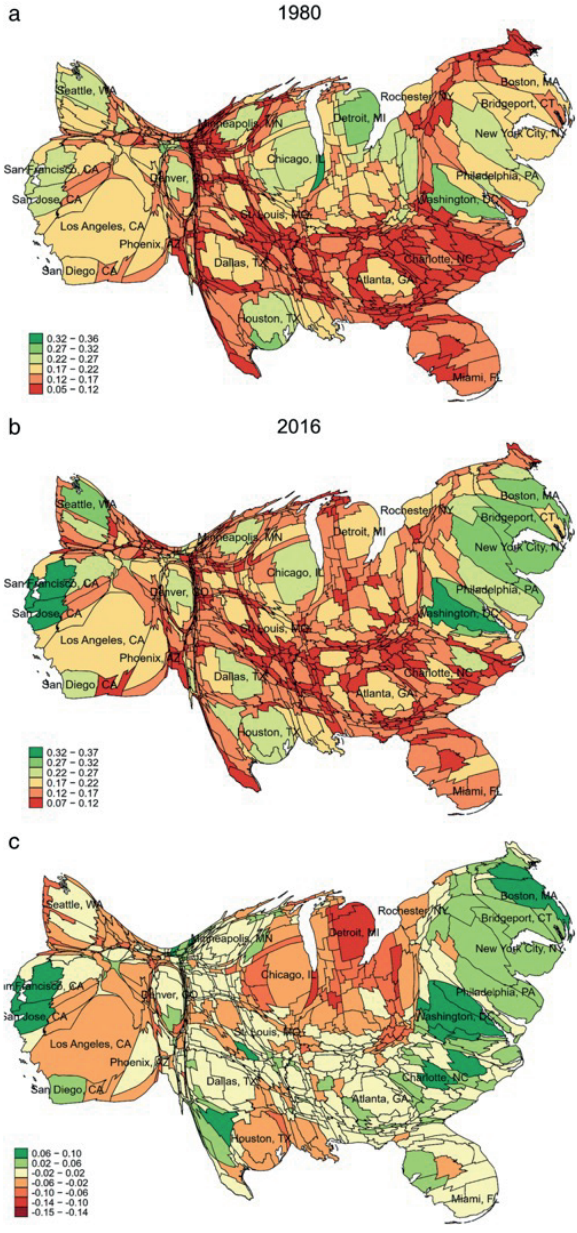
Piketty and Saez (2003) pointed out growing income inequalities in the US in the last 40 years. These trends become more profound when regional income disparities are considered. The small percentage of individuals that are doing well are concentrated in a few coastal large cities in the US while the incomes of most of the population have stagnated or declined. After 40 years of experimentation with a neoclassical economic policy agenda coupled with a decline in oversight and responsibility for the full range of stakeholders that support firm operations, US economy has reached unsustainable levels of spatial inequality. Economic power has become concentrated: just five cities accounted for 90 percent of growth (Atkinson et al., 2019)

To capture further nuances in income disparities, Feldman et al (2022) examine the top 20 percent of earners. The typical practice of examining the mean is inflated by the skewed long tail of the income distribution. There is much discussion about the top one percent or top five percent of the income distribution, but this group is too small and too geographically concentrated to examine statistically in any meaningful detail. The location of top 20 percent earners is correlated to those at the very top of the income distribution and provides an economic force in terms of multiplier effects in their purchase of goods and services.

Figure 1 presents the share of employed people with earnings above the 80th percentile, or the top 20 percent of the US earning distribution in 1980 (1a), 2016 (1b), and the change from 1980 to 2016 (1c). The map reflects commuting zones, with map areas proportional to population. The observed changes follow the decline of manufacturing since 1980 and the increase in wealth of places on the coast.

In 1980, the highest concentration of well-paid workers was in Gary, Indiana – a steel manufacturing center just east of Chicago; followed by Detroit (car manufacturing), and Washington DC. In 2016, the highest concentration of well-paid workers was in Washington DC, followed by San Francisco, San Jose, New York, and Boston. Looking to the change in position from 1980 to 2016 – each locality's rise, or fall, in the share of workers earning more than the 80th percentile nationally – the big winners were Washington DC, Boston, and San Francisco-San Jose, along with secondary hubs in banking (Charlotte, North Carolina) and technology (Seattle, Washington; Raleigh-Durham-Chapel Hill, North Carolina; Austin, Texas). Places in the middle of the country lost higher wage earners: most of the industrial heartland declined in relative terms, including yesterday's technological leaders, like Detroit, and Rochester NY (once the center of imaging technology, home of Kodak and Xerox). Simply being a large city and home to many large corporations is not enough, either. Metropolitan areas in both the Sunbelt and the Midwest, places like Houston, Los Angeles, Chicago and Atlanta have all experienced rising income inequality, with a falling relative share of high earners.

Figure 1. Share of employees in a commuting zone with earnings above 80th percentile of national earnings distribution



Source: Cambridge J Regions Econ Soc, Volume 14, Issue 1, March 2021, Pages 25–49, https://doi.org/10.1093/cjres/rsaa024

Consider the location of firms such as Apple, Google, and Facebook in Silicon Valley; Microsoft, and Amazon in Seattle; and Qualcomm in San Diego. While these firms were formerly entrepreneurial startups, they have gained economic power to become large employers. The increased concentration of better paid jobs in New York may be due to broad urbanization economies, but jobs in the tech sector as well as the high salaries in finance which is concentrated there is certainly an additional reason. Individuals in finance receive higher compensation relative to engineers with comparable educations (Philippon and Reshef, 2012).

Some of the spatial concentration of better paid jobs might be due to simple localization economies, skill-biased technological change, and the consequent emergence of specialized headquarter clusters (e.g., Moretti, 2012). Yet, as we celebrate and encourage entrepreneurship, several markets enabled by digital technologies exhibit market distributions and market dynamics that differs significantly from traditional markets for products and services, creating winner-takes-all or winner takes-most markets (e.g., see Weitzel et al., 2006). Current geographical concentrations of high-paid jobs coincide with headquarters of some of the biggest tech firms in such digital markets.

Feldman et al. (2021) make four arguments about regional income disparities. First, monopoly, and the market for new prospective monopolies, amplify agglomeration economies, making successful locations invincible and inimitable. Second, the taxes imposed by the monopoly firms on a wide range of economic activity, together with the restrictions they can impose on the dissemination and use of technology, further inhibit local economic development in other places. Third, financialization – the power of the financial sector over both firms which are receiving financing and firms which are paying cash out – serves to feed capital to these spatially concentrated monopolies and prospective monopolies while squeezing it out of other places and industries. Finally, efforts at local economic development would be best furthered by breaking up the concentrated economic power of technology and finance.

These shifts in income distribution and inequality have occurred during a time in the US characterized by massive technological changes embedded in a set of economic, political, and social decisions characterized by a neoliberal approach. Silicon Valley has been epitomized by Mark Zuckerberg's admonition to *move fast and break things*. We might expect that these income trends are temporary as the wave of Schumpeterian destruction will lead to new opportunities, the formation of new firms and new prosperity. Technology, rather than enriching a few, can be the force of freedom for onerous work and an agent for social progress as originally envisioned by early internet enthusiasts (Barlow, 1996). However, the result of technological change hinges heavily on the political decisions that accompany it. The next section discusses the potential of new technology and

argues that the current implementation limits the local knowledge spillovers so important to innovation and wealth creation.

3. THE DIGITAL REVOLUTION IN A SPATIAL CONTEXT

Certain technologies bring about societal change so profound we call them Revolutions. New digital platforms, artificial intelligence (AI), and related technologies bring fundamental changes in society that affects almost every aspect of human life by introducing new ways of organizing work, and redefining social relationships. Such general purpose technologies (GPT), have a wide range of adaptable capabilities and scope could affect an entire economy and offer great potential. Currently, the full potential of digital technology has yet to be realized. Choices made now may either increase concentrations of power or unleash the power of capitalism for the greater good. And these choices will have a tangible imprint on the current economic geography as well as the future geography of innovation.

The first technological upheaval was the Industrial Revolution (1760 to 1820), which marked the transition from craft production to a mechanized factory system, using water and steam as new sources of power, to process new materials, notably cotton and was the cumulation of various precedents that took time to realize their potential. The development of trade and the rise of institutions conducive to business, reinforced by advances in chemistry and machine tools, changed the nature of work, with increased standards of living. Increased urbanization was another result as activity centralized around factories. Every industrial revolution has a geographic epicenter. For the industrial revolution, the center was England.

A Second Technological Revolution (1870 to 1914) was marked by standardization, and the use of interchangeable parts, and was powered by the internal combustion engine and petroleum, and the wide-spread use of electricity. New materials, including steel and alloys, communication technologies, such as the telegraph, telephone and radio, and the advent of a transportation system based on railroads and modern shipping allowed for increased productivity which required greater capital and new management techniques. Urbanization and centralization increased as both cities and companies grew larger.

Currently, we are in the middle of another technological revolution, powered by computers and ICT, whose beginnings can be traced to the last half of the twentieth century with the breakthrough invention of semiconductors, which results in a Nobel Prize to inventors at Bell Labs and Texas Instruments. With this powerful new technology, new horizons opened, and the revolution began. William Shockley, the Bell Labs inventor, moved back to his family home in what was to become known as Silicon Valley. Intel, pioneer in integrate circuits, was started by engineers who had previously worked for Shockley at Fairchild Semiconductor. Thus, began the

creation of family trees of new technology startup firms or the *Fairchildren*. The benefits of industry localization set in place a reinforcing system predicated on high skilled labor, specialized suppliers and knowledge spillovers.

Even though much of the innovation that has fueled the ongoing digitalization is accredited to a highly localized cluster of firms in California, these technologies themselves allow people and firms to connect and interact across large distances in real time, thereby challenging the need for local proximity in at least six different ways. First, digitalization becomes exclusionary to those who cannot connect to the infrastructure. The US has relied on a system of private internet service providers and there are many rural towns, small cities and neighborhoods of large urban areas that are *internet or digital deserts*. Microsoft (2020) estimates 157.3 million people in the US (47%) do not have access to the internet at broadband speeds, mapping back to the spatial income disparities. This creates another self-reinforcing system as there is limited profit in providing internet service to low-income locations, yet without internet service opportunities remain limited.

Second, e-commerce provided an alternative to the local market for both sellers and buyers, and even those who did not get their business online have increasingly been exposed to outside competition. The threshold to local markets was broken down, first by shrinking transport costs and later by shrinking transactions costs online.

Third, digital platforms have become focal points of digital markets by matching groups with corresponding supply and demand (Evans and Schmalensee, 2016). Six of the ten most valuable companies in the world currently are platform businesses: Apple, Alphabet, Amazon, Facebook, Tencent, and Alibaba (Marr, 2022). These platforms contribute to further decreasing transaction costs which can aid local businesses in reaching new customers outside their local market. However, platforms also intensify the competition online by aggregating the supply-side and making it searchable, which may make it harder for local businesses to stand out in the crowd. Platform economies also exhibit a skewed winner-takes-all or winner-takes-most market distribution, concentrating competition and making it important for small leverage the largest platforms. At the same time, it has only become easier for local customers to find alternatives to local suppliers. Platform companies, much like supermarket chains, can also avail themselves of profitable opportunities, as Amazon has done with its inhouse product lines (Dudley, 2020).

Fourth, online activities generate data and as more and more economic and social activities have become digital, data has become a central resource to identify potential customers, to target advertising and to improve businesses. Local business owners can leverage data-driven resources as software as a service (SaaS) and cloud services, provided by large platform companies. The provision of cloud services is highly concentrated, with four firms, Amazon, Microsoft and Google and the Chinese firm

Alibaba, covering 70 percent of the global market, with Amazon accounting for one-third alone (Synergy Research Group, 2021). These private firms have invested heavily both in physical infrastructure, including supercomputer data centers, and research and development (R&D). However, the data economy is mostly not local and is concentrated to large platforms that can collect considerable amounts of data to analyze and use for innovation. This suggests business owners who benefit from data-driven services provided by platforms and cloud providers also become increasingly dependent on them. A small bakery that uses targeted advertising in social media to sell the last of today's pastries before closing shop is in effect dependent on one or several international tech companies to reach customers around the corner in their local neighborhood. Zuboff (2019) describes the accumulation of, and profits generated by, data as surveillance capitalism.

Fifth, with increasing bandwidth and improved tools for video conferencing and remote work, not only has working from home become an option in a growing number of occupations. It has also become possible to hire workers and to work remotely on a regular basis. This could benefit local residential communities because commuters may work from home more often and then also contribute to local consumption. On the other hand, local industrial communities may see a slope in incoming commuters for the same reasons. When people are less obliged to co-locate to work together, the conditions for local knowledge spillovers and unstructured or spontaneous interactions that could contribute to benefits within a single firm but also within a local community or economy.

Sixth, the development of artificial intelligence paves the way for increased automation of analytical tasks, which implies a transformation of the organization and distribution of work (Brynjolfsson et al, 2019). AI applications that benefit from scale in volumes and variation of data are likely to be centralized and operate across several geographical locations, whereas applications that is dependent on specific data from a local process may also be localized. AI-enabled automation will affect the organization and geographical distribution of knowledge-intensive human capital, which will in turn affect the conditions for local knowledge exchange and spillovers.

To realize change profound enough to be called a revolution takes time. Technological change moves cumulatively, and sequentially as new advances are realized and put into practice. Moreover, technology is shaped by institutions and the larger system of innovation it which it is situated. The current technological revolution is situated in a political and economic environment that helped to ignite and shape the digital technological revolution, but which may need to be reconfigured to maintain its positive effects while countering its negative consequences. Some local economies have been successful in leveraging the digital revolution, but those that cannot are instead at the risk of being left behind. The rising spatial

income inequality and decrease in factors necessary for geographic flourishing of innovation are not determined by digital technology but results from choices made by business and government.

4. THE DEMISE OF THE LOCAL

Economists have defined three factors as associated with the agglomeration factors that lead to innovation and start the self-reinforcing cycles of economic growth: within-industry concentration in localization spillovers, between-industry related activity spillovers, and urbanization or size effects. The two formers appear to be in decline.

The specialized suppliers or supply chain relationships that are part of localization economies that suggest new ideas and demand improvements are increasingly rare as supply chains have become increasingly international. This trend might be partially reversed through efforts to re-shore or rebuild local supply chains and offer greater economic resiliency for firms.

Furthermore, the Covid pandemic accelerated the use and adoption of digital technologies for remote work, resulting in a large scale social experiment whose impacts are still being evaluated, with firms balancing productivity and worker satisfaction as they are trying out hybrid organization forms. The outcome of this shift changes the conditions for localization economies. Rhymer (2022) summarizes three effects of remote work in location-independent organizations that affect the creation of knowledge spillovers. The first is the challenge of building familiarity and trust, resulting in a lack of depth and personal connection. The second is an overall reduction in information sharing due to oversimplification and limited documentation and the tendency to reduce inclusion (Malhotra et al., 2001). The result is that not all team members access the same resources and understanding. Third, distributed work introduces workflow delays, resulting in individuals being out of sync and not able to fully participate in decisions, resulting in a lack of consideration of all salient information.

Between-industry externalities that arise from related activities have similarly decreased, suggesting that local businesses do not benefit as much from their surrounding local community. Relationships and people shifting jobs between local industries creates a unique brand of locality that can tie seemingly unrelated industries closer together and thereby enable knowledge exchange. While this locality surely remains to some degree, its effect on local economies seems to be in decline, possibly because local businesses also increasingly turn outside the local economy. Digital markets offer all manner of services that were previous sources of local agency in a uniform and undifferentiated manner. Local public institutions such as universities, trade associations, and unions provide important sources for such

spillovers without concern about direct appropriability, but many of these institutions have diminished in stature.

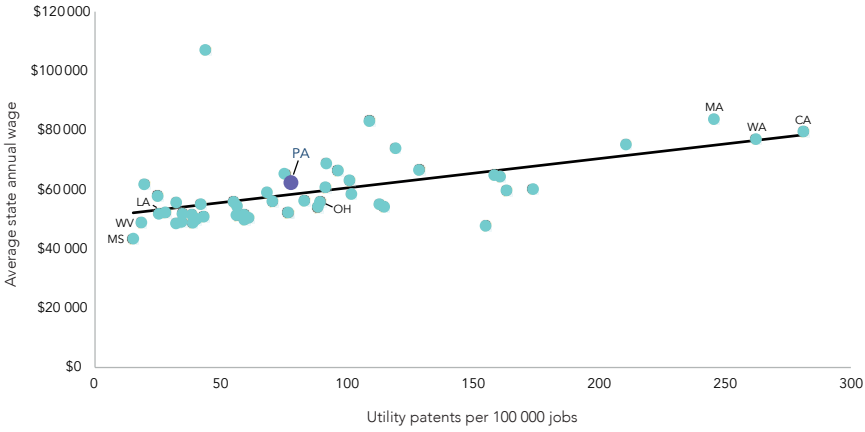
The only agglomeration factor remaining is urbanization or scale economies associated with population size. While government policy claims to be spatially neutral, policy has favored large urban areas (Turner et al., 2022). As more people move to large cities, small local economies loose population and human capital.

Before the digital age, geography conveyed some locational advantage are a way to organize economic activity and enhance human creativity. Historically, places historically developed due to what might even be seen as serendipity or accidents that resulted in the presence of anchor firms or institutions that started the process of creating innovative ecosystems. Consider the early examples automobile industry in Detroit or the Tire industry in Akron, or the more recent story of Silicon Valley. Places also benefitted from local experience as in the story of candle-wicking in Dalton Georgia as portrayed by Krugman (1992). Quirky and unexpected and often trivial historical accidents often underly what ultimately developed as a source of localization economies. In the wake of digitalization, economic interactions have increasingly shifted from long-term relationships to swift and efficient transactions at a loss of rich tacit information and social capital that contributed to local knowledge spillovers. It doesn't have to be that way. The benefits of digital interconnectivity can be combined with the values of locality.

5. BUILDING PLACES IN AN INTERCONNECTED WORLD

The consensus among economists is that innovation—the creation and adoption of new products, services, and business models—is the key to improved standards of living. Another realization is that the locus of innovative activity is still local. The challenge is how to best harness digitization. Figure 2 demonstrates the persistent links between innovation and positive economic outcomes: higher innovation rates in American states (measured by patents per 100,000 jobs) correlate with higher standards of living (measured by average annual wages). Places that create well-paying jobs, in turn, produce a solid tax base that support good local schools, public universities, and a robust infrastructure, which enables and feeds the business sector in a mutually reinforcing cycle. Thus, mayors, university presidents, and chambers of commerce are constantly striving to turn their towns into the next Silicon Alley, Silicon Desert, or Silicon Forest. The key is striking the most productive balance between high quality local context and outside interconnectivity. With digitalization, many places have the latter but those that lose the former risk falling behind.

Figure 2. Average state annual wage, given utility patents per 100,000 jobs, 2020



Source: Brookings analysis of US Patent and Trademark Office and Bureau of Labor Statistics data.

There is broad consensus that regions in which prosperity flourishes have several common denominators (Feldman et al., 2014). Locally, these include the participation of entrepreneurs, who invest in building infrastructure as they build their firms; local champions, who believe in a place and make long term investments; benevolent, and large anchors either academic institutions or firms that build and sustain the local resources. Outside the local economy, innovative regions link into broader national and international networks, often through multinational firms with a local presence; these connections allow regions to draw on new knowledge and talent.

The most critical factor in an innovative region is the process of constructing shared meaning over time that ties the local connection and the global interconnectivity together in a meaningful way: the way local actors build institutions and create social capital during the sequential and dynamic process of creating an industrial cluster.

Government plays an important part by making long-term and altruistic investments in the interest of public welfare. A related ingredient is good governance, defined as the democratic process of building consensus to solve a collective problem, which simultaneously creates the social norms and institutions that convey place-specific advantages.

Economists have been skeptical of place-based economic development strategies, arguing that a tradeoff exists between local gains and national welfare (Klein and Moretti, 2014). The contention is that resources are simply being redistributed from one place to another to the detriment of overall national welfare. A 2009 World

Bank Report advocates for a "spatially blind" (or people-based) approach rather than place-based as the "most effective way of generating efficiency, guaranteeing equal opportunities, and improving the lives of individuals where they live and work." The report asserts that encouraging mobility enables people to live in places where they will likely be more economically productive which, in turn, increases individual income, productivity, and aggregate growth, and leads to a more even geographical distribution of wealth.

On the other hand, proponents of place-based approaches to economic development argue that it is necessary to fully understand the local and regional context to create development policies that will succeed in a particular area. The industrial genesis of North Carolina's Research Triangle Region offers an illustrative example of adaptive and improvisation policy (Lowe and Feldman, 2019). The place-based approach asserts that one-size-fits-all policies that do not consider the regional context of the area that they are trying to assist may have unanticipated (and potentially negative) consequences. While the pros and cons of place-based policies make for an interesting academic discussion, at this point many policy makers cannot afford to wait. There is a need for a fresh take on policy to restructure and revive local economies across the US.

A paradox of our time is that we live with powerful technology accompanied by increasing income inequality in the developed world. A technology revolution calls for a revolution in our political and economic discourse. Nelson (1979) asked asks the question, "If we can land a man on the moon, why can't we solve the problems of the ghetto?" As a society we have become accustomed to spectacular technological achievements and great material progress, yet we have only modest gains for a host of urgent problems, including addressing regional income inequalities. The time has come to reevaluate the role of government and public infrastructure if we are to fully realize the potential of the digital revolution.

REFERENCES

Appelbaum, B. (2019). The Economists' Hour: False Prophets, Free Markets, and the Fracture of Society. Little, Brown & Company.

Arora, A., Belenzon, S., & Patacconi, A. (2018). The decline of science in corporate R&D. Strategic Management Journal, 39(1), 3–32.

Bikard, M. and Marx, M. (2020) Bridging Academia and Industry: How Geographic Hubs Connect University Science and Corporate Technology. Management Science 66(8):3425-3443.

Brynjolfsson, E., Rock, D. and Syverson, C. (2017). "Artificial Intelligence and the Modern Productivity Paradox: A Clash of Expectations and Statistics." Economics of Artificial Intelligence, University of Chicago Press.
Dudley, R. (2020). Amazon's New Competitive Advantage: Putting Its Own Products First. ProPublica, June 6. Accessed at https://www.propublica.org/article/amazons-new-competitive-advantage-putting-its-own-products-first
Evans, D. S., & Schmalensee, R. (2016). Matchmakers: The new economics of multisided platforms. Harvard Business Review Press.
Feldman, M.P., Hadjimichael, T., Kemeny, T. & Lanahan, L. (2014). The logic of economic development: A definition and model for investment. Environment and Planning C Government and Policy. 34 (1) 5–21.
Feldman, M.P. and M. Storper, (2018). "Economic Growth and Economic Development: Geographical Dimensions, Definition, and Disparities," In: The New Handbook of Economic Geography. Oxford University Press, Oxford, UK.
Grullon, G., Larkin, Y. and Michaely, R. (2019). Are U.S. Industries Becoming More Concentrated? (2019). Forthcoming, Review of Finance, 23 (4) 697–743.
Kline P, & Moretti E, 2014. People, Places, and Public Policy: Some Simple Welfare Economics of Local Economic Development Programs. Annual Review of Economics 2014 6:1, 629-662.
Lowe, N. and Feldman, M. P. (2018). Breaking the Waves: Innovating at the Intersections of Economic Development. Economic Development Quarterly, 32(3), 183–194.
McKinley, S. (2020). Microsoft Airband: An annual update on connecting rural America. Published online https://blogs.microsoft.com/on-the-issues/2020/03/05/update-connecting-rural-america/
Marr, B. (2022) The 10 Best Platform Business Model Examples. Accessed online at https://bernardmarr.com/the-10-best-platform-business-model-examples/
OECD (2021), The Digital Transformation of SMEs, OECD Studies on SMEs and Entrepreneurship, OECD Publishing, Paris, https://doi.org/10.1787/bdb9256a-en.
Piketty, Thomas, and Emmanuel Saez. 2003. "Income Inequality in the United States, 1913-2002." Quarterly Journal of Economics 118 (1): 1–39.
Rodriguez-Pose, Andrés. 2018. "The Revenge of the Places That Don't Matter (and What to Do about It)." Cambridge Journal of Regions, Economy and Society 11 (1): 189–209.
Turner, M.A. et al. (2022). Designing the Next Generation of Federal Place-Based Policy
Insights from Past and Ongoing Programs, Urban Institute https://www.urban.org/sites/default/files/publication/104331/designing-the-next-generation-of-federal-place-based-policy_0.pdf
Zuboff S (2019) The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. 1st ed. New York, NY: Public Affairs.

CHAPTER 3

THE GEO-ECONOMICS OF RENEWABLES:

Implications for innovation and entrepreneurship

THIJS VAN DE GRAAF

1. INTRODUCTION

The world is in the grip of perhaps the biggest global energy crisis since the 1970s. Following Russia's invasion of Ukraine, a full-blown energy war has erupted between Russia and the West, leading to a major reorientation of coal, gas, and oil trade flows and impacting all countries in the world. The 2022 energy shock forcefully drives home the point that energy is central to the power and wealth of nations. The aim of this chapter is to look past the headlines at more structural, long-term trends in the geo-economics of energy. The central argument is that we are at the cusp of an even more profound change in the energy system, one from fossil fuels to renewables. This impending shift will not merely reshuffle geopolitical power among different actors on the world map, it will also transform the map itself (see Yergin, 2020; Scholten et al., 2020).

The old fossil fuel map was characterized by a heavy geographic concentration of reserves, huge cross-border trade and investment flows, and monumental risks and rewards for participants in these value chains. The emerging renewables map looks entirely different. Renewables such as solar and wind power are available in most countries, take the form of inexhaustible flows rather than finite stocks, and can be deployed at any scale (from rooftop solar power at the level of households to utility-scale wind farms). The system will shift from a heavy focus on fuels and volatile operational expenditures (OPEX) to reliance on technology (hardware) and more predictable and declining capital expenditures (CAPEX). Asset ownership will change: whereas fossil fuels are concentrated in the hands of a relatively small number of states, a more dispersed form of ownership is now emerging along with

a more diverse energy ecosystem. The nature of energy dependency will evolve as international trade in fossil fuels gives way to trade in critical materials, technologies, and renewable electricity and fuels.

This new map is emerging much faster than many realize. Not so long ago, renewable energy was still referred to as "alternative" energy, too expensive to expand beyond niche markets. Today, this perception has fundamentally changed. As oil company BP notes, renewables are penetrating the global energy system "more quickly than any fuel ever seen in history" (BP, 2019). This is true in all of the scenarios presented by BP in its 2019 report. In its rapid transition scenario, which is largely aligned with the two degrees Celsius goal of the Paris Agreement, the company notes that the growth of renewables would be "literally off-the-charts relative to anything seen in history" (BP, 2019, p. 107). In the words of the International Energy Agency (IEA), the exceptional growth of renewables has become the "new normal" (IEA, 2021a). In its latest World Energy Outlook, the IEA sees fossil fuel demand peaking in every area and every scenario (IEA, 2022d). After more than 200 years of growth, we are at a turning point in the energy system as fossil fuel demand is squeezed between rising renewable deployment and increasing energy efficiency.

Renewables are at the leading edge of a global energy transformation. Their growth is dominated by wind and solar photovoltaic (PV) power and aided by at least three major forces: (1) falling production costs, (2) ever more stringent policies to combat climate change and air pollution, and (3) rising social and investor pressure for change (IRENA, 2019a). Renewables are growing fastest in the power sector, where they capture almost all of the growth, but they increasingly also find their way to other end-use sectors such as transport, buildings, and industry thanks to the decreasing cost of technologies such as batteries, heat pumps, and electrolyzers (IRENA, 2022b).

The world has transitioned to new energy sources before, from wood to coal and from coal to oil. Each shift has entailed changes in the geopolitical map of the world. Coal and steam power, for example, were essential pillars of the British Empire in the 19th century, whereas control over oil production and trade formed the bedrock of American power in the twentieth century. In a similar vein, the shift from fossil fuels to renewables will have effects that reverberate well beyond the energy sector and will shape the outlook of the twenty-first century world order. The grand energy transition from fossil fuels to renewables is not merely a technical process, nor is it a simple shift from one set of fuels to another. Instead, it is a much deeper transformation of our energy systems that will have profound geopolitical and global economic implications (IRENA, 2019a) for innovation and entrepreneurship.

The energy transformation is happening in an era of intense geopolitical competition. Without exception, great powers view technological prowess as a key component of

national security and deploy geo-economic strategies to bolster their technological and industrial positions. The geopolitics of renewables must be assessed against the backdrop of two consecutive and very severe shocks to global supply chains caused by, first, the Covid-19 pandemic, and second, Russia's war in Ukraine, which triggered or exacerbated a massive energy shock. These shocks have further reinforced the debate on reshoring or "friendshoring" supply chains and, particularly in Europe, have boosted the energy transition as a means to break free from Russian fossil fuel imports. In the US and China, the debate centers more on technology sovereignty and independence, a consequence of geopolitical rivalry, but the result is the same.

This chapter asks: what are the geopolitical and global economic implications of the global energy transformation? I argue that we cannot simply transpose our thinking from the old geopolitics of energy onto the new geopolitics of energy. Since renewables are essentially technologies (or hardware), future energy geopolitics will be less defined by what is extracted from the ground and more by knowledge and technology. Countries already find themselves locked in a hardnosed clean-energy technology race. The geopolitical drivers and consequences of the renewables-led energy transition will therefore have major implications for innovation and entrepreneurship. It could stimulate progress, in a twenty-first century equivalent of the "space race" of the Cold War, but it may as well stymie progress if it leads to protectionism and uneven access to new energy technologies and know-how.

The remainder of this chapter is organized into four sections. The next section, Section 2, provides an overview of the debates on how renewables are altering the geopolitics of energy. Section 3 outlines the contours (and winners) of the clean-energy technology race. Section 4 discusses emerging risks and vulnerabilities around clean-energy supply chains and discusses strategies to mitigate those risks. Finally, Section 5 concludes and outlines key trade-offs and scenarios that help to think in a more structured way about the future geopolitics and geo-economics of energy.

2. THE GEOPOLITICS OF RENEWABLES

2.1. An age of technological disruption

Throughout history, technological innovations from the steam engine to electricity not only molded national economies and societies but also restructured almost all aspects of human life, altered global trade patterns, and shaped the global balance of power. The development of frontier technologies can boost a country's economy and, therefore, global influence. In some cases, technological innovations allow a country to gain a military edge. The rise and fall of nations are driven in no small part by differences in their ability to harness scientific progress and create new growth industries (Van de Graaf and Sovacool, 2020).

In this age of rapid technological disruption, national power will come to be defined even more by a country's technological prowess and position in global value chains than at any time before. Breakthroughs and innovations in areas ranging from artificial intelligence, robotics, connectivity, and nanotechnology, among others, are driving a fourth industrial revolution (Schwab, 2016). These emerging technologies are already spurring the creation of new business models, the disruption of incumbents, and the reshaping of production, consumption, and transportation systems. The energy sector is no stranger to these effects. Technologies have always driven change, but perhaps never at this pace and on this scale.

All previous industrial revolutions have had both positive and negative effects. Nations have become wealthier, and entire societies have been pulled out of poverty, often thanks to technological innovations and breakthroughs. The benefits of new technologies have not been fairly distributed, however, and in many cases, societies have had to grapple with new externalities and global challenges brought about by technological innovations. Technological innovation sometimes leads to a first-mover advantage for pioneering countries and companies. This grants the top runners significant economic influence and a chance to shape global environmental and social norms and standards while deepening inequalities both within and between countries (UNIDO, 2017).

The emergence of new and disruptive technologies coincides with a period of radical uncertainty in world politics. The end of the Cold War inaugurated an era of geopolitical peace and stability. The world's largest powers seemed to converge on a single model of international order—a globalized version of the liberal order the US had led since the Second World War. Free trade deals, rapidly emerging economies, and increased cross-border investment and exchanges all combined to make a system that was more interdependent than at any other time in history. This order has gradually eroded after 9/11, and especially in the wake of the 2008 global financial crisis, due to global technological and power shifts that have left many nations unmoored from old certainties (Blackwill and Wright, 2020). Economic nationalism, unilateralism, and great-power rivalry have again come to characterize inter-state relations.

The dramatic technological and geopolitical transformations were already well underway before Covid-19, but the pandemic seems to have catalyzed or even accelerated existing trends. The outbreak of the novel coronavirus highlighted the vulnerabilities of global supply chains and strengthened calls for the reshoring of critical industries. It has reinforced a revival of industrial policy, once considered taboo in mainstream economic circles (Cherif and Hasanov, 2019; Andersson et al., 2021). Governments are not shying away from using all of the tools at their disposal to "build back better." At the same time, countries have grown wary of becoming too reliant on foreign companies or technologies, giving rise to concepts such as

"decoupling," "strategic autonomy," and "digital sovereignty." The war in Ukraine has only strengthened this trend.

2.1 WHY RENEWABLES WILL TRANSFORM GEOPOLITICS

After a decade of spectacular cost declines, renewables have emerged as the cheapest source of new power generation (IRENA, 2022a). In the most ideal locations, solar PV power is now even considered the "cheapest source of electricity in history" (IEA, 2020b). The decarbonization industry attracts more than half a trillion US dollars a year (IRENA, 2022b), almost matching total investments in fossil fuels (IEA, 2022a), the fuels that underpinned earlier industrial revolutions. These dramatic changes are ushering in a new era in energy geopolitics.

There are at least four reasons to believe that a renewable-powered world will be very different from the fossil fuel–powered world of the past 150 years (IRENA, 2019a).

- First, fossil fuels are concentrated in specific geographic locations, whereas renewables are much more dispersed. In fact, renewables (wind, solar, biomass, geothermal, hydro, and ocean energy) are available in one form or another in most countries.
- Second, renewables take the form of infinite flows (of wind, water, sun, and warmth from the Earth's crust) rather than finite stocks of energy, which means that they cannot be exhausted and are harder to disrupt.
- Third, while fossil fuels lead to centralized systems of energy production, renewables can be deployed on almost any scale and lend themselves better to decentralized forms of energy production and consumption.
- Fourth, the operating costs for fossil fuels are sensitive to underlying changes in fuel prices, which tend to be cyclical. Modern renewables, by contrast, have nearly zero marginal costs, and some, like solar, wind, or electrolyzers, are on technological learning curves (i.e., they enjoy cost reductions of nearly 20 percent for every doubling of capacity).

The energy transition is often discussed in the future tense, as something that might or will happen in the next few decades. In reality, the transition is already well underway and even shows signs of acceleration. Over the past ten years (2011–2021), the consumption of renewables grew at a compound annual rate of more than eleven percent while gas use increased at a rate of just 2.2 percent, both growing faster than total energy consumption (1.3 percent). By contrast, oil consumption (+0.7 percent) and coal use (+0.5 percent) increased more slowly than consumption as a whole (BP, 2022).

The geopolitical effects of the energy transition will be felt early on. Considering the massive impact that coal had on the nineteenth-century world order, it may be surprising that it only surpassed wood as the world's primary energy source around 1900 (Smil, 2014). Similarly, it was not until the 1950s that oil overtook coal as the world's primary energy source. By that time, the two devastating world wars had underscored the critical importance of petroleum for the security and wealth of nations.

All of this implies that we do not have to wait for renewables to overtake fossil fuels in the world's energy mix to see the contours of this new energy order. In fact, many countries are already recalibrating their foreign and strategic (geo-)economic policies to the clean-energy transition—whether it is the oil kingdoms of the Persian Gulf planning for life beyond oil (e.g., Saudi Arabia's Vision 2030), India's leadership in setting up the International Solar Alliance, Europe's Green Deal to achieve climate neutrality by 2050, China's bid for technology leadership in electric mobility, Japan's search for new energy trading partners to import hydrogen, or the critical materials strategies that all major nations have developed.

Having established that renewables are disrupting existing energy value chains, in the next section, I describe the emerging contours of the new geopolitics of energy.

2.3. KEY TENETS OF THE NEW GEOPOLITICS OF ENERGY

The geopolitical implications of renewable energy can roughly be organized around four clusters of key tenets: energy independence, technology leadership, new resource dependencies, and the risk of socioeconomic disruption (IRENA, 2019a; Scholten et al., 2020).

2.3.1. Energy independence

Countries currently dependent on imported energy will be able to produce (most of) their energy domestically, which entails improved energy security and fewer opportunities for energy statecraft—that is, the practice of weaponizing energy supplies (IRENA, 2019a).

Most countries possess some form of renewable energy, be it wind, solar, hydro, biomass, geothermal, or ocean power. This offers them the opportunity to reduce their dependence on foreign suppliers. Countries now face a make-or-buy decision between secure domestic production and imports of renewable energy. This fundamentally blurs the classical distinction between importers and exporters, creating a world of "prosumer" countries. Countries that switch from imported fossil fuels to domestically generated renewable energy will significantly improve their trade balance. They will also be less vulnerable or beholden to their suppliers and will

therefore be able to pursue their strategic and foreign policy goals more independently (IRENA, 2019a).

In a world powered mostly by renewables, energy statecraft as we know it will change. In the words of former US President Jimmy Carter, "no one can ever embargo the sun or interrupt its delivery to us." The use of energy as a geopolitical instrument will lose much of its currency. Electricity, hydrogen, biofuels, and other materials critical for renewable technologies will gain significance, but they are unlikely to pose the same geopolitical risks or gain the strategic importance of oil and gas (IRENA, 2019a).

2.3.2. Technology leadership

Countries that lead in technological innovation stand to gain from the global energy transformation, although they are unlikely to achieve the market dominance and geopolitical leverage that the fossil fuel leaders once had. Control over significant energy resources and markets is an important power asset because it enables states to protect vital national interests at home and to leverage economic and political influence abroad. Thus, states without such assets are vulnerable (IRENA, 2019a).

Countries like China, which are currently at the forefront of the clean-energy race, can expect to benefit the most from the opportunities that the transformation brings and enhance their global influence as a result. In aggregate, China is now the world's largest producer, exporter, and installer of solar panels, wind turbines, batteries, and electric vehicles (EVs); (IRENA, 2019a).

Since renewables tend to decentralize and democratize energy systems, the energy transformation will lead to a diffusion of power. It will empower new actors such as citizens, cities, and regions with a newfound ability to generate their own energy (Stephens, 2019). Governments will be forced to rethink their tax systems and energy market design. As the use of fossil fuels declines in a Paris-compliant scenario, so too will government revenue streams from taxing the production and the consumption of fossil fuels (including, for example, vehicle excise duties, plastic taxes, and carbon taxes more generally) (EEA, 2022). This could have political consequences for the role of the nation-state in energy systems (IRENA, 2019a).

2.3.3. New resource dependencies

Renewables will change the geography, nature, and volume of energy trade. In broad terms, the weight of energy dependence will shift from global fuel markets to regional grids. Countries that today import oil and gas from the other side of the world will seek to develop renewables at home and integrate their grids with those of neighboring countries, creating new geographies of energy trade. Electricity and hydrogen will become the cornerstone of new patterns of energy trade, altering the

nature of relations between states and fostering a regionalization of energy trade (IRENA, 2022c). Much of the energy-related trade that persists will concern renewable energy technologies and services rather than energy sources and carriers.

The shift from fossil fuels to renewables will reshuffle political and military relations between countries. Alliances that are built on fossil fuels, such as the Organization of the Petroleum Exporting Countries, are likely to weaken and change, while new bilateral and multilateral energy relations will emerge that are centered on renewables. US security partnerships with the Middle East could dwindle. Conversely, international organizations focused on renewables, such as the International Renewable Energy Agency and the International Solar Alliance, will thrive.

The energy transition will be mineral and metal intensive, creating new resource dependencies and vulnerabilities. In countries struggling with political instability and weak governance, the extraction of these minerals can be linked to violence, conflict, and human rights abuses. The search for minerals could also increase competition among states over the global commons (e.g., the Arctic, deep sea, outer space, etc.). Market concentration creates a risk that certain states will attempt to "cartelize" or even "weaponize" trade in minerals and raw materials.

2.3.4. Socio-economic disruption

The energy transition will bring socio-economic boons but also threats. The pivot to renewables will promote prosperity and job creation, improve food and water security, and enhance sustainability and equity. It will increase energy access and offer developing economies an opportunity to leapfrog a fossil fuel–based development model and centralized grids. Just as a number of countries have skipped landlines and moved to mobile phones directly, off-grid renewables do not require the large infrastructure investments of the past. In this sense, renewables have numerous benefits that will address many of the root causes of poverty, marginalization, migration, and political instability.

At the same time, the shift to renewables may also create new social tensions and financial risks, such as stranded assets, which could reverberate through international politics. In a classic process of "creative destruction," some companies will thrive while others may encounter their "Kodak moment."

Major fossil fuel exporters face economic, social, and political risks if they do not take steps to transform and diversify their economies. Countries that have historically gained geopolitical leverage because they supply fossil fuels are likely to see a decline in their relative global reach and power unless they can reinvent themselves

for a new energy era. High-cost producer countries with high exposure and low resilience to the energy transition may experience economic hardship and possibly political instability, with potential spillover across borders. Producer countries may battle for market share in what is ultimately a shrinking market (Van de Graaf, 2018; 2022). The competition could be commercial only, or it might also take on geopolitical dimensions, for instance, when the oil of rivals is kept in the ground through sanctions or attacks (Verbruggen and Van de Graaf, 2013).

3. THE INNOVATION LANDSCAPE OF RENEWABLE ENERGY

3.1. The growing green economy

A new global energy economy is emerging. Given the scale of the necessary transformation, the energy transition is a clear business opportunity. Explosive growth in clean-energy deployment over the next decades could create an immense market for manufacturers of key equipment, worth a cumulative USD 27 trillion through to 2050 (IEA, 2021c).

Many of the clean-energy technologies needed to hold the global temperature rise at approximately 1.5°C already exist and are mature. Despite this, numerous existing solutions are not yet deployed at scale. Only two out of 55 technologies or other components fundamental for achieving net-zero emissions by 2050 are currently fully "on track": electric vehicles (EVs) and efficient lighting, including the deployment of light-emitting diodes (LED). EV sales doubled in 2021 to account for almost nine percent of new car sales, and over 50 percent of the global lighting market now uses LED technology (IEA, 2022b).

Other technologies show positive trends, but progress needs to accelerate to align with a net-zero-by-2050 trajectory. Solar photovoltaic system (PV) and wind power, for instance, are progressing at rapid speed (each increased by around 20 percent in 2021) but must grow even faster in a Paris-compliant decarbonization scenario. Other components, such as electrification, hydrogen, and digitalization, must also develop faster than they currently are (IEA, 2022b). Finally, there are areas in which things are going in the wrong direction or progress is "substantially insufficient," including behavioral changes, carbon capture, utilization and storage (CCUS), and decarbonizing industries like steel, chemicals, cement, aluminum, and pulp and paper (IEA, 2022b).

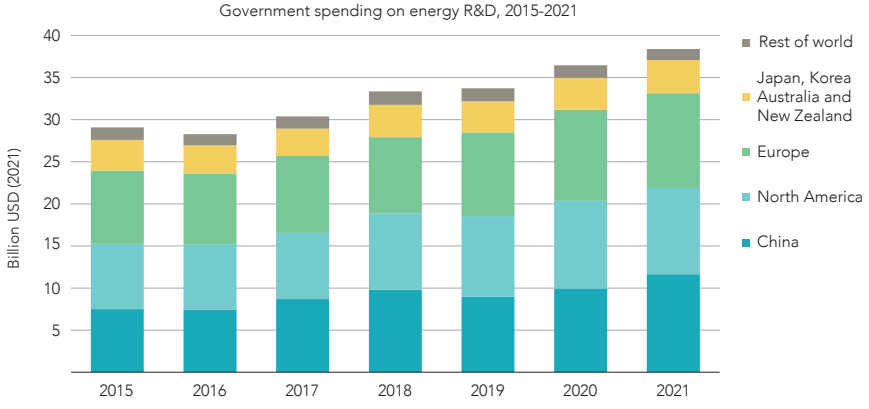
Reaching net-zero emissions by mid-century therefore still requires huge leaps in clean-energy innovation. The IEA reckons that almost half of the emission reductions by 2050 will come from technologies that are currently in the demonstration

or prototype phase, that is, not yet available on the market (IEA, 2021b). This is especially so for the so-called hard-to-abate sectors, including heavy industry and long-distance transportation. It is important to emphasize that innovation includes not only technological innovation (or inventions) but also innovation in business models, social systems, and lifestyles.

Several barriers are limiting the development and deployment of clean-energy technologies, including skills shortages, lack of public acceptance, policy uncertainty, and financial barriers (OECD, 2019). Technologies that are small and modular are less capital intensive than large engineering solutions, which reduces their investment risks in the development phase. Conversely, technologies that are more complex and less susceptible to standardization have progressed at a slower pace (Malhotra and Schmidt, 2022).

On the upside, governments are spending more and more on energy research and development (R&D; see Figure 1), and venture capital investments in clean-energy start-ups reached an all-time high in 2021 (IEA, 2022b). Figure 1 shows that public energy R&D has trended upwards in the last couple of years, and, if history provides any guidance, today's elevated fossil fuel prices and energy-security concerns could further bolster clean-energy innovation (IEA, 2022a). Energy R&D is in the order of USD ten billion per year in China, the US, and Europe. For comparison, public spending on energy R&D by Sweden amounted to approximately USD 322 million in 2021, or around 0.05 percent of the Swedish GDP (IEA, 2022d).

Figure 1. Spending on energy R&D by governments, 2015–2021 (bn USD)



Source: IEA (2022a).

3.2. Innovation needs for meeting the net-zero goal

Moving towards a net-zero emissions economy will create new challenges that require innovative solutions. The traditional boundaries between different energy sectors such as electricity, heat, and transport will get blurred with the rise of electric mobility, green hydrogen, and other solutions. The strict separation between consumers and producers is already giving way to a new class of energy "prosumers." Energy transport and storage systems traditionally geared towards fossil fuels will increasingly be used for moving and storing renewable fuels and carbon dioxide. These system transformations require new enabling technologies, business models, and market designs (IRENA, 2019b).

One of the central challenges is the integration of variable renewable energy, such as solar and wind power, into electricity systems. Rising shares of wind and solar PV power are putting a considerable premium on robust grids. In 2021, there were already ten countries where solar and wind power contributed more than a quarter of the electricity demand. These include economic powerhouses such as Germany but also developing countries like Namibia. The absolute frontrunner here is Denmark, where solar and wind met 65 percent of electricity demand in 2021 (Bloomberg Philanthropies and BNEF, 2022). The five largest economies in the world—the US, China, Japan, Germany, and the UK—already sourced over a tenth of their electricity from solar and wind power (Ember, 2022).

On the demand side, too, there will be increased variability, shaped by the growing deployment of heat pumps and air conditioners. Fluctuations in electricity demand could be exacerbated by poorly sequenced recharging of EV fleets or extreme weather events such as cold or heat waves (IEA, 2021c). Several enabling technologies are helping to decarbonize our economies and are thus an important part of the energy transition landscape. Digitalization will play a crucial role in integrating variable renewables into the power system. Smart meters, connected appliances, and machine learning, for instance, can help to match increasingly heterogeneous and dispersed electricity supply and demand (IRENA, 2019b).

Another area where innovation is warranted is energy storage, particularly long-duration energy storage. There is a wide range of candidate technologies, including electrochemical (e.g., flow batteries), mechanical (e.g., compressed air), thermal (e.g., latent heat storage), and chemical storage technologies (e.g., synthetic methane). Yet, they are at different levels of technology readiness and require more innovation efforts (Jenkins and Sepulveda, 2021).

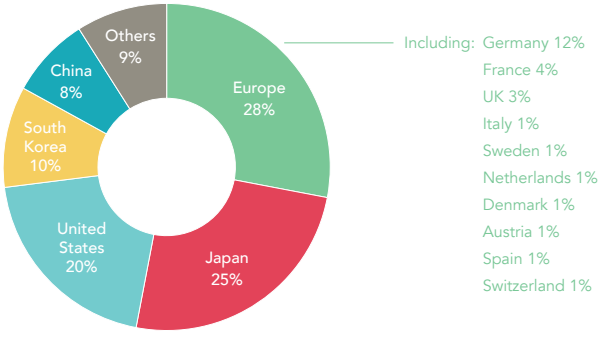
Other fields where many technologies are still in the prototype and demonstration phase are CO2 capture, transport, utilization, and storage, as well as clean hydrogen production and usage (IEA, 2020a).

3.3. Trends in clean-energy patents

Measuring innovation and technological advancement is not straightforward, but energy-related patent trends can provide a good picture of the countries and sectors that are leading clean-energy technology innovation. A joint study by the IEA and the European Patent Office reveals a clear divergence since 2015 between a continued rise in patents for low-carbon technologies and a decline in patenting for fossil fuels (IEA and EPO, 2021). The report counted instances when patents were filed in more than one office, known as international patent families (IPFs).

Europe, Japan, and the US dominate the global low-carbon energy innovation landscape, together accounting for more than 75 percent of all IPFs generated between 2000 and 2019. Europe has consistently led patenting innovations (28 percent of IPFs), followed closely by Japan (25 percent). The US has been a distant third (20 percent). South Korea and China remain modest innovation centers (at only ten percent and eight percent of all IPFs, respectively), but both countries have experienced a significant uptick in patenting activities in recent years.

Figure 2. Global share of low-carbon energy IPFs, 2010–2019



Source: IEA and EPO (2022).

Since 2017, most of the growth in clean-energy patents has been related to batteries, hydrogen, smart grids, as well as CCUS. This is indicative of a more general shift away from clean-energy generating technologies like wind, solar, hydro, or geothermal towards enabling technologies connected to fuel switching or energy efficiency.

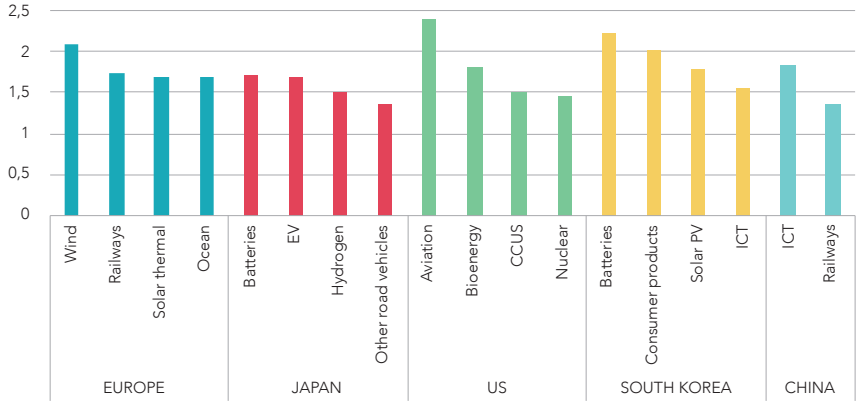
The IEA-EPO report also discusses the "revealed technology advantage" (RTA) of certain countries or regions over others, which results from a greater level of technological innovation and specialization. The RTA is defined as a country's share of IPFs in a particular field of technology divided by the country's share of IPFs in all fields of technology over the period 2010–2019. Any value above one indicates a relative specialization in a given technology. For example, a value of two indicates

that a country's share of patents for that particular technology is twice as high as the country's overall share of patents for all technologies.

The analysis reveals where countries have an edge. Europe has a leading position in wind-technology development. However, the level of expertise varies greatly within Europe. Denmark has by far the strongest specialization in wind-energy technology, with an RTA value of 28.91. This is aligned with an energy ecosystem that is more reliant on wind energy than any other country in the world as almost half of the country's electricity production comes from wind power (Ember, 2022). Spain, the UK, and Germany also have high RTA values for wind power (5.65, 1.82, and 1.83, respectively). These technological specializations are consistent with policy-driven focuses on wind-energy generation and high shares of wind power in national electricity mixes.

Japan is a world leader in batteries and hydrogen, which translates into an advantage in patenting for EVs. The main strengths of the US lie in fossil fuel technologies but also biofuels, CCUS, and nuclear power. Korea's main advantages are in battery technology, energy efficiency, and solar PV power. China holds a strong position in information and communication technologies (ICT) enabling the energy transition (IEA and EPO, 2011).

Figure 3. Main technological advantages in low-carbon energy of key innovation centers



Source: IEA and EPO (2022).

To conclude this section, a new green energy economy is rapidly emerging and attracting ever more funding, both public and private. While some low-carbon energy value chains are rapidly becoming mature (e.g., PV solar panels), other areas of the energy transition still require major innovation. In terms of both public energy R&D

and low-carbon technology patenting, Europe is a global frontrunner. Its biggest edge at the moment concerns wind technology, but it has placed high bets on other technologies such as hydrogen.

4. SECURING SUPPLY CHAINS FOR THE ENERGY TRANSITION

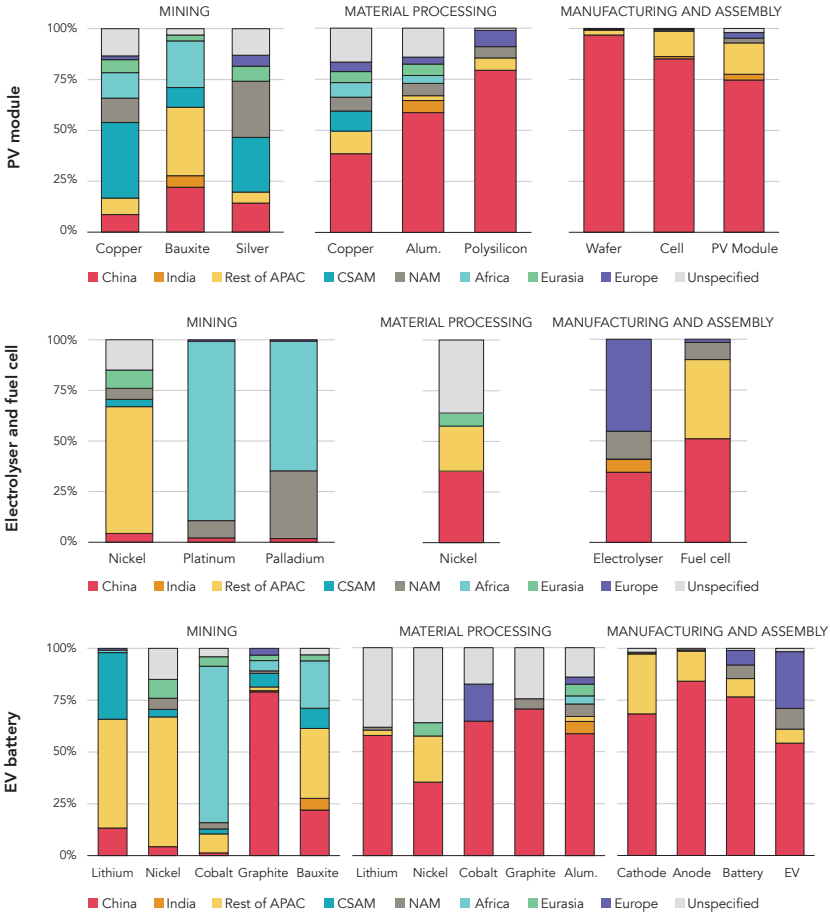
4.1. Assessing risks and vulnerabilities

Even though the global energy transition can foster more energy independence, its success still hinges on robust international supply chains for clean-energy technologies. The Covid-19 pandemic and Russia's invasion of Ukraine have put these supply chains under enormous stress and have led to rising prices and even shortages of critical minerals, materials, and components needed to manufacture clean-energy technologies. These disruptions are threatening the decades-long trend of declining costs of renewables (IRENA, 2022a). For example, supply-chain disruptions and higher raw materials prices are already slowing down the rollout of EVs. Volkswagen sold out of EVs in the US and Europe in the first three months of 2022, and Nio, a Chinese EV manufacturer, had to suspend production in April 2022 due to local supply-chain problems (IEA, 2022c).

Risks and vulnerabilities, which vary for each clean-energy technology, must be assessed along each step in the supply chain, from mining to processing and manufacturing. The factors to consider in each step are supply concentration, expected demand growth, exposure to geopolitical risks, substitution options, and lead times to scale up infrastructure (IEA, 2022c). According to the IEA, supply risks and vulnerabilities are particularly acute for battery and solar components. For example, the mining of lithium (critical for batteries) is geographically highly concentrated, and some trade routes are vulnerable to trade or natural disruptions. Bringing online new extraction requires major investments and is subject to long lead times. There are currently no alternative battery chemistries that avoid lithium (IEA, 2022c).

In today's geopolitical era, countries do not want to become overly dependent on their strategic rivals for key materials, components, and products. China's dominant position in key segments of the value chains of solar PV panels, batteries, and critical materials has caused concern in other parts of the world. The worry is not just that China might exploit its dominant position for geopolitical ends but also that it will disproportionately reap the economic benefits of the energy transition while the costs are borne by others. The decline of Europe's solar industry and the almost complete loss of manufacturing capacity to China in the 2010s made renewables subject to growing concerns around EU technology leadership in a strategically important sector. Similar concerns have surfaced in other major economies, including the US, Japan, and Australia.

Figure 4. Geographic concentration of selected clean-energy technologies by supply-chain stage and country/region, 2021



Source: IEA (2022c).

4.2. Strategies to secure supply chains

As the world moves towards a net-zero economy, the meaning of energy security will shift too. Instead of referring to the uninterrupted supply of fossil fuels at affordable prices, greater emphasis will be put on the resilience and sustainability of supply chains of clean-energy technologies and renewable fuels. However, the cornerstone of energy security—that is, the imperative of diversification—will remain unchanged. As Figure 4 shows, clean-energy supply chains are currently highly concentrated, in some respects even more than oil and gas. The diversification of firms, geographies, and technologies will therefore become the mainstay of energy security

in a decarbonizing world. For some critical materials, joint stockpiling might further bolster supply security.

Major economies are crafting green industrial policies to secure their share of the clean-energy value chains. The EU, for instance, has set up strategic alliances around batteries, clean hydrogen, and solar PV panels to maintain (or regain) technological leadership in crucial areas of the energy transition. The post-pandemic recovery plans of key member states such as France and Germany explicitly mention reshoring manufacturing chains, including those for renewables. The REPowerEU plan, adopted in May 2022 in the wake of Russia's war in Ukraine, contains specific proposals for strengthening European supply chains for solar, wind, hydrogen, and heat pump technologies and fostering breakthrough technologies and innovations along these value chains.

To prevent bottlenecks in renewable energy supply chains, a massive surge in clean-energy investment is needed, alongside programs to train workers and boost skills for the new energy economy. International collaboration between governments could help to create international standards (see chapter 6 by Rülig in this volume), monitoring, and verification for clean-energy products and goods. This does not solely cover technical and safety standards but also environmental standards to ensure that future trade in energy goods is compatible with the Paris climate goals. One area where such standards are particularly needed is clean-hydrogen trade given the various emission footprints of hydrogen production, conversion, and transport pathways. This trend is visible in the broader economy: nowadays, many companies—not just energy companies—want to "clean up" their supply chains.

5. DISCUSSION AND CONCLUSIONS

The rapid rise of renewable energy coincides with and contributes to major geopolitical shifts in the world order. Technological innovation for the net-zero economy is becoming a major battleground for geo-economic competition between major countries. A global clean-energy race might benefit climate action if it sparks innovation similar to the space race between the US and the USSR in the early days of the Cold War. Yet, it also brings major challenges.

In this conclusion, I highlight the crucial role of governments in fostering clean-energy innovation but also two dilemmas they must overcome: the tensions between secure value chains and open markets, on the one hand, and between protecting home-grown innovation and closing the global innovation divide, on the other. Finally, I outline four broad geopolitical scenarios for the global energy transition in an attempt to sketch possible future pathways.

5.1. The crucial role of governments

Governments undoubtedly have a vital role to play in fostering innovation for the renewable energy transition and bringing new technologies from the laboratory to the market. Public R&D is important. Research shows that large public energy R&D funds do not crowd out private investment but instead stimulate private spending (Nemet and Kammen, 2007). However, the role of governments goes well beyond the provision of funds for R&D. Through policies and regulatory frameworks, they can set the pace of the energy transition. Public investment and procurement policies are vital instruments to shape market expectations and de-risk early investment in infrastructure for the green energy economy. They can foster training programs to enhance the new energy skills, and they can compensate the losers of the energy transition.

What is somewhat worrisome in the current energy predicament is that European governments are spending ever-larger sums of public money to protect consumers and industries from high fuel and electricity prices (Sgaravatti et al., 2021). Governments do not have the fiscal space to maintain current levels of spending on compensation for high energy bills. Yet, research on fossil fuel subsidies has shown how difficult it is to retract energy support measures once they are in place (Skovgaard and van Asselt, 2018). With widespread fears of a recession, there is opposition among EU governments to increasing the EU's renewable targets for 2030 from 40 percent to 45 percent as proposed in the REPowerEU plan (Taylor, 2022). Moreover, as a crisis response measure, the EU allows governments to tax revenues from renewable plant operators above EUR 180/MWh. All of these measures run counter to the main imperative for governments to provide market players with the certainty and confidence to unleash the clean-energy construction boom required to tackle the twin climate and fossil fuel energy crises.

5.2. Two transition dilemmas

One of the key dilemmas facing governments is how to enhance the security and resilience of global supply chains for renewable and other low-carbon technologies while remaining committed to open and transparent global markets with few barriers to trade. Clean-energy supply chains are already under pressure, with significant consequences for the prices and availability of critical materials and components such as semiconductors. A full national carve-up of these global supply chains and a turn to autarky is neither feasible (e.g., because critical material deposits are where they are) nor desirable as it is not the most efficient economic route. Green industrial policy could spell good news for climate mitigation but only if it is not flanked by trade barriers. From the perspective of climate change, a subsidy war is preferable to a tariff war (Rodrik, 2014). A breakdown in global supply chains would exacerbate the risks of a "small country squeeze," with small industrialized economies lacking

the domestic market and resource base to achieve the economies of scale and cost reductions necessary to compete internationally (van Tulder, 1991).

Another dilemma is the risk of uneven access to energy technologies. The geographic distribution of clean-energy patents and R&D is already highly skewed and concentrated in a few major powers. Developing countries are exposed to higher transition risks than the technology-leading economies of the Global North. Existing tech-transfer initiatives focus on diffusing clean-energy hardware rather than building up local capacity or know-how (Eicke and Goldthau, 2021). Research has found that the fallout from Covid-19 has further widened the gap between leaders and laggards in the global energy transition (Quitzow et al., 2021). Catching up on clean-energy technologies remains challenging for latecomer countries, especially those with lower levels of economic development (Li et al., 2022), often because first movers "kick away the ladder"—that is, prevent other countries from reaping the same benefits (Chang, 2002).

5.3. Four geopolitical scenarios

There is a lot of uncertainty in the global energy transition, but the potential for a fast and disruptive energy shift is there. At the same time, however, several forces could slow down or even derail the energy transformation. These forces could be technological, economic, social, or political in nature. Indeed, one of the reasons why it is hard to fathom the future geopolitics of energy is that geopolitics itself could influence the trajectory and pace of the energy transition. Integrating such geopolitical motivations into energy models and scenarios is always difficult, but we should not treat them as completely exogenous factors.

In one landmark study (Goldthau et al., 2019), a group of scholars has done exactly this and identified four transition scenarios that are relevant to our story here:

1. **Big green deal**. Countries and companies cooperate on meeting the goals of the Paris Agreement, ushering in a wave of green globalization. Petrostates are assisted on their path to post-oil economies. Geopolitical friction is low.

2. **Technology breakthrough**. A clean-technology race leads to a technological breakthrough but also divides the world into two camps in a clean-tech Cold War.

3. **Dirty nationalism**. Populists rise to power on nation-first policies, which leads to fossil fuel protectionism, power rivalries, and runaway climate change

4. **Muddling on**. A mix of cooperation and competition reigns. The world economy decarbonizes, but the pace is too slow.

To conclude, there is much uncertainty, but the energy transition is in full swing, and it has already started shaping policies and shifting geopolitical debates. The 2022 energy shock has elevated the importance of the renewable-energy revolution and low-carbon technology innovation, but it has also put a new strain on public spending and prospects for economic growth in many economies. Europe is at the epicenter of the redirection of oil and gas trade flows following Russia's invasion of Ukraine. Amidst global upheaval, Europe must stay the course and frontload its climate policies as the most resilient way out of the current fossil fuel and climate crisis.

We are still in the early stages of the renewables revolution, and it is not clear where current pressures will take us. Even though a majority of countries has now adopted a net-zero emissions pledge, the world is still far off track to meet the central goal of the Paris Agreement to keep overall warming by the end of this century to 1.5°C. Yet, the push for a phase out of fossil fuels and a phase-in of renewables is strong and has been strengthened in major parts of the world since the start of Putin's war in Ukraine. While the old geopolitical map of fossil fuels is high on everyone's mind nowadays, a new map is emerging slowly but surely. The trend towards a more renewable, efficient, electrified, and decentralized energy system is unlikely to be reversed and should therefore be addressed in policy and business strategies.

REFERENCES

Andersson, M., Deiaco, E. and Eklund, J. (Editors) (2021). "Swedish Perspectives on Industrial Policy – The Washington Consensus and Beyond". Stockholm: Swedish Entrepreneurship Forum.

Blackwill, Robert D. and Wright, Thomas (2020). *The End of World Order and American Foreign Policy*. New York: Council on Foreign Relations.

Bloomberg Philanthropies and BNEF (2022). *Energy Transition Factbook. Prepared for the 13th CEM*. September 23, 2022. https://assets.bbhub.io/professional/sites/24/BloombergNEF-CEM-2022-Factbook.pdf.

BP (2019). BP "Energy Outlook: 2019 Edition". February 14, 2019. https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019.pdf.

BP (2022). Statistical Review of World Energy. June 2022. https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html.

Chang, H. J. (2002). *Kicking away the ladder: development strategy in historical perspective*. Anthem Press.

Cherif, R. and Hasanov, F. (2019). "The return of the policy that shall not be named: Principles of industrial policy" (IMF Working Paper, March 2019).

EEA (2022). "The role of (environmental) taxation in supporting sustainability transitions". Copenhagen: EEA. https://www.eea.europa.eu/publications/the-role-of-environmental-taxation.

Eicke, L. and Goldthau, A. (2021). "Are we at risk of an uneven low-carbon transition? Assessing evidence from a mixed-method elite study". *Environmental Science & Policy*, 124, 370–379.

Ember (2022). "Global Electricity Review 2022". https://ember-climate.org/insights/research/global-electricity-review-2022/.

Goldthau, A., Westphal, K., Bazilian, M. and Bradshaw, M. (2019). "How the energy transition will reshape geopolitics". Nature, 569, 29–31.

IEA (2020a). "Energy Technology Perspectives 2020: Special Report on Clean Energy Innovation". Paris: OECD/IEA.

IEA (2020b). "World Energy Outlook 2020". Paris: OECD/IEA.

IEA (2021a). "Renewable energy market update: outlook for 2020 and 2021". https://www.iea.org/reports/renewable-energy-market-update-2021.

IEA (2021b). "Net Zero by 2050: A Roadmap for the Global Energy Sector". Paris: IEA/OECD.

IEA (2021c). "World Energy Outlook 2021". Paris: OECD/IEA.

IEA (2022a). "World Energy Investment 2022". Paris: OECD/IEA.

IEA (2022b). "Tracking Clean Energy Progress". Paris: OECD/IEA.

IEA (2022c). "Securing Clean Energy Technology Supply Chains". Paris: OECD/IEA.

IEA (2022d). Energy Technology RD&D Budgets (database). https://www.iea.org/data-and-statistics/dataproduct/energy-technology-rd-and-d-budget-database-2.

IEA (2022e). "World Energy Outlook". Paris: OECD/IEA.

IEA and EPO (2021). "Patents and the clean energy transition: Global Trends in Clean Energy Technology Innovation". Paris: OECD/IEA.

IRENA (2019a). "A New World: The Geopolitics of the Energy Transformation". Abu Dhabi: IRENA.

IRENA (2019b). "Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables". Abu Dhabi: IRENA.

IRENA (2022a). "Renewable power generation costs in 2021". Abu Dhabi: IRENA.

IRENA (2022b). "World Energy Transitions Outlook: 1.5°C Pathway". Abu Dhabi: IRENA.

IRENA (2022c). "Geopolitics of the Energy Transformation: The Hydrogen Factor". Abu Dhabi: IRENA.

Jenkins, J. D. and Sepulveda, N. A. (2021). "Long-duration energy storage: A blueprint for research and innovation". *Joule*, 5(9), 2241–2246.

Li, D., Alkemade, F., Frenken, K. and Heimeriks, G. (2022). "Catching up in clean energy technologies: a patent analysis". *The Journal of Technology Transfer*, 1–23.

Malhotra, A. and Schmidt, T. S. (2020). "Accelerating low-carbon innovation". *Joule*, 4(11), 2259–2267.

Nemet, G. F. and Kammen, D. M. (2007). "US energy research and development: Declining investment, increasing need, and the feasibility of expansion". *Energy Policy*, 35(1), 746–755.

OECD (2019). "Innovation and business/market opportunities associated with energy transitions and a cleaner global environment". Prepared by the OECD as input for the 2019 G20 Ministerial Meeting on Energy Transitions and Global Environment for Sustainable Growth. https://www.oecd.org/g20/summits/osaka/OECD-G20-Paper-Innovation-and-Green-Transition.pdf.

Quitzow, R., Bersalli, G., Eicke, L., Jahn, J., Lilliestam, J., Lira, F., Marian, A., Süsser, D., Thapar, S., Weko, S. and Williams, S. (2021). "The Covid-19 crisis deepens the gulf between leaders and laggards in the global energy transition". *Energy Research & Social Science*, 74, 101981.

Rodrik, D. (2014)." Green industrial policy". *Oxford Review of Economic Policy*, 30(3), 469–491.

Scholten, D., Bazilian, M., Overland, I. and Westphal, K. (2020). "The geopolitics of renewables: New board, new game." *Energy Policy*, 138, 111059.

Schwab, K. (2016). *The fourth industrial revolution*. Davos: World Economic Forum.

Sgaravatti, G., Tagliapietra, S. and G. Zachmann. (2021). "National policies to shield consumers from rising energy prices". Bruegel. https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices.

Skovgaard, J., and Van Asselt, H. (Eds.). (2018). *The politics of fossil fuel subsidies and their reform*. Cambridge: Cambridge University Press.

Smil, V. (2014). "The long slow rise of solar and wind". *Scientific American*, 310(1), 52–57.

Stephens, J. C. (2019). "Energy democracy: redistributing power to the people through renewable transformation". *Environment: Science and Policy for Sustainable Development*, 61(2), 4–13.

Taylor, K. (2022). "EU countries eye scrapping 45% renewables target: document". *Euractiv*, 13 October 2022. https://www.euractiv.com/section/energy/news/eu-countries-eye-scrapping-45-renewables-target-document/.

UNIDO (2017). "Accelerating clean energy through Industry 4.0: manufacturing the next revolution". Vienna: UNIDO.

Van de Graaf, T. (2018). "Battling for a shrinking market: oil producers, the renewables revolution, and the risk of stranded assets". In D. Scholten (Ed.), *The geopolitics of renewables* (pp. 97–121). Springer.

Van de Graaf, T. (2022). "Transition troubles: petrostates, decarbonization, and the geopolitics of peak oil demand". In R. Dannreuther, and Ostrowski, W. (Eds.), *Handbook on Oil and International Relations* (pp. 427–444). Edward Elgar Publishing.

Van de Graaf, T. and Sovacool, B. K. (2020). *Global energy politics*. John Wiley & Sons.

Verbruggen, A. and Van de Graaf, T. (2013). "Peak oil supply or oil not for sale?". *Futures*, 53, 74–85.

van Tulder, R. (2002). "Small Industrialized Countries and the Global Innovation Race: The Role of the State in the Netherlands, Belgium and Switzerland". In Hilpert, U. (Ed.), *State Policies and Techno-Industrial Innovation* (pp. 293-316). Routledge.

Yergin, D. (2020). *The new map: energy, climate, and the clash of nations*. Penguin UK.

CHAPTER 4

GEARING UP FOR THE SPLINTERNET

RICHARD ALLAN

1. INTRODUCTION

The internet has a profound impact on business and society around the world. Inevitably, a technology this powerful will be subject to geopolitical forces.

We can consider the evolving shape of the internet in terms of two types of forces that may act on its components, shaping the network to be more coherent or more splintered. CENTRIFUGAL (moving away from the centre) forces cause objects to fly apart, fragmenting the whole into separate splinters. CENTRIPETAL (seeking the centre) forces pull and hold objects in an orbiting motion, creating a unified coherent system.

Following a timeline of the development of the internet, we can identify factors that have been pulling it together as a single global communications network and factors that tend to force it apart into functionally separate networks.

2. YESTERDAY: A NEW PROTOCOL

We start by looking back to the origins of the internet to understand the intent and choices of those who developed the technology.

2.1 The foundations

Once upon a time, it was impossible for computers to talk to each other without significant expense and technical expertise. Most of the important and interesting computers were hosted in institutions, primarily universities, and researchers felt that they could be much more useful if there were some way to connect them permanently to each other.

Thus, a group of academics and engineers set out to develop a set of common protocols that would enable computers everywhere to communicate with each other. The foundational Internet Protocol (IP) offered computers a common way to send packets of data to each other reliably via a range of types of hardware and network cabling.

For a full account of these early stages of the development of the internet and the thinking of the key players, the book *Where Wizards Stay Up Late* by Katie Hafner is recommended.[1]

2.2 A common toolkit

Once this basic model of data exchange was established, a series of other protocols were adopted to provide useful functions for the users of these now-interconnected devices. For example, interoperable email systems were developed in the 1980s using protocols called SMTP, POP3, and IMAP to replace earlier proprietary email services that were tied to a single type of computer.[2]

These days, we take for granted our ability to access information from a wide range of services via a common interface, our web browser. However, this was not possible in the early days of the internet. The creation of standard ways to format information to make it readable by different computers in the form of the World Wide Web protocols, notably HTML, was an effort of the late 1980s and 1990s.[3]

All of these developments had a strongly centripetal effect, pulling more and more computer systems into a single technical sphere. This is not surprising given that the primary motivation for all of these developments was precisely to bring computers and services together in a common information system that had previously been split across separate spaces. The early proponents of the internet believed that a network of interconnected computers would open up opportunities for creativity and technical developments that would fundamentally differ from those offered by unconnected computers. The experience of the last few decades has demonstrated how much power lies in connection.

2.3 IP rules

The adoption of common standards sometimes occurred in spite of organisational policies that favoured other technologies as internet technologies were easier and cheaper to implement than formal international networking standards such as X.25. We now often now talk about 'network effects' in terms of how online services can

1. Hafner, K. and Lyon, M. (1998). *Where Wizards Stay Up Late*. . https://katiehafner.com/books-new/where-wizards-stay-up-late/.
2. For a history of email development, see https://en.wikipedia.org/wiki/History_of_email.
3. For a history of the World Wide Web, see https://home.cern/science/computing/birth-web/short-history-web.

grow to dominate a sector once they have enough people signed up, and we can see the adoption of the internet itself as one such network effect. Alternative systems were available, but you got more out of connecting to the internet once it had reached a critical mass of users.

Using IPs is so commonplace today that they are replacing older technologies in telecommunications company networks. This was not a given from the outset, and many telecom companies were dragged kicking and screaming into offering internet services that they saw as cannibalising their traditional sources of revenue.

Although the nodes in the networks were all located somewhere and the carriers of the network signals were companies with national or regional establishment, a remarkable feature of these new protocols was their lack of respect for borders. This created an important power shift as we moved from telecoms services that were very much rooted in a nation-state, publicly owned or private but dependent on government-issued licenses, to internet services outside of local control.

2.4 Global governance

At the heart of these protocols is an addressing structure that ignores physical location: each address is a unique set of numbers that can be assigned to a device anywhere in the world. The only absolute requirement is that everyone agrees on which device the address belongs to so that data can be correctly routed to it.

A system of regional entities was set up to handle the allocation of unique addresses to the various entities wanting to use them, but this was an administrative convenience rather than because the technology conformed to geography. A pseudo-geographical layer was added with the development of the Domain Name System (DNS), which allows users to refer to services using names rather than their IP addresses. The domain contains a national element—for example, ".se" for Sweden and ".uk" for the United Kingdom—but it is not a given that a service with a national label is actually located in a particular country as many registries do not require this. For instance, the Pacific island nation of Tuvalu (with a population of around 12,000 people) gains significant revenue from over 90,000 registrations of ".tv" domains, often by global media companies. Similarly, more than 230,000 ".nu" domains are registered by companies who wish to appear "new" (as per the Swedish translation, "now"), despite being entirely unrelated to the 2,000 residents of Niue, which has the right to this suffix.[4]

The bodies that maintain the protocols and infrastructure of the internet are proudly non-governmental and most commonly organise along regional and global lines rather

4. For ".tv" domain registrations, see https://zonefiles.io/list/tv/. For ".nu" domain registrations, see https://zonefiles.io/list/nu/.

than being interested in individual countries. The core body defining technical standards, the Internet Engineering Task Force (IETF), works by issuing Requests for Comments (RFCs) inviting any interested person to contribute to the development of protocols. In true IETF fashion, the body defined its own mission and processes in 2004 by issuing an RFC (n. 3935), which states clearly and simply that "[t]he goal of the IETF is to make the Internet work better."[5] The IETF was established as a private corporation that answers to a global civil society organisation called the Internet Society. Various attempts have been made to link internet governance to intergovernmental structures, most notably through the UN-sponsored Internet Governance Forum, but the internet remains a world where national governments have little direct sway.[6] This operation outside of direct government control has been a strength from a technical point of view, creating positive conditions for innovation, but is a weakness from a geopolitical perspective. The fact that the internet infrastructure is largely owned and managed by private corporations can mean that accountability mechanisms are relatively weak. Although these are not entirely absent as companies have legal personalities and obligations, governments can and do argue that more direct accountability is needed, especially when key companies are outside their jurisdiction.

2.5 Global business

The impact of the internet on businesses has been felt in three main areas: a global customer base, lower barriers to entry, and a trend towards more rapid change. As more people have come online, they provide an ever larger potential customer base for internet-enabled businesses, with the default mode enabling easy connection to customers anywhere in the world. The ability to reach these customers varies according to the type of business—for example, those delivering physical goods and onsite services face different challenges from those delivering entirely digital products—but the potential pool is likely to be larger and more widely distributed than pre internet.

There can be significant technical and cost challenges to setting up shop online, but these have been falling dramatically over time such that it is now possible to buy cheap off-the-shelf packages to set up an online business. These packages have evolved with the development of software-as-a-service (SaaS) models, which allow users to rent at a reasonable cost highly sophisticated tools such as specialised custom servers and machine-learning models, which were previously only available to a few big businesses. This again varies according to the type of service, but the trend is clearly towards lower barriers to entry for creating and running most kinds of business. This lowering of barriers to entry can happen across a host of areas, from a cheaper 'shopfront',

5. IETF RFC 3935, 2004. https://datatracker.ietf.org/doc/rfc3935/.
6. https://www.intgovforum.org/en.

through more cost-effective marketing and to lower administrative costs thanks to cloud services for banking, accounting, or office applications, among others.

A more equivocal shift that the internet brings about is in the speed of change which it enables as a result of both technological developments and shifts in markets as more people join the network. This can provide considerable opportunities for businesses offering a valuable service with the right technology and capable of keeping up with trends, but it can also be massively disruptive, threatening established business models as well as new ones.

Several aspects of these economic shifts are of concern to governments. The first is the turn from established pre-internet businesses to these new platforms and services. Sectors such as telecommunications, media and retail are seeing profound changes in value as new internet-based services provide alternatives to the products they have offered for years. These are sectors that typically employ a large staff and have significant political influence, which they naturally use to raise concerns about whether the transition benefits society overall.

The second aspect is the dynamics between internet services themselves as there may be concerns about market concentration and dominance of particular sectors by a few large platforms. This debate often contains a global trade element when local internet businesses feel that they are treated unfairly by global players headquartered in other jurisdictions. These concerns are evident in the competition case brought by the European Commission against Apple following complaints by Spotify.[7]

Third, the fact that barriers to entry have been lowered for everyone has created new opportunities for illegal activity as well as legitimate enterprises. For most people most of the time, using the internet is a safe activity, but new risks certainly exist, which people have to watch out for, such as emails and messages from fraudsters and abuse of personal information. Much like when navigating any city, although the main public areas are well maintained, a certain amount of "street smarts" are needed that come from familiarity with the space. Additionally, some people have used internet technology to create spaces outside the mainstream with the express intent of enabling criminal activity – the so-called "darknet". Governments are concerned with both aspects: ensuring that the main streets are safe enough for their citizens and limiting the scope for criminal threats to emerge from unpoliced spaces.

All these elements have contributed to the increasing interest of national governments in reasserting control, which we examine next.

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7. European Commission case AT.40437, Apple App Store Practices (music streaming). https://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=1_AT_40437.

3. TODAY: THE EMPIRES STRIKE BACK

As we have moved our engagements as customers and businesses onto a network whose architecture is by default global and designed to disregard geography, the new digital world has created both winners and losers.

The winners are those who can thrive in this environment, with much attention paid to those who have been able to develop the massive global online services that most of us use daily. It is tempting to see this as a settled situation based on the current winners, but we should also note that services can fade away over time, as the names Altavista, Myspace, and Yahoo! remind us. They were each eclipsed by newcomers, and innovative platforms continue to spring up that may take on the leadership mantle from incumbents. This is often presented as a shift in power from governments to these large platforms, but it remains a fact that corporations are established through and bound by laws that are determined by political leaders.

Increasingly, political leaders in all kinds of systems and along the ideological spectrum express their interest in asserting control over both local and global corporations. We may see this as an instinctive play by politicians who are determined not to cede control to others in areas that are important to their societies—a classic struggle between competing entities over who gets to wield power. The scale and complexity of online services mean that politicians may seek to exert indirect as well as direct control, which can create additional challenges. Regulations may require platforms to make specific decisions—for example, about whether content must be restricted to comply with the EU's 'Right to be Forgotten', and this is experienced by users as the platforms having more rather than less power even though they are responding to a government mandate.[8]

Nonetheless, we should also recognise that in many cases, individuals ask their politicians to take greater control in response to material harms that they believe they are suffering and are not being fixed by the current power brokers of the internet. Bad behavior by users is a phenomenon that drives regulation.

Most politicians see their primary duty as to protect people in the regions and countries they govern. There can be widely differing views about the policies that would best protect people hence, there can be very hostile partisan divides, but the common thread that connects politicians is the belief that the policies they advocate will benefit people. The feeling that 'nothing can be done' to deal with online challenges is therefore a source of considerable frustration for politicians across the political spectrum. This feeling is turbo-charged when the reasons for the inability to act stem from the fact that online service providers are private companies that are outside of the

8. For an explanation of the EU Right to be Forgotten, see https://gdpr.eu/right-to-be-forgotten/.

politicians' jurisdiction. The frustration is often expressed in language that compares the internet with the 'Wild West'[9] The assumption is that services are lawless because local law cannot be applied even if the companies are subject to a whole raft of legal obligations in their home jurisdictions.

We can walk through a non-exhaustive list of areas in which this dynamic of demand for political intervention is unfolding. These are the centrifugal forces that push us away from a single sphere as national governments look to control their splinter of the internet.

3.1 Intellectual property

One of the earliest areas in which governments were asked to intervene was the enforcement of intellectual property rights. As content such as music and movies was digitised and the internet provided a cheap data-transfer capability, the barriers to transferring content to other people fell.

There was a significant movement of people in the internet space who believed that the public interest lay in the widest possible distribution of content, whether protected by copyright or not. The legal owners of content, unsurprisingly, felt that just because their property could now be transferred more easily did not mean that this should be done without their permission and appropriate compensation.

The difference of opinion between content owners and some sections of the internet-using population survives to this day, but governments have largely sided with content owners, and the trend has been towards tightening and extending copyright law as it applies to online services. A legitimate business aiming to become a serious player at scale and that needs copyrighted content thus has no choice but to negotiate with the relevant licensing bodies and pay the required fees.

In many cases, this necessitates country-by-country licensing, and enforcement action against any breaches typically falls to national courts, in line with local laws and policy. Consequently, this is also part of a broader geopolitical debate about respect for intellectual property rights that plays out in bodies such as the World Intellectual Property Organisation.

3.2 Law enforcement

A priority for any government is to be able to identify and prosecute people who are suspected of committing serious crimes. Longstanding arrangements are in place in

9. The Huffington Post (2018). "MP Matt Hancock Demands More Control Of 'Wild West Free-For-All' Internet Companies", March 22. https://www.huffingtonpost.co.uk/entry/matt-hancock-data_uk_5ab3659ae4b0decad046ca7a.

most countries for the authorities to request information from local businesses with appropriate legal safeguards, but these do not typically apply to entities outside of the country.

A major driving force of moves to bring services into jurisdictional scope is this need to secure access to data when residents of a country commonly use foreign services. This push is especially fueled by cases in which serious crimes have been committed, triggering public outrage, but the lack of data is complicating the work of investigators.

The pressure may also be acute when an ongoing threat (e.g., from terrorists) needs to be monitored but the intelligence is not coming through. There is scope for conflicts of laws here as one country requires data to be collected and disclosed while another forbids it. In these cases, companies have had to decide whose law to respect and whose to defy, with the winner generally being the law of the country hosting their headquarters.

3.3 Speech

Standards for what constitutes legal and illegal speech vary widely from country to country. Something close to a global consensus has been reached in a few areas (e.g., in relation to the worst kinds of child-abuse imagery), but significant divergence remains in many others (e.g., on the issue of whether blasphemy should be illegal).

Because these can be highly contentious and emotive issues for people in a country, politicians are under pressure to ensure that local standards are upheld even when people are using global services. These concerns may be compounded when services are 'foreign' and seen as operating on standards that differ from local norms. This is a driving force for many of the current legislative proposals that aim to regulate social media, for which the common rallying cry is that governments rather than private companies should set the standards (whether making them more restrictive or more permissive).

While governments want to be able to set the standards for speech online, the scale of online activity is such that they do not realistically have the capacity to enforce these. This has led to the adoption of legislation like the Network Enforcement Act in Germany, which requires platforms to enforce German legal standards. The rules are set by the state, but private companies act as judge and jury.[10] This model of private enforcement of public law is criticised but is found in an increasing number of legal instruments in the absence of any realistic alternative. Policymakers know that their

10. German Network Enforcement Act. https://www.bmj.de/DE/Themen/FokusThemen/NetzDG/NetzDG_EN_node.html.

court systems simply could not assess content at the speed and on the scale required if they were to take this role away from platforms.

There are particular sensitivities around political speech and suggestions that services are operating in a biased or partisan way. These criticisms often come from both the left and right of the political spectrum as each side feels that it is being discriminated against. Politicians may become very personally invested in trying to shape the rules of internet services because they see these as materially affecting their fortunes. This can cut both ways, with some believing that service providers are too permissive and others that they are too restrictive of certain types of speech. Questions exist about the rules themselves and about their enforcement. Do restrictions on hate speech have a disproportionate effect on people raising questions about immigration and multiculturalism? Do variations in how content is reported mean that there is stricter enforcement against some groups than others?

There are concerns that any biases could become even more significant if regulation 'bakes in' specific rules and processes as a requirement for all platforms. This could potentially remove the scope for some platforms to take a deliberate stance of being more permissive of speech that other platforms might reject. In the future, we may see concerns about biases shift from being directed at platforms to being aimed at regulators as platforms claim to be acting under instruction rather than at their own discretion.

In many cases, there will be very broad public support for governments regulating this area when people feel that service providers are unaccountable, especially in the context of high-profile instances of 'bad' decision-making by platforms. There may be concerns about governments stepping in if they are also seen as untrustworthy, in a democracy, the government and its representatives are at least more directly accountable for any mistakes they make.

A common criticism of moves towards more explicit speech regulation is that the same legal tools would be extremely harmful in the hands of a less democratic regime. These are legitimate concerns but are unlikely to win political arguments. A country that has strong freedom of expression obligations in its constitution and is willing to comply with the rulings of bodies like the European Court of Human Rights will argue that it can be trusted to regulate speech precisely because of these constraints.

3.4 Finance

The original spirit of the internet as a radical force that would cause positive disruption to established business and societal models has been taken up recently by promoters of new financial products and services. Evangelists for these products often

echo the language used by champions of the internet as a force bypassing traditional governments. This sentiment was captured by John Perry Barlow in his "Declaration of Independence of Cyberspace": "Governments of the Industrial World, you weary giants of flesh and steel, I come from Cyberspace, the new home of Mind. On behalf of the future, I ask you of the past to leave us alone. You are not welcome among us. You have no sovereignty where we gather."[11]

These new financial products are bundled under the banner of crypto-assets and decentralised finance as tools that will liberate people from services that have traditionally been tightly regulated and controlled by nation-states. We are still in the midst of this debate, but the direction points strongly towards national governments reasserting control and creating a raft of new regulations. Governments have been progressively tightening up the rules for traditional financial services to combat money laundering and tax evasion, and the last thing they want is for these to be displaced to a new unregulated space.

The control of money is a major concern for any government, but we should not overlook the protection of citizen interests as a genuine motivation for regulation. As the pool of investors has expanded dramatically, there are many potential losers from any drop in market value. Some people may accept losses as a fact of life, but others will turn to their governments, asking them to do more to protect people and avoid future losses.

Some of the state's significant interests may also be at risk, as well as those of individual citizens. Some of these are systemic, but others are more immediate, such as the risk that new channels are being created for money laundering.

The founding rationale for the development of technologies like Bitcoin was that it would create a common, borderless sphere for people to exchange value. This is consistent with the early philosophy of the internet itself and has wide appeal in the technical community. However, this is challenged by pressures steering us back towards nationally organised and regulated stores of value, whether these are maintained as traditional currencies or in the form of digital tokens.

In the case of finance, there has been a rapid shift from the 'Wild West' of these technologies' development and adoption towards a more regulated model. This reflects the critical importance of money compared to other areas such as speech, where the regulation has taken longer to catch up with reality.

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11. "Declaration of Independence of Cyberspace." https://www.eff.org/cyberspace-independence.

4. TOMORROW: RETURN OF THE INTERMEDIARIES

As the trend moves towards more national government intervention, the effects on business are likely to limit the opportunities that the internet offers, namely, a global customer base, lower barriers to entry, and a trend towards more rapid change. Rather than being by default open to a global customer base, service providers may be more inclined to open up market by market, using technology to restrict access to customers in new countries until they understand the full legal and cost implications.

Any geographical restrictions will necessarily be imperfect as there is no foolproof way to know the location of a user connecting with an internet service. It is common today for people to seek access to locally licensed content like TV and movies by using technology that makes them appear to be connecting from a permitted location. We may move to a world where some people have tools to access a much wider range of services than those with a simple internet connection that is linked to one location. Resource-rich users will thus have the online equivalent of a private jet that can transport them anywhere in the virtual world whenever they fancy.

As well as absolute barriers to access based on geography, there may be restrictions on specific features, making the various national versions of a service more or less attractive. This is visible today in the different catalogues of content that are offered by Netflix depending on the country in which it believes the user to be located when they access it. The bigger the gap in functionality between different national portals, the stronger the incentive for people to want to choose an alternative location if they are stuck with a low-powered version in their country.

New barriers to entry may emerge as regulation requires certain things to be put in place before a service can be offered, which can be technically and financially material—for example, if you have to rent local data centre space separately for each country. From a financial perspective, this may encourage service providers to spend more time building a revenue base in their home market before opening up to other countries. While this may previously have been cost free as a single hosting provider could accept connections from anywhere, an active decision to pay for additional hosting services for new markets will now have to be made.

By nature, the regulation of technology tends to slow down innovation not because that is the intent of the lawmakers but simply because it captures the state of play at a particular moment in time. A different kind of innovation may emerge as people try to develop products that circumvent the regulated space, but within it, developments are likely to be slower. There is a complex array of forces at play in the relationship

between technology and innovation, which the UK government summarises in its 2020 paper "Regulatory types and their impacts on innovation: a taxonomy."[12]

A rational response to this new environment is for businesses to reduce their own compliance complexity by having others take on this task for them. This is where we may see a very profound unintended consequence of regulation.

One of the great promises of the internet was that it would 'disintermediate' a range of activities, allowing people and organisations to connect directly with each other in ways that were previously impossible. Yet, we have seen phenomenal growth in new forms of intermediaries, such as search engines, social media, and e-commerce platforms, and regulatory trends may steer us yet further in this direction.

A critical difference with the new intermediaries is that they share the characteristics of other internet businesses in terms of operating at a massive scale, globally rather than nationally, and at a low cost. This contrasts with the old world, where intermediaries were commonly limited to one or a small number of countries and only enabled access to relatively small numbers of players for relatively high prices. If we think of an independent media production house trying to get their content out, there are now many video distribution platforms they can use rather than being limited to negotiating deals with a small group of television broadcasters.

In practice, the new intermediaries offer many of the benefits that were the goal of European single-market legislation. While the EU previously sought to create a pan-EU market for video content by imposing quotas on each national broadcaster, we now see intermediaries making much more content from every member state available across the region.

4.1 Interpersonal communications

The archetypal interpersonal communication system that the internet brought us was email. All you needed to do was install email servers and clients built to the relevant open standards and you could happily message away. For a number of years, this worked well, and the centripetal force of the common standards brought millions into the network. However, over time, we have seen significant shifts both in how email itself works and in terms of people moving to alternative modes of communication, notably interpersonal messaging systems.

The primary force effecting these changes has not been regulation but rather bad behaviour. The very open nature and low cost of email meant that it supported business

12. UK Department for Business Energy and Industrial Strategy (2020), research paper. https://www.gov.uk/government/publications/regulatory-types-and-their-impacts-on-innovation-a-taxonomy

models based on sending irrelevant and unwanted communications at scale. Email continues to be a widely used tool in spite of the fact that around 85 percent of all email is spam, but it is only useful because filtering technology has been introduced. In an effort to raise the barriers against spammers, additional protocols have been added that aim to sort out trusted and untrustworthy sources of email.

The effect has been to steer people towards large email services such as those offered by Google, Microsoft, and Amazon, as well as many large web hosting services. Businesses wanting to have their email delivered on the same day are likely to use the underlying engine of one of these big providers. While they can still technically set up their own email server, they may find that their emails are filtered out, making the server useless.

As well as email converging towards large, verified server platforms, a significant substitution effect has led people to use tools other than email for interpersonal communications. The switch to mobile has contributed to this shift as messaging apps are more nicely integrated into phones than email clients. This has been a splintering issue, with users moving from a unified interconnected system—email—to disparate unconnected systems such as iMessage, WhatsApp, and WeChat.

There are now moves to force these separate services to interconnect, bringing us into an entirely new sphere. We are moving from an open unified system developed by technologists (email) through a phase when people have chosen to use more closed systems (WhatsApp, etc.) and into one when regulation will try to force the closed systems to interconnect so as to create a new unified network. Significant technical doubts exist about how this new interoperability may work in practice, but it seems likely in all scenarios that we will continue to use some form of intermediary for our interpersonal communications.

4.2 Public broadcasting

The internet has lowered the barriers for people to distribute content that they have produced to a wider audience than their interpersonal communications. This was initially restricted to those who had the technical skills to build and maintain their own websites or other forms of content-serving technology. Nonetheless, over time, simpler tools were created for the content producer under the broad banner of "blogging," although running these remained non-trivial. More recently, large platforms have made publishing to the world accessible to everyone, requiring little technical skills and no upfront cost—debates are raging about whether 'free' means free, but there is typically no or a low upfront cash cost.

The centripetal forces steering people towards these large platforms have been cost and technical capability. Although this has provoked some backlash, with people advocating for more distributed and open alternatives, these have not taken off to date.

Adding new regulations into the mix would seem to increase the pressure for most people to use an intermediary platform over the do-it-yourself options. People who do not wish to conform to the regulation may experience pressure to break away from the large platforms as these come into compliance; however, this may be a limited-term strategy.

Regulations such as the UK Online Safety Bill include provisions for degrading or blocking non-compliant services, which the regulator can apply to anyone defiantly striking out on their own. The outsourcing of many of the regulatory obligations to the platforms will be attractive to content creators who want to focus on their creation and not build an infrastructure for risk assessment, complaint handling, and so on.

4.3 Commerce

The potential of the internet to create economic growth led many governments to take a deliberately hands-off approach in the initial stages of its development. This meant refraining from seeking to control what was being bought and sold and from taxing these new activities. As more and more business has moved online, the sector has become too important to be left alone, and governments are becoming ever more hands-on. Thus, companies need to understand a host of regulatory matters in every country where they wish to operate and make arrangements to pay any taxes or duties that apply to their activity.

If companies could previously build their own websites to advertise goods and services globally and take customers from virtually anywhere with a low risk of interference, this is an increasingly challenging model. The intent of regulation is not to drive people to use large platforms, but this is its effect as a simple matter of good business sense.

Platforms carrying out all the compliance functions make life simpler for the business. This comes at a cost but has the benefit of predictability and can significantly reduce risk. If a platform guarantees compliance for a markup of five percent when a seller sells in a country, the latter can calculate whether it is still worth doing business there and factor this into their pricing. Except for large volumes of business, the costs of doing one's own due diligence work are likely to outweigh the cost of the platform markup and may leave companies exposed to greater risk. In simple terms, it is more likely that the large platform will have done all the due diligence and meet all the required standards as it has more resources and its business depends on getting this right.

The incentive to use an intermediary is especially strong for smaller markets where the legislation is complex and/or there is a need to work in unfamiliar languages. For instance, we can imagine a small business in Australia wanting to sell in Slovakia. They may look for a Slovak lawyer to advise them, but this will likely mean using a large, expensive global law firm with a local branch. Alternatively, the company could

sell through a platform that is already established for sales in Slovakia and will take on the responsibility of paying taxes (inter alia) for it.

We are seeing this process play out following the UK's departure from the EU. A range of new obligations have been created as the UK stepped out of the single market, and businesses involved in cross-border trade have struggled to manage these themselves. A common strategy to continue trading is to use intermediaries who can handle all of these processes.

5. CASE STUDIES: THE RISE OF REGULATION

We can bring these changes to life by looking at some cases of national regulations and considering how these might impact business decisions.

5.1 The united kingdom

The UK Online Safety Bill provides a painfully detailed example of what a comprehensive set of regulatory obligations can look like as well as some indicative figures of the cost of compliance for businesses. The UK Government has estimated that around 24,000 entities will be within the ambit of the new regulatory scheme. The law does not just cover British entities but anyone who offers services to people in the UK over the internet and meets certain criteria in the bill. Most of the new costs will fall on these entities, but there may also be some costs for all online service providers as they try to establish whether or not they are concerned.

The UK Government published a regulatory impact assessment[13] document that includes estimates of compliance costs for various aspects of the legislation. The actual figures are open for debate, but the list of tasks is a good starting point for understanding the impact of these new kinds of regulation on businesses.

In-scope businesses may have to update their terms of service and other policies to ensure compliance with the requirements of the new legislation. They will have to do this for their UK users and will need to decide whether to maintain two sets of terms—for UK and non-UK users—or apply the UK ones to their global community.

For a micro business that essentially uses boilerplate text for its terms of service and policies, the initial compliance costs may in practice be quite low. Some enterprising advisory firms will likely offer compliance services including "Online Safety Bill Compliant Terms," and smaller businesses may feel that these are sufficient.

13. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1061265/Online_Safety_Bill_impact_assessment.pdf.

However, any larger business whose terms may be tested either by the regulator or in court will want to do this work very carefully and is thus likely to require extensive internal and external legal advice. Not everyone will require the same scale of effort as a major player like Facebook (which has faced repeated challenges in settling on its updated terms despite dedicating massive resources to this task) but it is going to involve a lot more than a few hours of advice from a regulatory professional.

The law will also place requirements on entities to provide people with ways to report specific types of content or behavior on their services. Many services already have some kind of reporting system, but these will presumably need updating to meet the specific requirements of the new legislation. Again, the costs may be manageable for micro-businesses, who may simply display a new contact email address on their website, but any larger entity larger that offers dedicated user reporting functionalities is likely to have to do much more work.

Changing any kind of public-facing feature on an internet service, especially a sensitive one such as capturing reports of illegal or harmful content, requires putting together a team. The team will comprise "programmers" to write the code but also a range of designers and content experts to assess the different ways in which the form could be presented and how users react to various options. Any change to an input form is likely to generate more work for changing the systems that process submissions through the form, which sometimes entails developing entire new workflows for the content moderation teams. There is also an ongoing maintenance challenge as global services may update their reporting systems regularly for various reasons and have to ensure that the special UK features are not lost as they do so.

Service providers will also be asked to pay a fee to the UK regulator, Ofcom, to cover the costs of their supervision. The precise level of the fee has not yet been determined, but the impact assessment tells us that the levy from all regulated entities may be in the order of 50 million pounds a year. This is likely to result in annual fees in the millions for the very largest platforms, down to a few hundred pounds for businesses with smaller UK operations.

5.2 Russia

Russia is at the forefront of our minds given the current importance of sanctions and reputational issues associated with working there. Interestingly, Russia has been busy legislating for a series of onerous local obligations for years, which has not attracted significant attention outside of the internet industry itself.

There has been variable enforcement of these requirements as the Russian government sought to balance its goals with a desire to be seen as part of the global economy. The

global side of the equation has shifted in the wake of Russia's invasion of Ukraine, and enforcement action has followed against large name-brand internet services.

Prior to this there had been blocks of various services, but these had largely avoided the biggest players. The blocks are themselves imperfect because of the structure of the Russian telecoms networks, which are quite disparate, making it difficult to ensure that the blocks work. Additionally, at least as of the time of writing, the blocks have not sought to stop all virtual private network connections.

It is instructive to reflect on what this set of obligations is in Russia as we consider what it might look like in more countries. Internet service providers may be required to store data locally in Russia, block certain types of content, retain data for law enforcement purposes, and collect and provide data about certain types of users to the authorities.

The explicit goals of the Russian government are to seek sovereignty over the services used by people in Russia as well as to build a "Russian internet" that can function independently of the global internet. The size of the potential user base in Russia is attractive to global internet services, which have remained interested in the market, albeit generally not to the extent that they would be willing to comply with the increasing range of local obligations. In many cases, this has resulted in a stand-off, with services still operating without fully complying with Russian law.

6. CONCLUSIONS

There appear to be growing interest in following a path similar to the UK and the EU towards more internet regulation in a number of countries. This is evident across a range of countries from smaller countries like Singapore to major markets like India. In some cases, online service providers will be hesitant to comply with new rules on human rights grounds, but in many other places, there will be no basis to refuse cooperation, and the expectation will be one of full compliance with the associated costs.

Fast forwarding a few years, we can expect to see a situation in which a new internet service that is offered globally will, once it starts to gain users in multiple countries, receive communications from dozens of regulators asking it to pay fees and make specific changes to comply with the local regime. Absent any human rights concerns that would rule out compliance, the question will then be whether the compliance costs are worth it for the value of having users in that country.

The EU may lower the compliance burden if it can adopt a 'one-stop shop' regime, under which services are only regulated in one of the 27 member states. However, this

may prove challenging given that attitudes towards restrictions on content can vary widely across EU countries. Even if the EU agrees on a single regime, and assuming that the US stays out of the game for First Amendment reasons, service providers may still face a long list of regulators asking for their time and money.

The internet itself has not necessarily 'splintered' in that computers using the common protocols can technically still communicate with each other wherever they are located. Yet, the new regulatory overlay means that the physical location of both the service and each of its customers is an important factor for compliance and the legal provision of the service.

Businesses will have to consider for each market the regulatory and legal implications of allowing people to access their services. They will then need to decide whether a market is sufficiently valuable to subject themselves to oversight, which could be costly and time consuming, and pay any applicable fees.

If they decide it is not worth it, they may use technology to try to identify and block users from a country, which is likely to be sufficient for them to defend themselves against regulatory action if done well. Blocking people will come with implementation costs but may be far cheaper than full regulatory compliance and may be seen as a less risky approach depending on the nature of the regulatory requirements and penalties.

In some cases, there could be significant penalties for unintentional non-compliance. Something similar occurred previously with online gambling service providers, whose executives ended up being arrested when they strayed into the US.[14] Although the services were based outside the US, they were still pursued by US authorities for taking insufficient action to prevent their use by US persons.

We may see a 'blacklist' of countries develop initially where legal advice is to block users unless and until compliance can be ensured. This happens today with sanctioned countries, which companies must block or risk serious criminal penalties. When the potential penalties are harsh, a safety-first approach for businesses is to take all possible steps to keep out of this market unless there is a very compelling business case that would justify full and careful compliance.

In one possible model that may develop, services remain open globally except for blacklisted countries, which would look and feel similar to the world today, where a few countries are out of bounds. However, there is another potential future model that would imply a very different world, namely, a switch to a "whitelist model," in which services are not offered globally by default but only rolled out country by country.

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14. https://www.theguardian.com/business/2006/sep/30/usnews.internationalnews.

We still lack sufficient information to know clearly where we are heading, and a critical factor is whether new regulatory models are convergent or divergent. If governments seek to align their rules, as the EU does internally, this would steer us towards maintaining a more open internet where services can still largely be offered globally. If they opt for very different models with highly specific local requirements, this will drive us towards the country-by-country model as services have to be tailored to each market.

The impact will also vary significantly depending on the size of both businesses and countries.

It is possible that the smallest businesses may be able to carry on largely as they are today if they are excluded from new regulations or only have minimal obligations that they can meet through the use of 'compliance consultants'. This compliance work may cost significantly more than the kind of optimistic estimates published in the UK impact assessment, especially in countries where the requirements are more specific, but they should not be ruinous.

Larger businesses are likely to have to invest millions in their compliance work, hiring large in-house teams to deal with regulators in each market and using leading outside counsel from the global law firms they employ. There will be regular challenges to the policies and practices of large companies, which will require them to update their documents and tools continually with big cross-functional teams. We can see how this works in other sectors, such as the pharmaceutical industry. While many small companies are developing innovative drugs and treatments, they frequently work with a large global company to have their products tested and brought to the market. This is a rational response to the complexity and costs of the various compliance regimes that governments have put in place to ensure the safety of new pharmaceutical products coming into their markets.

There may come a time when the regulatory demands in a market cause a large company to question its presence there. Nonetheless, as irritated as it may be, it will usually find the resources to maintain its overall global presence. Where even large companies may decide that enough is enough is where we see significant compliance costs for very small markets. If a government misjudges the value of its country as a market, it may drive away some companies, which simply choose to opt out of offering their services there.

The most difficult decisions may be faced by medium-sized entities that are large enough to attract attention and, thus, have to take compliance seriously but do not have the abundant resources of the internet giants. These entities may find that decisions about whether or not to operate in a particular market are more finely balanced,

especially where the risks seem high (e.g., threats of large fines or criminal action against executives) and the entity does not feel it is fully across them.

We might see mid-sized companies confine their operations to a restricted set of relatively safe and lucrative markets while staying out of those where the risk-reward calculation falls the wrong way. This would result in fewer services for consumers and less competition for the large established players in non-core markets.

The impact on growing companies will be a key test of whether the new regulatory models are working. It is certainly not the intention of policymakers to entrench the position of today's large platform leaders. Their preference would be for new entrants to continue to be able to displace incumbents just as the present winners displaced those that came before them. For this reason, it is common to see tiers of obligations in the new regulations, which place a much greater burden on the largest platforms than on smaller companies. The hope is that this will help new entrants catch up with existing players as they grow under a lighter regime to the point where they have the resources to play on the same field as the biggest platforms. Time will tell whether this hope is realised.

We are still in the early stages of this next evolution of the internet, and it is not yet clear where current pressures will eventually take us. However, the push for increased local sovereignty seems material and unlikely to be reversed and should thus be factored into business strategies.

It would be a mistake to think that the desire to regulate will recede. The activities that take place online are simply too important, and increasingly so, for governments not to want to have a say in how they should be managed. Government intervention can happen on an ad hoc basis when policymakers put pressure on companies to act in a particular way. This has been a regular occurrence for some time, as evidenced by the frequent headlines in which politicians criticise internet platforms for their inadequate response to a matter of public interest. Yet, there are advantages to moving away from ad hoc requests to a model in which governments codify their demands in legislation. A regulated model is likely to be more consistent and predictable, which is helpful to both businesses and consumers.

The ultimate impact on businesses of this shift towards a more regulated online world will depend on the extent to which they are workable and interoperable across jurisdictions. It is possible that governments will use regulation to make entirely unrealistic demands of online service providers and that these will be incompatible or even contradictory between different countries. Still, with the right political will and a sound understanding of what is reasonable and effective, it is equally possible that governments will adopt common standards, compliance to which is not too onerous technically or financially for businesses operating in many places.

Businesses have an important role to play in steering us towards the right model. Policymakers need evidence and insights into the likely effects of particular regulatory measures, and this can only come from an open dialogue with the companies that will have to comply with them. This can be challenging for both sides, but it is worth the investment to maintain the economic benefits of the internet while ensuring sufficient local accountability to safeguard societal interests.

CHAPTER 5

DIGITAL DEPENDENCIES, PANDEMICS AND THE CAPABILITY-VULNERABILITY PARADOX

JACQUELYN SCHNEIDER

1. INTRODUCTION

Sometime in early 2020, an unseen biological invader infested our modern lives, traversing the globe through air travel corridors, train systems, bus routes, and subway lines, and finally diffusing from individual to individual through the intimate community clusters of daily life. The networks that previously connected global economies became facilitators for a viral pandemic that threatened an entire global population.

The solution to this biological infestation was to turn inward, to become socially-distant islands, sustained by the digital networks that provided the foundations for physically isolated communities. The internet made this physical isolation possible, delivering meals and toilet paper, teaching children, facilitating virtual meetings, and broadcasting the voices of neighborhoods singing together while living alone. Economies—once bustling markets of human interaction—were held together by clouds of information, networks of wireless transmission, warehouses of servers, and databases all struggling to quench the global thirst for data, bandwidth, and disinfectants. As an entire globe decentralized and deconstructed into the smallest possible units, fractured communities became not just digitally enabled, but digitally dependent.[1]

The internet made our deconstruction and pandemic survival possible in the short term, but these same digital dependencies may have exacerbated dangerous

1. United Nations Conference on Trade and Development, for example, reported that "global Internet bandwidth rose by 35 percent in 2020, the largest one-year increase since 2013." UN Conference on Trade and Development. (2021). Digital Economy Report 2021, 15. https://unctad.org/system/files/official-document/der2021_en.pdf.

incentives for instability in the long term. As the world dived headfirst into the digital world[2] to protect its physical health, cyber threats exploded. Malicious websites with fraudulent maps of the Covid-19 outbreak introduced malware into users' computers.[3] Phishing emails, playing on fears about the new coronavirus or offering to register citizens for their stimulus check, spiked 600 percent immediately after the world went into lockdown.[4] Health websites and hospitals, seen as especially desperate cyber victims, became lucrative targets for criminals looking for ransomware paydays.[5] National security communities, once siloed in classified buildings and secured networks, emerged as profitable espionage targets as they migrated to home computers and civilian WIFI networks.[6] Public health advocates found their voices lost and distorted in the digital melee as they struggled to communicate through a barrage of both domestic and foreign disinformation campaigns.[7] Now, even as a vaccinated world returns to "normal" and to in-person interactions, there is a new digital normal: a society of QR codes, automation, and digital enclaves.

However, the pandemic only catalyzed a move towards digital dependency—and information centralization—that had been progressing (albeit perhaps more cautiously) before Covid-19 and continues its forward march today.[8] As early as 2006, Richard Danzig warned that the world was eating a diet of poisoned fruit, doubling down on digital technologies without solving the cyber threat that these capabilities

2. European Commission (2021). "New Commission Report shows the importance of digital resilience in times of crisis". https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1025
3. Brown University (2020, March 23)." Malicious website disguised as Covid-19 live map". https://it.brown.edu/phish-bowl-alerts/malicious-website-disguised-covid-19-live-map
4. Muncaster, P. (2020, March 26). "#Covid-19 drives phishing emails up 667% in under a month." *Infosecurity-magazine.com*. https://www.infosecurity-magazine.com/news/covid19-drive-phishing-emails-667/.
5. Collier, K. (2022, October 7). "Ransomware attack delays patient care at hospitals across the US". *NBCNews*. https://www.nbcnews.com/tech/security/ransomware-attack-delays-patient-care-hospitals-us-rcna50919.
6. US Department of Defense Inspector General. (2021). "Evaluation of Access to Department of Defense Information Technology and Communications During Coronavirus Disease-2019 Pandemic", Report No. DODIG-2021-065. https://media.defense.gov/2021/Apr/01/2002612366/-1/-1/1/DODIG-2021-065.PDF.
7. Ferreira Caceres, M. M., Sosa, J. P., Lawrence, J. A., Sestacovschi, C., Tidd-Johnson, A., Rasool, M. H. U., Gadamidi, V. K., Ozair, S., Pandav, K., Cuevas-Lou, C., Parrish, M., Rodriguez, I. and Fernandez, J.P. "The impact of misinformation on the Covid-19 pandemic". *AIMS Public Health*, 9(2), 262–277. https://doi.org/10.3934/publichealth.2022018
8. United Nations (2019). "The Age of Digital Interdependence – Report of the UN Secretary-General's High-level Panel on Digital Cooperation". https://www.un.org/en/pdfs/DigitalCooperation-report-for%20web.pdf

brought.[9] Despite these early warnings, the world could not break its digital habits. Instead, it flung itself headfirst into digital addiction, connecting cars, refrigerators, and weapons to the internet, creating a society of digital junkies unable to function without their binary inputs. Over a decade after Danzig's warning, the increasingly prolific cyber threat to vital infrastructure and the simultaneous rise of information warfare have demonstrated how digital vulnerabilities could eat away at the very foundations of modern economies and societies.

Almost three years into a biological pandemic, we find ourselves mired in a dangerous paradox: digital technologies have created revolutionary—even life-saving—capabilities but at the expense of potentially existential vulnerabilities. How will this digital capability-vulnerability paradox shape market and military power in today's shifting international system? How, in the wake of the pandemic, will the move towards digital dependency impact international and domestic stability? Who are the winners and the losers in this digitally enabled world, autocracies or democracies? Finally, in what state will this paradox leave the post-pandemic global economy? That is, can our digital interdependencies keep globalization alive or will they become weaponized as we splinter into dangerous digital islands?[10]

2. THE CAPABILITY-VULNERABILITY PARADOX: THE IMPACT OF TECHNOLOGY ON STABILITY

Today's digital dependencies are part of what many laud as the "information revolution," the latest in a series of technological innovations dating back thousands of years that have brought with them such revolutionary improvements in military or societal capabilities that their introduction changes the winners and losers in global politics and economies.[11] "Like Oil in the 18th Century: an immensely, untapped valuable asset,"[12] or "what the railroad was to the Industrial Revolution—a totally

9. Danzig, R. (2014, July 21). "Surviving on a Diet of Poisoned Fruit: Reducing the National Security Risks of America's Cyber Dependencies". *CNAS.org*. https://www.cnas.org/publications/reports/surviving-on-a-diet-of-poisoned-fruit-reducing-the-national-security-risks-of-americas-cyber-dependencies.
10. Drezner, Daniel W., Farrell, H., and Newman, A. L. Newman (Eds.). (2021). *The uses and abuses of weaponized interdependence*. Brookings Institution Press.
11. Gray, C. (2004). *Strategy for chaos: Revolutions in military affairs and the evidence of history*. Routledge; Xu, M., David, J. M., and Kim, S.H. (2018). "The fourth industrial revolution: Opportunities and challenges". *International journal of financial research*, 9(2), 90–95; Schwab, K. (2017). *The fourth industrial revolution*. Currency; Krepinevich, A. F. (1994). Cavalry to computer: The pattern of military revolutions. *The National Interest*, 37, 30–42.
12. Toonders, T. (2014, July). "Data is the New Oil of the Digital Economy". *Wired*. https://www.wired.com/insights/2014/07/data-new-oil-digital-economy/.

new, totally unprecedented, totally unexpected development,"[13] revolutions like today's information revolution are often presented as grand moments, progress that leaves in its wake better communication, health, transportation, and military outcomes. This is certainly true—technological leaps often create societal progress that makes states more productive, increases the quality of life, and leaves people generally better off. However, to achieve this long-term progress, technological shifts often generate revolutions that are rarely utopian moments in history or peaceful grappling for better societies. Instead, technological revolutions not only create new capabilities and winners but also, in the process, introduce destabilizing vulnerabilities and, therefore, produce losers. This generates a capability-vulnerability paradox, where the quest to adopt a new technology engenders vulnerabilities that can exacerbate international and domestic tensions, create new classes of haves and have-nots, and engender new competition for the resources that undergird technological progress.[14] At its worst, the conflict that ensues from these technological shifts can actually move society backwards, stifle innovation, and cause states to focus inordinately on guns versus butter. The challenge when thinking about the introduction of these new technologies is how to make these vulnerabilities less dangerous while reaping the long-term benefits of technological progress.[15]

While the quest for digital capabilities may be relatively recent, this paradox of technological progress and destabilizing vulnerabilities is not new. For example, the industrial revolution and its ability to harness coal and steam for large-scale manufacturing wrestled power away from agricultural landlords to a new manufacturing elite.[16] Railways, telegraphs, and electricity changed the geography of societies, leaving in their wake not only new loci of life but also entrenched steel grids of imperial expansion.[17] Together, railway schedules and new lethal machines on the battlefield

13. Drucker, P. F. (1999, October). "Beyond the Information Revolution". *The Atlantic*. https://www.theatlantic.com/magazine/archive/1999/10/beyond-the-information-revolution/304658/.
14. Schneider, J. (2019). "The capability/vulnerability paradox and military revolutions: Implications for computing, cyber, and the onset of war". *Journal of Strategic Studies*, 42(6), 841–863.
15. Frey, C. B. (2019). "The technology trap". In The Technology Trap. Princeton University Press, 2019; Leonard, M. (2021). *The Age of Unpeace: How Connectivity Causes Conflict*. Random House.
16. More, C. (2002). *Understanding the industrial revolution*. Routledge; Clark, G, and Cummins, N. (2014). Inequality and social mobility in the era of the industrial revolution. *The Cambridge Economic History of Modern Britain*, 1, 211–236; Hudson, P. (2014). *The industrial revolution*. Bloomsbury Publishing.
17. Ward, J. R. (1994). "The industrial revolution and British imperialism," 1750–1850. *Economic History Review*, 44–65; Wehler, H.-U. (1970). Bismarck's imperialism 1862–1890. *Past & Present*, 48, 119–155; Henderson, W. O. (2013). *Industrial Revolution on the Continent: Germany, France, Russia 1800–1914*. Routledge; Faith, N. (2014). *The World the Railways Made: Wolmar's Railway Library*. Head of Zeus.

fanned the flames of the first World War.[18] Finally, at the apex of this new machine age, the barreling of militaries and societies into dependencies on oil to power their new internal combustion machines, created the perfect storm for preemptive strikes and the expansion of World War II.[19]

The Industrial Revolution, in particular, illustrates this complicated relationship between technological capability and instability. Although it made many states wealthier, introduced modern sanitation, electricity, and the first telecommunications, it also led to unsafe labor conditions, increased inequality, and set the stage for the violence of World War I and World War II. In the long run, the Industrial Revolution decreased inequality and increased global productivity; it made the modern state. However, these effects were so revolutionary that they brought with them, in the short term, a tumult of discord and violence that had to be reckoned with in order to realize the promise of the Industrial Revolution for modern societies. This is because large technological changes often reapportion power and resources within the domestic market, with knock-down effects on the reallocation of wealth, disruptions in the labor force, and pressures on governance that often lay the seeds for political disruption and, in the most serious cases, revolution.[20]

These domestic disturbances often reverberate into the international system by changing the winners and losers within the system. A state that may have been a dominant power before the technological revolution must now adapt and adopt the emerging technologies in order to hold on to its position within global politics all the while maintaining peace at home. The rise and fall of powers as they respond to emerging technologies creates natural friction, a tinderbox of potential conflict as states vie for position within the new structure.[21] Part of this reapportionment of power within the international system comes from the way states compete for these limited but valuable resources. At its most brutal, competition for resources mani-

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18. Lieber, K. A. (2018). "War and the engineers". In *War and the Engineers*. Cornell University Press; Stevenson, D. (1999). War by timetable? The railway race before 1914. *Past & present*, 162, 163–194; Satia, P. (2019). *Empire of guns: the violent making of the industrial revolution*. Stanford University Press; Wolmar, C. (2010). *Engines of War: How Wars Were Won and Lost on the Railways*. Public Affairs Press. Christian Wolmar.
19. Haycock, R., and Neilson, K. (1988). Men, Machines & War. Wilfrid Laurier University Press; Yergin, D. (1991). *The prize: The epic quest for oil, money & power*. Simon and Schuster; Glaser, C. (2013) How Oil Influences National Security. *International Security*, 38 (2), 118.
20. Landes, D. S. (2003). *The unbound Prometheus: technological change and industrial development in Western Europe from 1750 to the present*. Cambridge University Press; Richta, R. (2018). *Civilization at the crossroads: social and human implications of the scientific and technological revolution*. Routledge.
21. Brodie, B. and McKay Brodie, F. (1973). *From Crossbow to H-bomb*. No. 161. Indiana University Press; Van Evera, S. (2013). *Causes of war: Power and the roots of conflict*. Cornell University Press; Boot, M. (2006). *War made new: technology, warfare, and the course of history, 1500 to today*. Penguin.

fests in wars, campaigns of coercion, and imperialism. Queen Elizabeth I raised a mercenary navy of pirates to stymie and plunder Spanish New World resources.[22] European empires colonized vast territories in Africa and Asia, searching for the material resources that fueled the industrial age economy.[23] But even short of war, international power dynamics shift as states create alliances and trade structures that allow some to benefit from the new technological shift while other resource-poor nations must bend to the will of resource-rich states to ensure access to vital materials. The resulting networks that emerge from global trade in these resources can create a new form of state power, which Farrell and Newman call "weaponized interdependence," when "states with political authority over the central nodes in the international networked structures through which money, goods, and information travel are uniquely positioned to impose costs on others. If they have appropriate domestic institutions, they can weaponize networks to gather information or choke off economic and information flows, discover and exploit vulnerabilities, compel policy change, and deter unwanted actions."[24]

Technological change can create a tinderbox by reallocating domestic and international power, which may ultimately ignite conflict. This is because technological revolutions often do two things that increase the chance of war. First, emerging technologies frequently change the nature of warfare in a way that advantages offensive, preemptive campaigns. In these situations, when emerging technologies increase incentives for first strike and uncertainty about state intentions, countries may find themselves in a spiral towards otherwise undesired conflict.[25] The capability-vulnerability paradox exacerbates this dynamic by putting even more pressure on the states that are behind the technological curve to strike early. Because these less capable states cannot compete with militaries that have fully adopted the new revolutionary technology, they fear they cannot survive against a more capable, technologically advanced military, even in a limited-aims coercive war. Seeking a way to mitigate their position of extreme asymmetry, the less capable states look for vulnerabilities to attack early in a crisis in order to win an otherwise unwinnable war.

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22. Thomson, J. E. (1996). *Mercenaries, pirates, and sovereigns: state-building and extraterritorial violence in early modern Europe*. Vol. 63. Princeton University Press.
23. Le Billon, P. (2014). *Wars of Plunder: Conflicts, Profits and the Politics of Resources*. Oxford Academic.
24. Farrell, H., and Newman, A. L. (2019). "Weaponized interdependence: How global economic networks shape state coercion". *International Security*, 44(1), 45.
25. Jervis, R. (1978). "Cooperation under the security dilemma". *World politics*, 30(2), 167–214; Glaser, C. L. (1997). "The security dilemma revisited". *World politics*, 50(1), 171–201; Glaser, C. L. (2004). "When are arms races dangerous? Rational versus suboptimal arming". *International Security*, 28(4), 44–84; Lieber, K. A. (2000). "Grasping the technological peace: The offense-defense balance and international security". *International Security*, 25(1), 71–104.

This leads to the second way in which the technologies of these technological revolutions can spark conflict. Technologies that spread across societies, economies, and militaries create widespread dependencies—on both the technology and the resources required to enable those technologies. The most dangerous examples of the capability-vulnerability paradox arise when technological revolutions are dependent on resources that are finite, have limited temporal availability, are geographically distant, and are highly tangible. These kinds of resources are vulnerable to adversary exploitation and therefore make dependencies dangerous for international politics. In the past, these vulnerable resources included saltpeter[26] and oil, but today, they could include materials used for batteries, such as lithium and cobalt.

Perhaps the greatest example of this is the way oil revolutionized mechanized warfare between World War I and World War II, ushering in new and dominant battlefield tactics like the German blitzkrieg or the use of airpower in naval campaigns. This new revolution relied on oil-dependent mechanized tanks, aircraft, and armored personnel carriers to conduct rapid and coordinated offensive campaigns. Oil-fueled mechanized warfare made states extraordinarily capable, but the dependency on oil to carry out mechanized warfare made states extraordinarily vulnerable to attacks on energy supplies. This vulnerability was compounded by the dominance of manufacturing in economies and the reliance on oil to power both production and modern societies. The pressure to maintain an oil supply played a major role in Japan's surprise attack on US naval forces in Pearl Harbor.[27]

3. THE CAPABILITY-VULNERABILITY PARADOX, DIGITAL DEPENDENCIES, AND DOMESTIC INSTABILITY

The danger of the capability-vulnerability paradox lies in how it creates exploitable dependencies or redistributes resources within societies. What does this mean for stability within governments and markets? Can it lead to civil unrest, revolutions, and war? How does the capability-vulnerability paradox produce new economic winners and losers?

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26. Cressy, D. (2013). *Saltpeter: The Mother of Gunpowder.* Oxford University Press.
27. Kelanic, R. (2016). "The Petroleum Paradox: Oil, Coercive Vulnerability, and Great Power Behavior". *Security Studies*, 25(2), 181–2013; Sagan, S. D. (1988). "The origins of the pacific war". *The Journal of Interdisciplinary History*, 18(4), 893–922; Jensen, W. G. (1968). "VIII. The Importance of Energy in the First and Second World Wars". *The Historical Journal,* 11(3), 538–554; Winegard, T. C. (2016). *The first world oil war.* University of Toronto Press.

The rise of the digital economy over the last two decades reshaped labor markets and reallocated wealth. The initial leader was the United States. According to the US Bureau of Economic Analysis, the digital economy contributes over three trillion dollars to the country's gross domestic product (GDP)—almost ten percent of the entire economy—and eight million jobs.[28] However, China follows close behind: its digital economy comprised 7.8 percent of its GDP in 2020, with a goal to hit ten percent of GDP by 2025.[29] As the United Nations Conference on Trade and Development noted about the dominance of these two countries in the landscape of the digital economy, "together, they account for half the world's hyperscale data centres, the highest rates of 5G adoption in the world, 94 percent of all funding of artificial intelligence (AI) start-ups in the past five years, 70 percent of the world's top AI researchers, and almost 90 percent of the market capitalization of the world's largest digital platforms."[30]

The winners and losers in this digital revolution are those able to control the digital economy's most valuable commodity: information. As large corporations like Alibaba, Apple, Google, Facebook, Tencent, Twitter, and Amazon dominate the digital market, information becomes increasingly centralized in a handful of companies' repositories even as the dependency on this information spreads across the globe. Individuals are both using more information and giving more of their information away, creating an asymmetry between countries in Europe, parts of Asia, and even Africa increasingly dependent on information and a few major corporations to fulfill their needs. This need was compounded as businesses increasingly turned towards cloud computing as a service while individuals uploaded the images, documents, and internet history of their lives to a handful of companies. The end result is a world of information haves and have-nots, where a few major actors controlled access to and analysis of information within a society increasingly reliant on this very information to prosper and even function. As the United Nations Conference on Trade and Development concluded, "as the data-driven digital economy has evolved, a data-related divide has exacerbated the digital divide. In this new configuration, developing countries may find themselves in subordinate positions, with data and their associated value capture being concentrated in a few global digital corporations and other multinational enterprises that control the data.

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28. United States Bureau of Economic Analysis. (2022). New And Revised Statistics of the US Digital Economy, 2005-2020. https://www.bea.gov/system/files/2022-05/New%20and%20Revised%20Statistics%20of%20the%20U.S.%20Digital%20Economy%202005-2020.pdf
29. Wu, Y. (2022, August 11). "Understanding China's Digital Economy: Policies, Opportunities, and Challenges". *China Briefing.com*. https://www.china-briefing.com/news/understanding-chinas-digital-economy-policies-opportunities-and-challenges/.
30. United Nations Conference on Trade and Development. (2021). Digital Economy Report 2021, 15.

They risk becoming mere providers of raw data to global digital platforms while having to pay for the digital intelligence obtained from their data."[31]

This digitally dependent world of information haves and have-nots has implications for regional and domestic stability. First, the reliance on information to undergird the new digitally reliant economy changed the labor force, shifting focus from manufacturing increasingly towards digital services.[32] The shift was not seamless. As digital technologies decreased the need for human labor in many industries, replacement jobs called for more technical skills or higher education. Those able to work in the digital economy were rewarded with higher pay while those without the requisite skills faced an increasingly gig-based economy with less stability and social safety nets.[33]

This created inequality within states and among states. For instance, in Europe, investment in digital infrastructure and digital skills for the workforce varied significantly between early adopting states like the UK, Germany, and Sweden and countries like Greece or the Slovak Republic.[34] The subsequent regional inequality led to both digital and economic disparity between the states, even within the European Union. Within states, digital divides are also shaping inequalities and creating social cleavages in domestic politics. Urban areas hosting the digital labor force—like San Francisco, Seattle, or the tech giants of China's east coast—saw huge leaps in housing values as neighborhoods gentrified to accommodate these well-paid

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31. United Nations Conference on Trade and Development. (2021). "Digital Economy Report 2021", 16.
32. Chinorický, R., and Čorejová, T. (2019). "Impact of digital technologies on labor market and the transport sector". *Transportation research procedia*, 40, 994–1001; Lishchuk, E. N., Chistiakova, O. A., Boronina, E. S., Churikova, A. A., and Kapelyuk, Z. A. "Rural labor market and digitalization: New challenges and opportunities". (2021). *Frontier Information Technology and Systems Research in Cooperative Economics*, 159–164.
33. Noam, E. (2018). "Inequality and the Digital Economy". In Digitized Labor (pp. 117–140). Palgrave Macmillan, Cham; Sadovaya, E. (2019). "Digital economy and a new paradigm of the labor market". *Mirovaia ekonomika i mezhdunarodnye otnosheniia*, 62(12), 35–45.; Rogulenko, T. M., Ponomareva, S. V., and Krishtaleva, T. I. (2019). "Competition between intelligent machines and digital personnel: the coming crisis in the labor market during the transition to the cyber economy". In *The Cyber Economy* (pp. 185-194). Springer, Cham.
34. Greve, B. (2019). "The digital economy and the future of European welfare states". *International Social Security Review*, 72(3), 79–94; Jepsen, M., and Drahokoupil, J. (2017). "The Digital Economy and its Implications for Labour". *Transfer: European Review of Labour and Research*, 23(3) (pp. 249-252). https://doi.org/10.1177/10242589177146.

tech workers.[35] Meanwhile, rural areas and aging industry bastions struggled to adjust to the new digital economy. In the US, inequality has increased tenfold over the last two decades. The 2022 World Inequality Report warns that "the poorest half of the global population barely owns any wealth at all, possessing just two percent of the total. In contrast, the richest ten percent of the global population own 76 percent of all wealth."[36]

The wealth divide created social schisms that information dependence only exacerbated. Digitally dependent societies became more and more connected over social media applications, sharing baby pictures and travel photographs on social media sites. Meanwhile, the algorithms honed by social media companies targeted users, at first with products and services, but by 2016, these sites were becoming platforms for political targeting. Candidates, political organizations, and foreign intelligence organizations used the data that these companies had been collecting to galvanize communities, often exploiting the wealth and social inequalities created in the transition to a digital economy. Social media companies incentivized this viral information sharing, largely indifferent to the nature of the information. The monetization of data and its impact on society made information increasingly a tool of conflict[37] while

35. Wilson, C. K., Thomas, J., and Barraket, J. (2019). "Measuring digital inequality in Australia: The Australian digital inclusion index". *Journal of Telecommunications and the Digital Economy,* 7(2), 102–120; Liu, H., Fang, C., and Sun, S. (2017). "Digital inequality in provincial China". *Environment and Planning A*, 49(10), 2179–2182; Martynenko, T. S., and Vershinina, I. A. (2018). "Digital economy: The possibility of sustainable development and overcoming social and environmental inequality in Russia". *Revista Espacios*, 39(44) (pp. 12-20); Francis, D. V., and Weller, C. E. (2022). Economic inequality, the digital divide, and remote learning during Covid-19. *The Review of Black Political Economy*, 49(1), 41–60; Kruglov, D., Tsygankova, I., Reznikova, O., and Mikhailov, S. (2020). *Influence of digital technologies on migration flows and the regional labor market of Russia*. No. 2649. EasyChair; Nijman, J., and Wei, Y. D. (2020). "Urban inequalities in the 21st century economy". *Applied Geography*, 117,102188.
36. WID World. (2022). "World Inequality Report 2022". https://wir2022.wid.world/executive-summary/.
37. Tucker, J. A., Guess, A., Barberá, P., Vaccari, C., Siegel, A., Sanovich, S., Stukal, D., and Nyhan, B. (2018). "Social media, political polarization, and political disinformation: A review of the scientific literature". *Political polarization, and political disinformation: a review of the scientific literature*; Flew, T., and Iosifidis, P. (2020). "Populism, globalisation and social media". *International Communication Gazette*, 82(1), 7–25; Allcott, H;, and Gentzkow, M. (2017). "Social media and fake news in the 2016 election". *Journal of economic perspectives*, 31(2), 211–36; Jaiswal, J., LoSchiavo, C., and Perlman, D. C. (2020). "Disinformation, misinformation and inequality-driven mistrust in the time of Covid-19: lessons unlearned from AIDS denialism". *AIDS and Behavior*, 24(10), 2776–2780; Tandoc, E. C., Lee, J., Chew, M., Tan, F. X., and Goh, Z. H. (2021). "Falling for fake news: the role of political bias and cognitive ability". *Asian Journal of Communication*, 31(4), 237–253; Iosifidis, P., and Nicoli, N. (2020). *Digital democracy, social media and disinformation*. Routledge.

government associations with social media led to data collection for foreign disinformation campaigns and posturing within the international order.[38]

The pandemic pushed these forces into overdrive, creating incentives for social media and digital information propagation, automation, robotics, and AI. Digital behemoths prospered during a global shutdown, and the subsequent migration to virtual lives made global citizens far more dependent on these digital providers in what became a natural experiment in individual companies' attempts to self-regulate the spread of information on their platforms. Even as initial pandemic headlines warned of staggering unemployment and bankruptcies, information technology companies became more integrated and more vital to daily lives, harvesting more data and consolidating more wealth.[39]

The inequities created in the transition to an information-based society catalyzed unrest during a pandemic that left individuals uncertain, fearful, and alone. The companies that kept individuals connected as they disconnected physically became fertile grounds for domestic discord, sowing both misinformation and distrust. Social media applications like Facebook and Twitter mirrored and magnified existing divisions, catalyzing frustration about the externalities of technological revolution to foment social change. Although we had seen the effect of information on domestic instability as early as 2007 and the Arab Spring,[40] social protests in the United States after the killing of George Floyd, along with the radicalization of right- and left-wing factions across the world and, finally, the January insurrection attempt against the US Capitol demonstrated how destabilizing digital dependencies

38. Melin, E. (2021). "China's sharp power through TikTok: A case study of how China can use sharp power through TikTok"; Gray, J. E. (2021). "The geopolitics of platforms: The TikTok challenge". *Internet policy review*, 10(2), 1–26; Mishra, M., Yan, P., and Schroeder, R. (2022). "TikTok politics: Tit for tat on the India–China cyberspace frontier". *International Journal of Communication*, 16, 26.
39. Kemp, S. (2022, July 21)." Digital 2020: July Global Statshot". *Datareportal*. https://datareportal.com/reports/digital-2020-july-global-statshot; Wong, A., Ho, S., Olusanya, O., Antonini, M. V., and Lyness, D. (2021). "The use of social media and online communications in times of pandemic Covid-19". *Journal of the Intensive Care Society*, 22(3), 255–260.
40. Herrera, L. (2004). *Revolution in the age of social media: The Egyptian popular insurrection and the Internet*. Verso Books.

can be for societies.[41] After the pandemic, it has become clear that far more than other resources that have undergirded technological revolutions, information— and the ability to connect to collect, disseminate, and use it— is an incendiary for social change.

What makes information so dangerous to domestic stability is how it can be not only controlled but also manipulated by foreign actors, making it a more insidious dependency than in other past technological revolutions. There was already significant foreign interference in data before the pandemic. Russian attempts to influence the 2016 US election, as well as the misinformation campaigns led by China against Taiwan, all targeted populations' reliance on data to create discord.[42] Yet, as states grow more dependent on information and digital interfaces for social interaction (as we all have during the pandemic), individuals become more susceptible to these tactics. The schisms produced by changes in wealth and inequality—themselves often a product of the digital revolution—are vulnerable to this foreign manipulation, creating a doubly dangerous phenomenon where those left behind by the new digital economies can be weaponized through their very dependence on the digital technologies that left their labor markets and economies outdistanced.

Finally, there are implications for the stability of the modern market itself. Modern financial and commerce systems are built on digital information. Users must trust

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41. Martin, K. (2022). "Recommending an Insurrection: Facebook and Recommendation Algorithms". In *Ethics of Data and Analytics* (pp. 225–239). Auerbach Publications; Carney, N. (2016). "All lives matter, but so does race: Black lives matter and the evolving role of social media". *Humanity & Society*, 40(2), 180–199; Mundt, M., Ross, K., and Burnett, C. M. (2018). "Scaling social movements through social media: The case of Black Lives Matter". *Social Media+ Society*, 4(4), 2056305118807911; Wilkins, D. J., Livingstone, A. G., and Levine, M. "Whose tweets? The rhetorical functions of social media use in developing the Black Lives Matter movement". *British Journal of Social Psychology*, 58(4), 786–805; Mirchandani, M. (2018). Digital hatred, real violence: Majoritarian radicalisation and social media in India. *ORF Occasional Paper*, 167, 1–30; Sikkens, E., van San, M., Sieckelinck, S., Boeije, H., and De Winter, M. (2017). "Participant recruitment through social media: Lessons learned from a qualitative radicalization study using Facebook". *Field Methods* 29(2), 130–139; Myagkov, M., Shchekotin, E., Goiko, V., Kashpur, V., and Aksenova, E. (2019). "The socio-economic and demographic factors of online activity among right-wing radicals". *Studies of Transition States and Societies*, 11(1), 19–38.
42. Bennett, W. L., and Livingston, S. (2018). "The disinformation order: Disruptive communication and the decline of democratic institutions". *European journal of communication*, 33(2), 122–139; Beskow, D. M., and Carley, K. M. (2020). "Characterization and comparison of Russian and Chinese disinformation campaigns". In *Disinformation, misinformation, and fake news in social media* (pp. 63–81). Springer, Cham; Berghel, H. (2017). "Oh, what a tangled web: Russian hacking, fake news, and the 2016 US presidential election". *Computer*, 50(9), 87–91; Blanchette, J., Livingston, S., Glaser, B., and Kennedy, S. (2021). "Protecting democracy in an age of disinformation: lessons from Taiwan"; Harold, S. W., Beauchamp-Mustafaga, N., and Hornung, J. W. (2021). *Chinese Disinformation Efforts on Social Media*. RAND PROJECT AIR FORCE SANTA MONICA CA.

that the 1s and 0s behind digital transactions have meaning, that lines of code can ensure the safety of assets and currencies, and that physical items bought using e-platforms will become real-life objects on front porches and inside mailboxes. As companies move towards e-commerce, cryptocurrencies, or digital transactions and away from brick-and-mortar establishments, their business becomes reliant on digital technologies and their customers' trust in these technologies.[43] These become lucrative vulnerabilities for competing companies, criminals, and even states. Suddenly, states that would otherwise be losers in the digital market can exploit digital vulnerabilities and redistribute market power.[44] For example, North Korea—a loser in the information revolution—reaps millions from ransomware attacks on Western digitally enabled companies. Elsewhere, a declining Russia looks away as criminal actors launch large-scale cyber campaigns against digitally enabled companies, redistributing trillions of dollars away from the normal digital economy towards black markets of shadowy actors across Russia, Eastern Europe, and Asia.[45] So far, businesses have withstood these costs. However, there may come a pivotal point at which the costs become too high to sustain or user distrust leads markets to crumble. At this inflection point, the crash of the digital economy could take with it the governments and societies built upon the capabilities promised by the turn towards digital markets.

4. THE CAPABILITY-VULNERABILITY PARADOX, DIGITAL DEPENDENCIES, AND INTERNATIONAL POLITICS

Foreign disinformation campaigns and cyberattacks against digitally enabled markets are only part of how digital dependencies shape the international system. The digital revolution helped pave the way for globalization in the early 2000s, linking countries across the world through information, the internet, and a global supply chain that produced the chips, motherboards, and servers necessary for the information age. The early golden digital years were full of promise—about how

43. Schneider, J. (2022). "A World without Trust: The Insidious Cyberthreat". *Foreign Affairs*, 101, 22.
44. United States Department of Justice. (2022, July 19). "Justice Department Seizes and Forfeits Approximately $500,000 from North Korean Ransomware Actors and their Conspirators". https://www.justice.gov/opa/pr/justice-department-seizes-and-forfeits-approximately-500000-north-korean-ransomware-actors.
45. Harding, E., and Ghoorhoo, H. (2022, September). "Hard Choices in a Ransomware Attack". *CSIS*. https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220928_Harding_HardChoices_RansomwareAttack.pdf?XzYG9_BSC1yZhE.sAbvYXThCqSBQNmb4.

globalization and information would link countries, creating interdependencies and ultimately diffusing good governance for an era of peace and prosperity.[46]

These golden digital years coincided with the end of the Cold War, a resurgent West, and a hegemonic United States with no clear peer competitor and a booming tech economy. Silicon Valley–based Apple revolutionized communication across the globe with the introduction of its iPhone, a "smart" device capable not just of making calls but also of connecting to the internet, downloading music and data, and even providing real-time location updates to its users. Meanwhile, US-based digital search companies like Google and Yahoo were creating the rules of the road for the internet, fostering international e-commerce, and experimenting with both collecting and commoditizing users' data, thus implicitly setting the norms of digital behavior for the international community. Seeking new ways to interact and communicate, internet users turned to burgeoning websites designed to create social communities by sharing information, such as MySpace and Facebook. By the beginning of the 2010s, the United States featured the leading companies acquiring, organizing, storing, and employing information.

For decades, the clear winner in the digital revolution was the US. Companies based in the United States patented the technology, set the rules, and collected the data. The US economy boomed, its digitally enabled military grew even more powerful, and the spread of information through social media seemed—with the onset of the Arab Spring—to promote democratic governance. Scholars opined that global and internet interdependencies could create restraint and peace while easy access to information would lead to a better-informed citizenry.

However, the balance of digital power is shifting. Chinese and Russian views of a centralized, controlled, and sovereign internet rife with domestic censorship have become a strong competitor to the more open US model.[47] Chinese investments in internet infrastructure, in particular 5G and its follow-ons, in Africa, South America, and even Europe have shifted dependencies away from the US, creating new loci of informational control in companies like Huawei and ZTE. Chinese social media interfaces, like the popular message platform WeChat and the video

46. Micklethwait, J., and Wooldridge, A. (2003). *A future perfect: The challenge and promise of globalization*. Random House Trade Paperbacks; Wolf, M. (2004). *Why globalization works*. Vol. 3. Yale University Press; Knutsson, R. (2007). Macroeconomic Aspects of the Golden Arches Theory of Conflict Prevention; Friedman, T. L. (2000). *The Lexus and the olive tree: Understanding globalization*. Farrar, Straus and Giroux.
47. Flonk, D. (2021). "Emerging illiberal norms: Russia and China as promoters of internet content control". *International Affairs*, 97(6), 1925–1944; Hurwitz, R. (2014). "The play of states: Norms and security in cyberspace". *American Foreign Policy Interests*, 36(5), 322–331.

application TikTok, have become wildly popular across the globe, featuring over a billion users (approximately 12.5 percent of the total population).

Digital Dependencies and Modern Warfare: Incentives for First Strike

The race for digital dominance is only part and parcel of a broader drive towards competition between the United States and China.[48] While the digital revolution may not have created the deteriorating relationship between the two countries, the characteristics of digital dependencies can exacerbate the danger that comes with the contentious dyad, with implications for the entire international system. What we have learned from the capability-vulnerability paradox and its historical precedent is that these dependencies can create instability in two ways. First, the current focus on digital technologies for offensive dominant campaigns introduces lucrative first-strike incentives to target data-dependency vulnerabilities for both the United States and China. Second, the quest for the resources required for digital dominance (semiconductors, batteries, cabling, antennae, and talent) introduces new vulnerabilities, with consequences for both economic and military power. The pandemic has only made these dangers more pressing.

Digital technology changed modern warfare. It took modern militaries from wars of attrition in which mass and quantity determined winners and losers to campaigns of networked sensors and weapons in which precision effects and quality dictate the victors of wars. It created a revolutionary leap in capability but also a belief that victory would be won by leveraging speed and information dominance to strike quickly, from long ranges, and with overwhelming effect. To make this theory of victory work, states invested in data and information (sensors, processing centers, datalinks, smart weapons, and digitized command and control). Modern militaries became digital junkies.[49]

But did the data addiction create instability? While digital technology may have increased states' incentives to enter into conflicts, over the last twenty years, digital vulnerabilities have had a lesser impact on military power. Despite years of dire pronouncements about cyber Armageddons or Pearl Harbors, states have found it difficult to generate large-scale effects with cyber weapons. We do not know of any cyberattacks that turned the tide of a battle or had a strategic effect that could stymie a campaign or change the outcome of a conflict. Instead, cyber operations targeting digital vulnerabilities have existed at the fringe of physical conflict,

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48. Colby, E. A., and Wess Mitchell, A. (2020). "The age of great-power competition: How the Trump administration refashioned American strategy". *Foreign Affairs*, 99, 118.
49. Cebrowski, A. K., and Garstka, J. J. (1998). "Network-centric warfare: Its origin and future". *US Naval Institute Proceedings*, 124(1), 28–35; Brose, C. (2020). *The kill chain: Defending America in the future of high-tech warfare*. Hachette Books.

sometimes enabling conventional operations but more often acting as nuisance or intelligence operations. This is because cyber targeting to create physical effects on the battlefield is difficult, leaving countries without enough confidence in their cyberattacks to rely on exploiting digital vulnerabilities to change the course of a war.[50] Cyber operations then become primarily weapons of influence, creating fog and uncertainty and modifying information narratives but not substituting for conventional weapons. Nonetheless, this may change in the future, partly because the Covid-19 pandemic catalyzed a drive towards automation and remote operations.

Militaries are transitioning from sloppy data users and accumulators with inefficient networks to centralized networks of ubiquitous sensors that enable AI, smart weapons, and (after Covid-19) increasingly remote operation. As states rely more and more on offboard data generation and cloud computing, they create structures of database farms, cabling, and over-the-horizon satellite relays. These are in many ways akin to railroads, shipping chokepoints, or pipelines, which create a geography of digital targets for states to attack. As the freeflow and storage of more and more data becomes reliant on a few pipelines or stored in a few database farms, it is increasingly tempting for states to attack these capabilities early in a crisis.

Meanwhile, the drive for automation and AI makes the effect of exploiting these vulnerabilities more binary. The ability to turn a data stream on or off is far more lucrative than existing cyber exploits, which may be able to decrease the overall flow of the stream but cannot create the kind of blockade effects possible with oil. Additionally, the ability to poison or pollute data may attack the very trust in digital systems required for modern warfare. Finally, entanglement between private cloud company vendors (for example, Amazon Web Services) and national security information further increases the chance for deliberate escalation that begins with an opportunistic attack on information-holding civilian enterprises. Together, these moves towards entanglement, automation, and centralized networks of information could make data look more like the kind of tangible, finite resources that have threatened international stability before, because of both the pressure for preemptive war and the kinds of accidents and miscalculations that inadvertently escalate crises into full-blown conflicts.

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50. Schneider, J., Schechter, B., and Shaffer, R. (2022). "A Lot of Cyber Fizzle But Not A Lot of Bang: Evidence about the Use of Cyber Operations from Wargames". *Journal of Global Security Studies*, 7(2), Article ogac005; Valeriano, B., and Maness, R. C. (2015). *Cyber war versus cyber realities: Cyber conflict in the international system*. Oxford University Press; Borghard, E. D.,and Lonergan, S. W. (2019). "Cyber operations as imperfect tools of escalation". *Strategic Studies Quarterly*, 13(3), 122–145; Borghard, E. D., and Lonergan, S. W. (2017). "The logic of coercion in cyberspace". *Security Studies*, 26(3), 452–481; Schneider, J. (2021, July 27). "The Cyber Apocalypse Never Came, Here's What we Got Instead". *Politico*. https://www.politico.com/news/magazine/2021/07/27/cyber-apocalypse-russia-china-warfare-500787.

Digital Dependences and Resource Vulnerabilities

The danger of digital dependencies is exacerbated by resource vulnerabilities. While data is often credited as the primary resource of the information revolution, it runs on both a physical backbone of cabling, WIFI conduits, and silicon chips and a virtual backbone dependent on parsing algorithms, user software, and human talent. Access to these resources will also affect international stability.

First, today's digital dependencies rely on semiconductors as the brain of computer processing power. Semiconductors—small silicon chips that contain an array of electric circuits—give process and function to the 1s and 0s of digital information. They are used for traditional computing but also enable the internet of things and advanced weapons systems. As chips have become more integral to digital societies, they have also gotten more complex and their manufacturing more consolidated. Today, almost all modern semiconductor chips are manufactured by one Taiwanese company, a fact that the Covid-19 pandemic has highlighted as trade and labor disruptions created large bottlenecks for industries reliant on chips to build their goods. This resource vulnerability becomes an especially salient issue for the US–China relationship as a Chinese invasion of Taiwan could create an existential supply chain vulnerability for the weapons the United States needs to conduct its digitally dependent campaigns.[51] A recent US Department of Defense's Industrial Capabilities Report to Congress warned pointedly that "the dependence on foreign sources for semiconductor products continues to represent a serious threat to the economic prosperity and national security of the US".[52]

Additionally, because semiconductors are information conduits, these resources have a dual vulnerability to access and potential manipulation (or control of data). A 2018 Bloomberg article highlighted the possibility of a backdoor installed on a microchip, giving Chinese government personnel access to the motherboards containing the infected chip. While the article was refuted, it illustrated how the control of chip manufacturing could create large-scale vulnerabilities for states reliant on digital technologies.[53]

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51. Shepardson, D. (2022, April 6). "White House warns of 'escalating vulnerabilities' to US from semiconductor shortage". *Reuters*. https://www.reuters.com/world/us/white-house-warns-escalating-vulnerabilities-us-semiconductor-issue-2022-04-06/; Donovan Smith, C. (2022, August 18). "The Vast and Vulnerable Semiconductor Supply Chain". *Amcham Taiwan*. https://topics.amcham.com.tw/2022/08/the-vast-and-vulnerable-semiconductor-supply-chain/.
52. US Department of Defense. (2021, January 14). FY20 Industrial Capabilities Report. https://www.defense.gov/News/Releases/Release/Article/2472854/dod-releases-industrial-capabilities-report/.
53. Lumpkin, M. and Levin, P. (2022, August 27). "The mother of al 'zero-days'—immortal flaws in semiconductor chips". *The Hill*. https://thehill.com/opinion/cybersecurity/3617715-the-mother-of-all-zero-days-immortal-flaws-in-semiconductor-chips/.

Additionally, today's digital world relies on infrastructure to connect data providers, collectors, and users. The need for infrastructure also creates resource vulnerabilities. To process large amounts of data, networks need fiber-optic cables, wireless transmitters, and satellites. Like the semiconductor industry, investment in these technologies requires significant capital outlays; therefore, digital infrastructure—particularly the best 5G networks—are dominated by only a few companies. Because of this considerable capital outlays, many countries have turned to the leading Chinese 5G network providers, Huawei and ZTE, to provide 5G infrastructure at a low cost.[54] This has given rise to significant concerns in the United States and some Western countries about how Huawei and ZTE's broad control of data infrastructures could create vulnerabilities not solely in market share but also in access to data. Control of these network infrastructures dictates who can control data, who can see or use it, and who can manipulate it.

In this way, network infrastructure companies become chokepoints and loci of communication, resembling much more the vulnerabilities created by railroads or telegraphs than those created by oil. This is because the components of networks are often not scarce, and the market for creating fiber-optic cables, satellites, and wireless antennae—all core parts of the 5G network architecture—is generally diverse and receptive to new companies. Even behemoths like Huawei rely on manufacturers in Europe, the United States, and Taiwan for antennae and chips. Meanwhile, the recent rise in commercial satellite manufacturers also enhances the resilience of satellite nodes in these modern infrastructures.[55]

Data can be transmitted and used to control machines via investments in infrastructure and semiconductors, but it cannot be utilized effectively without software and talent. This primarily requires investments in human capital, which can be extremely competitive for some of the most sophisticated data services. The market for talent to develop AI algorithms experiences labor shortages created by both high demand and highly specialized education and training.[56] Similarly, cybersecurity jobs have multiplied exponentially over the last few years, with a potential labor shortage of 3.5 million workers. To solve this problem, states have invested in education and training, but this is a long-term pipeline solution. In the short term, they have relied on immigration and foreign talent to keep up with the demand for data workers,

54. Congressional Research Service. National Security Implications of Fifth Generation Mobile Technologies; Brake, D. (2018). "Economic competitiveness and national security dynamics in the race for 5G between the United States and China". *TPRC*.
55. Vinion, K. (2022, October 20). "How Elon Musk's Starlink Became Invaluable to Ukraine's War Efforts". *RadiofreeEurope*. https://www.rferl.org/a/starlink-elon-musk-ukraine-war-russia-funding/32091045.html.
56. Gehlhaus, D. (2021, April 9). "The Reality of America's AI talent shortage". *The Hill*. https://thehill.com/opinion/technology/547418-the-reality-of-americas-ai-talent-shortages

although this can also introduce new vulnerabilities if talent is not given a pathway to full citizenship.

Finally, data runs on power. While coal and oil may have fueled previous revolutions, increasing reliance on green energy sources and batteries also generates a new vulnerability for information technology. In particular, the reliance on lithium has created a resource vulnerability among Western nations. This is because currently, "China controls 51 percent of the global total of chemical lithium, 62 percent of chemical cobalt and 100 percent of spherical graphite — the major components of lithium-ion batteries."[57] However, unlike other resources, new potential sources of lithium and investments in mines in countries like Australia could move some of the sources of mineral resources required in batteries from those controlled by a few (like oil) to ones that are plentiful in many locales (like coal).

5. TOWARDS THE FUTURE: HOW TO MOVE OUT OF THE PARADOX

In 1941, an oil-dependent Japan made a preemptive strike against the US, hoping it would weaken the US resolve to deprive Japan of the oil resources it needed to conduct war and support its society. In the decades that followed World War II, states went to great lengths to escape Japan's oil-induced capability-vulnerability paradox. They diversified their energy supply, reducing dependence on oil. Others increased their access to oil, building up domestic reserves, trading with multiple countries, and searching for new sources of oil. By decreasing both dependence on oil and the adversary's ability to cut off this access, states were able to mitigate the danger posed by oil's capability-vulnerability paradox.

There are lessons to be learned from this, about how to govern data, how to build digitally dependent infrastructure, and, ultimately, how to create human and societal resilience in the face of technological change. The key to solving the capability-vulnerability paradox is not in abandoning technology completely but instead in building societies, economies, and militaries that can reap the long-term benefits of technological progress to survive temporary technological turmoil. In the most optimal of solutions, the paradox can be avoided completely by innovating alternatives to resource dependencies, building defenses and fail-safes that deter attacks against vulnerabilities, decreasing economic incentives to attack vulnerabilities, and creating social safety nets that save the losers in technological leaps from being left out of the new technological world. We do not have to retreat to digital islands to avoid the paradox; indeed, it may be that resilience is created by re-connecting

57. Roselund, C. (2019, June 14). "State Department issues strategy on diversifying clean energy, storage supply chains". *PV-magazine-USA.com*. https://pv-magazine-usa.com/2019/06/14/state-department-issues-strategy-on-diversifying-clean-energy-storage-supply-chains/.

and redistributing the vulnerabilities (and some capabilities) of the information revolution.

Before the pandemic, it might have seemed rational to advocate for less societal dependence on digital resources. However, digital dependence has been pivotal to holding societies together through the Covid-19 health crisis. It seems unlikely or unreasonable to try and decrease this dependence now. This means that societies must make more complicated choices about how to depend on information. Oil was especially dangerous because it was scarce, easily measurable, and had chokepoints from which actors could alter the distribution of the resource. Information is everywhere and difficult to measure or even visualize; however, it has significant chokepoints. These chokepoints are becoming more valuable and potentially dangerous as data is increasingly stored and owned by a few corporations that either collect their own or store that of others. As our entire lives move to the digital world, these chokepoints carry more and more information about how we live, govern, and fight. While the diffuse nature of the early internet made data hard to use effectively, it also made it a difficult resource to manipulate. States like the United States need to think about how the centralization of data creates lucrative targets for adversaries and have tough conversations about the geography of this data. This is already happening in Europe and is a foregone conclusion in autocracies like Russia and China. Perhaps it is time for the West to think about whether data localization or, alternatively, investments in redundant data centers throughout allied countries, can support the economy while also protecting its citizens and its economic and military power.

While it may be difficult to reduce the digital dependencies that existed before Covid-19 and that are now important characteristics of a post-pandemic world, the United States and other liberal democracies can take steps to decrease adversaries' ability to exploit or cut off access to information. Part of the solution is in building human resilience—educating citizens to question their biases, look at data sources, and know how to operate when they do not have access to digital resources. To mitigate information vulnerabilities, users must move beyond treating information as a binary variable (good or bad) and instead be able to gracefully degrade their trust in information. In warfare, this involves building campaigns that can be executed without access to many types of data. For states like the US, which have completely embraced the network-centric warfare revolution, this will entail delegating authority and responsibility to lower echelons of command and planning and exercising platform-based warfare. It will also involve significant training of military forces to understand where their data comes from, how it is processed, and what uncertainties might exist within both the raw data and the algorithm that is parsing it. For businesses and national economies, it means building resilience by investing in backups for data and vital processes, diversifying supply chains, and innovating technologies that can mitigate or eliminate existing resource vulnerabilities.

Finally, in order to mitigate the domestic implications of a data-induced capability-vulnerability paradox, states will need to address the inequality created between the economic winners and losers of digital adoption as well as adversaries' ability to manipulate societal schisms between haves and have-nots by weaponizing information. The latter issue can be combatted with better policies regarding the proliferation of data on social media but will not be fully resolved until the fundamental societal problems of education, inequality, and human resilience are rectified.

In the end, the solution to the data capability-vulnerability paradox will lie in good governance. So far, the greatest instability created by data has not been in warfare but, instead, in the ways our digital dependencies can be manipulated to deepen already existing divides in our societies. Ironically, only a more connected world will solve this problem.

CHAPTER 6

TECHNICAL STANDARDIZATION AND INNOVATION IN A CHANGING GEOPOLITICAL LANDSCAPE

TIM NICHOLAS RÜHLIG

1. INTRODUCTION

> *Technical standards are of strategic importance. Europe's technological sovereignty, ability to reduce dependencies and protection of EU values will rely on our ability to be a global standard-setter.*[1]

The European Commission, widely perceived as a technocratic organization, seldom unveils highly technical strategies and legislation with a great sense of urgency. Not so in early 2022, when European Commissioner Thierry Breton could have hardly attributed more strategic expectations to the European Union's (EU) new technical standardization strategy. Only a few years earlier, most Europeans would have considered technical standard setting largely nonpolitical. What had happened?

In 2020, two incidents came as wake-up calls to Europe. At first, when considering developing new technical standards for lithium batteries that are central to energy transformation, the EU realized that the People's Republic of China (PRC) had already advanced not only in terms of production but also in terms of standard setting. Being reminded of the widespread saying that he who owns the standards owns the market, Europe understood that its late coming threatened the continent's

1. European Commissioner for the Internal Market, Thierry Breton, upon the presentation of the new European Standardization Strategy in Brussels, 2 February 2022. Online available at https://ec.europa.eu/commission/presscorner/detail/en/ip_22_661 (accessed: 3 August 2022).

competitiveness in the central field of the green transition.[2] Only a few months later, the Financial Times reported a Chinese attempt to rewrite the international standard for the internet protocol. If implemented, the rather decentralized character of the internet would be turned into a more hierarchical structure that eases state oversight, control and censorship.[3] These cases made clear that Europe's decreasing ability to set technical standards had negative implications for the technological competitiveness of the EU as well as political costs potentially infringing on fundamental values.

The urgency of this challenge is particularly severe considering the ongoing digital transformation. Technical standards generate interoperability. Never has the connectedness of technologies and products been more important than now. Therefore, it is no wonder that the first concrete case of change in Europe emerged with regard to radio equipment:

In late summer 2022, the European Commission published a new mandate for the development of a technical standard supporting the Radio Equipment Directive (RED) that sparked a controversy. Previously, it would have been expected that the European Telecommunications Standards Institute (ETSI) would develop the technical standard. In 2022, the European Commission decided to mandate the two other European Standardization Organizations (ESOs), namely, the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC), with this task.[4]

While this may sound like a minor and rather technical detail, the European Commission's decision was a highly political one responding to the geopolitical turn of technical standardization. Supposedly, the EU was concerned with the influence of non-European companies, not least the Chinese technology giant Huawei, on technical standards. In ETSI's Technical Committee (TC) on Cyber, which was normally in charge of such a mandate, non-European tech firms are strongly

2. Crompton, P. (2020). "The new Global Committee on Lithium Standards Will Be Led by China". Online available at https://www.bestmag.co.uk/indnews/new-global-committee-lithium-standards-will-be-led-china (accessed: 24 April 2021).
3. Murgia, M. and Gross, A. (2020). "China and Huawei Propose Reinvention of the internet". London: Financial Times. Online available at https://www.ft.com/content/c78be2cf-a1a1-40b1-8ab7-904d7095e0f2 (accessed 30 April 2020).
4. European Commission (2022). Commission Implementing Decision on a Standardisation Request to the European Committee for Standardisation and the European Committee for Electrotechnical Standardisation as regards Radio Equipment in Support of Directive 2014/53/EU of the European Parliament and of the Council and Commission Delegated Regulation (EU) 2022/30. Online available at https://ec.europa.eu/transparency/documents-register/detail?ref=C(2022)5637&lang=en (accessed 10 September 2022).

represented.[5] The members of CEN and CENELEC, in turn, are National Standard Bodies (NSBs) representing the standardization community from the organizations' European member states.

Critics of the European Commission's decision argue that technical standardization is predominantly cooperative in nature. Standardization is driven by the technical contributions of mostly private sector actors to be discussed not by politicians but by leading engineers in their field and judged upon technical criteria. To them, the strength of standardization lies in its nonpolitical character and in ETSI's global reputation as an inclusive and transparent standard-developing organization (SDO).[6]

The European Commission counters that the RED is not a random piece of legislation but a highly critical one. The mandated technical standards are supposed to become harmonized European Norms (hENs) that are voluntary on paper but will serve as the de facto technical operationalization to comply with European regulation. In other words, the standards will be almost equal to European legislation in their effective force. Since the technical standards mandate comprises cyber security, the protection of privacy and protection against fraud, they are hardly peripheral but rather highly sensitive.[7]

While the European Commission aims to adapt to the new geopolitical realities, many EU member states hesitate to take a clear position. Sweden, for example, remains largely skeptical, fearing that the existing system could be dismantled. In Germany, many public officials share such skepticism while the new administration is supporting the EU's actions. This makes Germany a somewhat ambivalent actor. In contrast, Dutch public officials appear to unitedly support the European Commission's efforts.

This controversy around the role of ETSI in technical standards supporting the RED is illustrative of a broader dilemma faced by European stakeholders in technical standardization. On the one hand, they aim to preserve the existing bottom-up approach that is driven by private sector actors. Europe is a world power in technical standardization and has profited from the existing system. On the other hand, I will argue Europe needs to adapt to an ongoing top-down geopolitical turn of technical standard setting with the aim of shaping its future course. In the United States (US), but even more so in the PRC, state institutions are taking a growing interest in

5. At the time of the EU's decision, both US and Chinese company representatives were part of ETSI's technical leadership in the relevant bodies.
6. Author interviews with representatives from SDOs and industry, June-August 2022, several cities.
7. Author interview with representatives of the European Commission, June–August 2022, Brussels.

technical standardization. The ability to shape technical standards is increasingly recognized as a source of state power and has become an arena of rising power competition over high technology. If Europe does not adapt to this trend, I argue that it may very well fall victim to political interest-driven standardization policies of non-European states. China is a particular source of concern since it neither shares European values and interests that are enshrined in technical standards nor is it a security ally of the EU.

A world power in technical standardization, the EU needs to respond to this geopolitical turn of technical standardization. European policymakers seek to strike a balance: On the one hand, they aim to preserve a privately driven bottom-up system that has played to its advantage for decades. On the other hand, the EU wants to make sure it does not fall victim to the ongoing top-down geopolitical turn in international technical standard setting but instead adapts to the new realities.[8]

Instead of determining whether the European Commission or its critics are right about the technical standards mandate related to the RED, this chapter explains the geopolitical turn of technical standardization and reveals Europe's resulting dilemma between the need to preserve the existing system and adapt to the geopolitics of standards. For this, it first contextualizes the geopolitical turn of technical standardization, explains why it is counterintuitive and summarizes how it manifests in policy documents of the EU, the US and the PRC (Section 2). Next, the chapter identifies China's state-centric approach to technical standardization as a particular concern for Europe (Section 3). Identifying four dimensions of technical standardization power, the chapter further details how the ability to shape technical standards translates into state power and thereby explains why states have a growing interest in it (Section 4). As indicated, the geopolitical turn of technical standardization is far from uncontested and bears risks. Hence, the chapter concludes by identifying fragmentation and politicization as risks stemming from this development, discussing the dilemmas resulting from the new geopolitics of technical standardization and closes with policy recommendations for European policymakers and businesses (Section 5).

2. THE GEOPOLITICAL TURN OF TECHNICAL STANDARDIZATION IN CONTEXT

Technology has never been apolitical. Both states and companies have treated technological advances as crucial to national power and economic competitiveness. In recent years, however, high technology has turned into one of the central arenas of

8. Rühlig, T. (2022). "The Rise of Tech Standards Foreign Policy. Brussels Goes Strategic". DGAP Online Commentary. Online available at https://dgap.org/en/research/publications/rise-tech-standards-foreign-policy (accessed: 3 August 2022).

great power competition, primarily between the US and the PRC. Gone are the days when interdependence and globalization were interpreted as irreversible and "flattening" the world.[9] The "weaponization" of interdependence, as Farrell and Newman famously coined it,[10] is at the heart of this trend. This trend may have been rightly described as a geoeconomic turn. Since this paper focuses on its political dimension, I use the term geopolitics.[11]

Defensively, states aim to reduce their strategic technological and economic dependence. This may not lead to a full "decoupling" but focuses on a partial economic disentanglement that strives to preserve the ability to act autonomously without fear of being cut off from strategic technologies. Chinese President Xi Jinping's "dual circulation" policy is an example of this trend.[12] Offensively, dependencies are being used to block political rivals from accessing technologies that are crucial to their development. Means to weaponize strategic dependencies in fields such as 5G infrastructure or semiconductors range from export controls and national security reservations to industrial policies and competition law.[13] Technical standard setting has turned into one subject of this competition in the eyes of many—from both the public and private sector—in Europe, the US and the PRC.[14]

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9. Friedman, T. (2005). *The World Is Flat: A Brief History of the Twenty-first Century*. New York: Straus and Giroux.
10. Farrell, H. and Newman, A. L. (2019). "Weaponized Interdependence: How Global Economic Networks Shape State Coercion", *International Security*, 44.
11. In this chapter, "geopolitics" describes the reemerging tendency of states to utilize control over essential items such as goods, data, people to create spheres of influence by means of crucial dependencies. When economic means are used, this can be described as geoeconomics. Hence, geoeconomics describes an essential component of geopolitics but is not identical.
12. Dual circulation, (guónèi guójì shuāng xúnhuán), is an official Chinese strategy first mentioned in May 2020 by the Standing Committee of the Chinese Communist Party's Politburo to reorient China's economy prioritizing domestic consumption and technological self-reliance.
13. Rühlig, T. (2020). "Who Controls Huawei? Implications for Europe". Online available at https://www.ui.se/globalassets/butiken/ui-paper/2020/ui-paper-no.-5-2020.pdf (accessed: 30 January 2022). Kleinhans, J.-P. and Baisakova, N. (2020). "The Global Semiconductor Value Chain. A Technology Primer for Policy Makers". Online available at https://www.stiftung-nv.de/sites/default/files/the_global_semiconductor_value_chain.pdf (accessed: 30 January 2022).
14. Seaman, J. (2020). "China and the New Geopolitics of Technical Standardization". Online available at https://www.ifri.org/sites/default/files/atoms/files/seaman_china_standardization_2020.pdf (accessed: 30 January 2022). de La Bruyère, E. and Picarsic, N. (2020). China Standards 2035. Beijing's Platform Geopolitics and "Standardization Work in 2020". Online available at https://www.horizonadvisory.org/china-standards-2035-first-report (accessed: 30 January 2022). Yan, X. (2020). "Bipolar Rivalry in the Early Digital Age", *Chinese Journal of International Politics*, 13, 318.

2.1 Turning strategic (1)—technical standards in the US

First, US concerns over China's growing footprint in international technical standardization are prominent and enjoy bipartisan consensus. It has also been reflected in legislative work. The *US Innovation and Competition Act*, for example, requires the secretary of state to assess Chinese influence in international SDOs and tasks the assistant secretary of commerce for communication and information with a report on existing barriers to US participation in the standardization activities of the International Telecommunication Union (ITU). Both are clearly formulated to provide information on how to counter China's growing influence. The creation of an interagency working group as well as the provision of grants to private sector entities to participate in standardization as well as obtaining technical leadership positions are the most obvious examples of how the US Congress aims to boost American influence based on strategic political reasoning. That the PRC is the primary target of US activities is not the least obvious from another passage of the Act that deals with regular dialogue between the United States and allied partners that include standard setting.[15] Further efforts from the US government to strengthen its footprint in international standardization are likely given that concerns over growing Chinese influence are widespread among political observers in Washington D.C.[16]

2.2 Turning strategic (2)—technical standards in China

Indeed, US efforts react to the PRC's activities in technical standard setting. In October 2021, the Chinese government and the Central Committee of the Chinese Communist Party (CCPCC) jointly published a new "Standardization Outline" (the Outline).[17] It is rare that the CCPCC, one of the most influential organs of the Chinese Communist Party (CCP, the Party), issues documents of such a technical nature. Since Party organs are far more influential in China than the central government, the joint publication is indicative of the importance given to technical standardization by the leadership of the party-state. Shortly after the Outline was released, the country followed up with a "Five-year Plan for Promoting the High-Quality Development of the National Standards System" (the Five-year Plan), providing

15. United States Congress (2022). United States Innovation and Competition Act of 2021. Online available at https://www.congress.gov/bill/117th-congress/senate-bill/1260/text (accessed 4 August 2022).
16. de La Bruyère, E. and Picarsic, N. (2020). "China Standards 2035. Beijing's Platform Geopolitics and "Standardization Work in 2020"'. Online available at https://www.horizonadvisory.org/china-standards-2035-first-report (accessed: 30 January 2022).
17. Chinese State Council (2021). Online available at http://www.gov.cn/zhengce/2021-10/10/content_5641727.htm (accessed: 4 August 2022).

further details of the Outline's implementation.[18] The Outline and the Five-year Plan comprise a wide range of components to further increase Chinese influence on standard setting, including the following:

- Binding investments in innovation to standardization efforts in strategic sectors ranging from digital technologies to mobility, infrastructure, energy and biotechnology;
- Strengthening of China's role in international standardization for the purpose of increasing the resilience of supply chains and rising influence in international SDOs;
- Attracting industry consortia to China with the purpose of developing technical standards of global importance;
- Deepening of standardization cooperation with countries participating in the Belt and Road Initiative (BRI).

Similar to the US, the PRC documents clearly position standardization efforts in the context of global competition, although unleashing the potential of private sector actors is also on China's agenda.

2.3 Turning strategic (3)—technical standards in the EU

When unveiling its new technical standardization strategy in February 2022,[19] the European Commission was faced with these political circumstances. In reaction, the European Commission suggested a new high-level forum of standardization to facilitate regular exchanges among all relevant stakeholders. It further proposed inventing a hub of excellence within the European Commission to pool existing competences. An amendment of the European standardization regulation further suggests that foreign companies should effectively be banned from being included in the development of hENs that support European regulation.[20] The example cited at the beginning of the introduction could be the first example of the impact of this policy change.

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18. Center for Security and Emerging Technology (2022). "14th Five-Year" Plan for Promoting the High-Quality Development of the National Standards System". Online available at https://cset.georgetown.edu/publication/14th-five-year-plan-for-promoting-the-high-quality-development-of-the-national-standards-system/ (accessed 4 August 2022).
19. European Commission (2022). "An EU Strategy on Standardisation - Setting global standards in support of a resilient, green and digital EU single market". Online available at https://ec.europa.eu/docsroom/documents/48598 (accessed 4 August 2022).
20. European Commission (2022). Proposal for a Regulation amending Regulation (EU) No 1025/2012 as regards the decisions of European standardisation organisations concerning European standards and European standardisation deliverables. Online available at https://ec.europa.eu/docsroom/documents/48599 (accessed 4 August 2022.

Additional financial resources, including tax breaks or instruments particularly devoted to small and medium-sized enterprises (SMEs) that are not part of the documents released by the European Commission, remain on the table in the ongoing European discussion.

All these documents released by the US, the PRC and the EU treat the ability to shape technical standardization as a crucial competitive and security strategic asset to obtain technological leadership and gain power advantages over political rivals.

2.4 The geopolitical turn of standard setting—a counterintuitive development

To anyone working in the field of technical standard setting, however, this development is counterintuitive. Granted, technical standards have always been political. However, the exclusionary logic that aims to diminish the role of entities based on the territory of a political rival remains in sharp contrast to the very nature of technical standards. Being a form of private self-regulation, broad market acceptance based on a consensus in its development is widely regarded as foundational to the effectiveness of technical standards.

Technical standards are omnipresent but highly technical product specifications that establish basic safety conditions and interoperability. Consider the example of USB. Everyone knows the term for this standard for cables, connectors and protocols that enables charging and the exchange of data on a wide range of devices. Similarly, Wi-Fi is a famous family of radio technology standards that enable wireless local area networking (WLAN) for all sorts of technological equipment. In summary, technical standards allow products of all kinds to be applicable in a wide range of contexts across countries and manufacturers. Without technical standards, the technologies of the two suppliers would hardly be complementary. This is why technical standards facilitate international trade and are conducive to innovation and competition.

Technical standards may be omnipresent, but they are voluntary technical specifications. This is not to say that technical standards can result in enormous commercial force. Many products that do not comply with given technical standards cannot be sold on world markets because they only work in isolation and not in concert with other products. Imagine a mobile phone that only communicates with a certain share of other phones. It is not difficult to imagine that such a solution would not be adopted by the market or consumers. While one might describe these effects as inherently political, the very subject is highly technical.

Technical standards aim to harmonize products and technologies. In contrast to intellectual property rights and patents, a good standard is available and accepted

globally.[21] Since standards are voluntary, they are only effective when they are adopted by the market. Where technical standards consist of patented technologies, patent holders are obliged to license their standardessential patents (SEPS) under fair, reasonable, and nondiscriminatory terms (FRAND). Courts around the globe are enforcing FRAND terms on patent holders. Hence, technical standards apply a very different logic than, for example, export controls or punitive tariffs that aim to exclude competitors from supply or hinder market access.

Technical standards are predominantly developed by private sector actors. Technical standards may be the result of market concentration. In that case, the technical specifications of a limited number of actors shape the ecosystem. Prominent examples include the operating systems of Microsoft and Apple. Computer software that does not run on Microsoft's Windows and Apple's iOS will only gain niche status on the global market. We speak of de facto standards.

Where such market concentration does not exist, SDOs that overwhelmingly consist of representatives of private industry develop technical standards. In these SDOs, TCs and their subgroups consult over different technical solutions and normally decide by consensus or a broad majority. The results are referred to as formal standards. Hence, technical standardization has often been portrayed as an example of private selfregulation.

Consequently, the geopolitical turn of technical standardization is anything but a given and significantly deviates from the very nature of standard setting as it has emerged over the last few decades.

This is not to argue that the political nature of technical standards had previously been ignored. Studies influenced by realist accounts of international relations have been most explicit in de-scribing standards as an expression of state power, ultimately by attributing significance to the distribution of power rather than standardization.[22] Even researchers who regard contemporary standardization as a particularly efficient alternative to established international organizations do not

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21. Deron, L. G. (2022). "Chinese Standards and the New Industrial Markets". Online available at https://www.irsem.fr/institut/actualites/research-paper-no-98-2020.html (accessed: 30 January 2022).
22. Bishop, A. D. (2015). "Standard Power: The New Geopolitical Battle". Online available at https://nationalinterest.org/feature/standard-power-the-new-geopolitical-battle-14017 (accessed: 9 September 2019). Drezner, Daniel W. (2005). "Globalization, Harmonization, and Competition. The Different Pathways to Policy Convergence", *Journal of European Public Policy*, 12(5), 841Ğ59. Krasner, S. D. (1991). "Global Communications and National Power. Life and the Pareto Frontier "World Politics, 43(3), 336Ğ66.

deny its political character.[23] However, even when standard setting is understood as a form of hybrid authority involving private and public actors, the focus lies on private sector actors that have the necessary technical expertise to influence standard setting.[24] Even the enforcement of technical standards by means of certification and accreditation is primarily left to private actors.[25]

The predominance of private sector actors in international technical standardization is both the result of the fact that they possess more technical expertise and can be traced back to the domestic standardization approaches of the most influential countries, namely the US and the EU.[26] As a result, the growing influence of standardization in power competition and the rising engagement of state actors – not least due to China's rise – is challenging the very nature of technical standardization. Sitting idly by and watching is not an option for the European Union.

As the ongoing transformation is closely linked to the PRC's rise in international standardization and China's distinct approach to standard setting, the next section turns to this phenomenon.

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23. Berstein, S. (2011). "Legitimacy in Intergovernmental and Non-state Global Governance", *Review of International Political Economy*, 18(1), 17-51. Boström, M. (2006). "Regulatory Credibility and Authority Through Inclusiveness. Standardization Organizations in Cases of Eco-labelling", Organization, 13(3), 345-367.
24. Brunsson, N. and Jacobsson, B. (2002). *A World of Standards*. Oxford, Oxford University Press. Busch, L. (2011). *Standards. Recipes for Reality,* Cambridge: MIT Press. Büthe, T. and Mattli, W. (2011). *The New Global Rulers. The Privatization of Regulation in the World Economy*. Princeton: Princeton University Press. Graz, J.-C. (2019). *The Power of Standards. Hybrid Authority and the Globalisation of Services*. Cambridge: Cambridge University Press. Henson, S. and Reardon, T. (2005). "Private Agri-food Standards: Implications for Food Policy and the Agri-food System", *Food Policy*, 30(3), 241-253. O'Rourke, D. (2006). "Multi-stakeholder Regulation: Privatizing or Socializing Global Labor Standards?", *World Development*, 34(5), 899Ğ918. Schepel, H. (2005). *The Constitution of Private Governance. Product Standards in the Regulation of Integrating Markets*, Oxford: Hart Publishing. Timmermanns, S. and Epstein, S. (2010). "A World of Standards but not a Standard World: Towards a Sociology of Standards and Standardization", *Annual Review of Sociology*, 36(1), 69-89. Werle, R. and Iversen, E. J. (2006). "Promoting Legitimacy in Technical Standardization", *Science, Technology & Innovation Studies*, 2(1), 19-39.
25. Fouilleux, E. and Loconto, A. (2017). "Voluntary Standards, Certification, and Accreditation in the Global Organic Agriculture Field. A Tripartite Model of Techno-politics", *Agriculture and Human Values*, 34(1), 1-14.
26. Nicolaidis, K. and Egan, M. (2001). "Transnational Market Governance and Regional Policy Externality: Why Recognize Foreign Standards?", *Journal of European Public Policy*, 8(3), 454-473. Tate, J. (2001). "National Varieties of Standardization", in: Hall, P. A. and Soskice, D. (eds.), *Varieties of Capitalism. The Institutional Foundation of Comparative Advantage*, Oxford: Oxford University Press, 442-473.

3. THE NEW GEOPOLITICAL PRACTICE OF TECHNICAL STANDARDIZATION: THE CASE OF CHINA

3.1 China's growing footprint in formal standardization

China's influence in both formal and de facto standardization is growing.[27] In established technical standardization bodies, the PRC has been successful in obtaining leadership positions, both at the institutional and technical levels. In most SDOs, China is still lagging behind European and US representation, but the PRC's influence is rising. From 2011 to 2018, China's share of TC and SC secretariat positions in ISO grew from five percent to 8.21 percent. In the same period, its share of WG secretariat positions increased from two percent to 6.58 percent.[28] Today, only Germany and the United Kingdom participate in slightly more TCs than China.[29] While rather a high number of Chinese standard contributions are rejected at an early stage due to quality issues, Chinese actors are learning quickly and become more successful in formulating their technical standard proposals. In some emerging technologies, most prominently 5G and 6G, Chinese actors have not only been ahead of their competitors in terms of standard contributions but also declarations of SEPs.[30]

3.2 China's growing footprint in de facto standardization

Strength in de facto standardization is more difficult to measure. However, qualitative research indicates that at least in the transport and infrastructure sector, China's BRI has helped to grow market share and, thereby, has supported the spread of Chinese technical standards. This not only increases the opportunities for Chinese de facto standardization but also makes standard setting an explicit part of the PRC's BRI policy. In 2015, China's main macroeconomic agency, the National Development and Reform Commission (NDRC), issued the first 'Action Plan for Harmonization of Standards along the Belt and Road' (the Action Plan) for

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27. For a more detailed discussion of China's growing footprint in technical standardsetting, see Rühlig, T. (2022). "Chinese influence through technical standardization power", *Journal of Contemporary China*. Online available at: https://doi.org/10.1080/10670564.2022.2052439 (accessed: 4 August 2022).
28. Information privately obtained from the German Institute for Standardization (DIN).
29. Seaman, J. (2020). "China and the New Geopolitics of Technical Standardization". Online available at https://www.ifri.org/sites/default/files/atoms/files/seaman_china_standardization_2020.pdf (accessed: 30 January 2022).
30. For the example of 5G, please see Pohlmann, T. et al. (2020). "Studie zur Untersuchung und Analyse der Patentsituation bei der Standardisierung von 5G. Studie im Auftrag des Bundesministeriums für Wirtschaft und Energie" [Study to examine and analyze the patent situation in the standardization of 5G. Study on behalf of the Federal Ministry for Economic Affairs and Energy]. Berlin: IPlytics.

2015–2017.[31] The Action Plan explicitly states that China will strive to internationalize its domestic standards in BRI countries and prioritize several economic sectors. In a first step, the Action Plan stipulates that 500 national standards developed under the Standards Administration of China and sectoral standards developed by national ministries should be translated into foreign languages to make them accessible to international audiences. At the end of 2017, the NDRC issued a new Action Plan for 2018–2020 that essentially builds on and perpetuates the 2015 Action Plan.[32]

These Action Plans are not empty rhetoric. In June 2019, the PRC officially announced that it had signed 85 cooperation agreements on technical standardization with 49 countries and regions along the Belt and Road.[33] Several of these agreements contain mutual recognition clauses, which imply that the signatory countries will adopt domestic technical standards in some economic sectors.

3.3 China's domestic state-centric standardization approach

Strikingly, not only is China's growing influence a concern to many European and US observers, but the PRC also has a deviating technical standardsetting system that is essentially state-centric.

Until 2018, China's domestic standardization was formally entirely public. All three types of technical standards—national, local, and sectoral—were developed under the auspices of ministries or local governments. With the growing importance of private companies, private firms were increasingly involved in standard setting but were always within the institutional framework of state ministries and local governments. A significant share of what China referred to as standards (*guóbiāo*) was mandatory.

The new Standardization Law that came into force on January 1, 2018, institutionalized the increasing role of the private sector in Chinese standardization. Technical standards are now developed in two tiers, one state-driven and one market-driven. National, local and sectoral standards continue to exist, representing the state tier. All local and almost all sectoral standards are voluntary, and the number of

31. SAC (Standards Administration of China) (2015). "Action Plan to Connect "One Belt, One Road" through Standardization (2015-2017)". Online available at www.followingthemoney.org/wp-content/uploads/2017/06/2015_Leading-Group-for-the-BRI_Action-Plan-to-Connect-BRI-through-Standardization-2015-2017_E-1.pdf (accessed: 19 February 2019).
32. SAC (2018). Online available at www.sac.gov.cn/zt/ydyl/bzhyw/201801/t20180119_341413.htm (accessed: 26 October 2018).
33. Office of the Leading Group for Promoting the Belt and Road Initiative (2019). "The Belt and Road Initiative. Progress, Contributions and Prospects". Online available at www.chinaembassy.se/eng/zgxw/t1675676.htm (accessed: 22 September 2019).

mandatory national standards was reduced from more than 10,000 to approximately 2,000, according to policy documents from the Standards Administration of China (SAC). In the market tier, industry associations are encouraged to issue association standards, and a national registry for enterprise standards has been established.[34] China's state-tier standard setting contrasts with both the EU and the US systems in that China's standards are developed in state institutions, not private SDOs. China's market tier might appear similar to the US system, but a closer look reveals that Chinese market tier standardization is also state-centric. Interviews with both Chinese and European industry representatives participating in standard setting in China show that many SDOs have close ties to the party-state and receive informal guidance. In the absence of clear boundaries between private and public actors, private SDOs are far from free of party-state influence. Both formally private and state-owned companies rely on resources allocated by state-controlled actors, for example, loans, land-use rights, subsidies, and procurement.[35] Furthermore, party-state support is essential for technical standards developed in the market tier to become influential.

One might question why the PRC's state-centric approach is problematic. Both the importance of the Chinese market and its domestic standards, as well as international effects, are crucial.

3.4. The externalization of China's state-centric approach

Academic research indicates that states tend to externalize their domestic standardization approaches in (re)shaping the international system of standard setting.[36] As I have argued elsewhere in more detail, the same holds for the PRC, which is utilizing its state-centric approach in the international context, thereby making the international standardization system more state-centric.[37]

In the formal standardization of 5G and 6G, the PRC makes use of its state-centric model in four different dimensions. First, China uses significant financial resources from the state to support the research and development (R&D) of supposedly private firms. Huawei, a national champion with close ties to the party-state (though not state-owned),

34. SAC (2020). Online available at: www.sac.gov.cn/sxxgk/zcwj/202101/t20210122_347055.html (accessed: 6 February 2021).
35. Milhaupt, C. J. and Zheng, W. (2015). "Beyond Ownership: State Capitalism and the Chinese Firm", *The Georgetown Law Journal*, 103(3), 665-722.
36. Nicolaidis, K. and Egan, M. (2001). "Transnational Market Governance and Regional Policy Externality: Why Recognize Foreign Standards?", *Journal of European Public Policy*, 8(3), 454-473. Tate, J. (2001). "National Varieties of Standardization", in: Hall, P. A. and Soskice, D. (eds.). *Varieties of Capitalism. The Institutional Foundation of Comparative Advantage*, Oxford: Oxford University Press, 442-473.
37. Rühlig, T. and ten Brink, T. (2021). "The externalization of China's technical standardization approach", *Development and Change*, 52(5), 1196-1221.

has rapidly expanded its technical expertise.[38] Strikingly, the Chinese firm benefits from party-state support. In 25 years, Huawei has received as much as US$ 75 billion in tax breaks and cheap loans. Huawei received US$ 46 billion in cheap loans, credit lines and other support from state lenders alone. Between 2008 and 2018, the company saved US$ 25 billion in taxes due to state incentives to promote the tech sector.[39]

Second, since China has identified first-mover advantage as an effective tool to shape standardization, the PRC has made early commercialization a central feature of its industrial policy.[40] In 5G, the PRC has not only sponsored the world's largest 5G trial area in the Yangtze River Delta,[41] but the state-controlled mobile operators have been instructed to roll out the most innovative version of 5G, known as standalone 5G. The financial risks of this decision have effectively been socialized in China.[42]

Third, striving to increase the participation of Chinese actors, the PRC has handed out scholarships and other financial rewards to fund standardization efforts from Chinese firms. Local and regional governments in China provide annual stipends of up to US$ 155,000 to companies that develop technical standards.[43]

Fourth and finally, the party-state has actively engaged in coordination among Chinese actors to ensure that firms from the PRC speak with one voice in international SDOs and always vote as a block. In the field of 5G, for example, the PRC founded the IMT 2020 (5G) Promotion Group, which comprises Chinese public agencies (Ministry for Industry and Information Technology, Ministry of Science and Technology and the National Development and Reform Commission), research

38. Interviews, representatives of European mobile operators, Berlin, January 2019.
39. Rühlig, T. (2020). "Who Controls Huawei? Implications for Europe". Online available at https://www.ui.se/globalassets/butiken/ui-paper/2020/ui-paper-no.-5-2020.pdf (accessed: 30 January 2022). Yap, C.-W. (2019). "State Support Helped Fuel Huawei's Global Rise". Online available at www.wsj.com/articles/state-support-helped-fuel-huaweis-global-rise-11577280736 (accessed: 9 February 2020).
40. Medin, M. and Louie, G. (2019). "The 5G Ecosystem: Risks & Opportunities for DoD". Washington, DC: Defense Innovation Board.
41. Shi-Kupfer, K. and Ohlberg, M. (2019). "China's Digital Rise. Challenges for Europe". Berlin: Merics.
42. Eisenstark, R. (2018). "Why China and the US Are Fighting over 5G". Online available at https://technode.com/2018/03/30/5g/ (accessed: 11 April 2019). Rühlig, T. and Björk, M. (2020). "What to Make of the Huawei Debate? 5G Network Security and Technology Dependency in Europe". Stockholm: The Swedish Institute of International Affairs.
43. Pop, V. et al. (2021). "From Lightbulbs to 5G, China Battles West for Control of Vital Technology Standards". Online available at https://www.wsj.com/articles/from-lightbulbs-to-5g-china-battles-west-for-control-of-vital-technology-standards-11612722698 (accessed: 4 August 2022).

institutes (Beijing University of Posts and Telecommunications) and all sorts of Chinese tech companies for coordination purposes in 2013.[44]

In de facto standardization, China has also externalized its state-centric approach. Here, three mechanisms have been decisive. First, the party-state has fostered its prospects by facilitating mergers and acquisitions and, thus, the enlargement of firms. Big companies with a high market share are well positioned to gain the status of de facto standard-setters. In recent years, the average size of SOEs has grown considerably, which helps China to establish more de facto standards.

Second, the party-state supports de facto standard setting by facilitating market dominance. Package deals of the BRI often combine financing of infrastructure projects with the condition to execute the projects by Chinese companies that use Chinese technical standards.

Third, the results are long-term lock-in effects. For example, countries building their railways using Chinese technical standards will depend on Chinese manufacturers for decades to come. If, in a specific country, exclusively Chinese vendors produce according to Chinese technical standards, potential competitors, including from Europe, are essentially excluded from markets in BRI countries since their products are compatible with the existing technology. Producing two types of equipment, one in accordance with European standards and the other in line with Chinese standards, is noneconomic for most producers in the rail industry. Chinese experts are aware of these effects.[45]

While being locked into de facto standards is not a new phenomenon, China's state-centric approach involves more than just economic dependencies. Railways, for example, are critical infrastructure. Their functioning is crucial for supply reliability, the logistics of production, people's mobility, including cultural and social participation, and, thus, public stability and security. If countries build critical infrastructure based on Chinese standards, there might be strings attached.

All this indicates that the ongoing competition over technical standardization is not just about the share of influence but also contests the very nature of the existing standardization system. Previously largely a domain of private self-regulation, China has not only a state-centric system domestically, but party-state presence also shapes its international practices. The state-centric system and its execution through national champions and state-owned firms make a close linkage between political goals and technical standards relatively easy for the PRC.

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44. Chen, S.-Z. and Kang, S.-L. (2018). "A Tutorial on 5G and the Progress in China", *Frontiers of Information Technology & Electronic Engineering*, 19(3), 309-321.
45. Interview, senior researcher in a leading think tank, Beijing, November 2019.

4. FOUR DIMENSIONS OF TECHNICAL STANDARDIZATION POWER

China's growing ability to shape international technical standards and the fact that its state-centric vision allows for a direct link between strategic objectives and technical standard proposals is not without consequences. Technical standard setting may have been rather absent from the agenda of states for several decades. However, technical standards translate into a power resource in at least four dimensions.

Economically, a growing proportion of technical standards consist of patented technology. While SEP holders commit to licensing their patented technology on FRAND terms, this does not imply that the distributary effects are low. Licensing SEPs can be costly. US Qualcomm, for example, earned ₵.2 billion by licensing technology in 2017, accounting for more than 20 percent of the company's revenue. The share of Sweden's Ericsson is, however, much smaller, standing at 3.3 percent.[46]

The distributary effects of technical standards are not limited to the payment of royalties for SEPs. Companies that fail to establish their technological solutions as technical standards must redesign their products to comply with standards. This results in switching or adaptation costs. In an extreme example, Sony lost all its investment in the development and production related to the Betamax standard to the triumphant VHS format of video screening. Observers calculate that the lost battle cost Sony a three-digital million sum. Another example is China's unsuccessful attempt to establish a rival standard for the third generation of mobile communication. Chinese observers agree that one reason Huawei emerged as the Chinese market leader in later generations of mobile infrastructure equipment is that it did not apply the indigenous Chinese 3G standard and, therefore, did not need to absorb significant financial losses.

In short, the ability to shape technical standards may have an enormous impact on the profitability of firms and on the technological and economic competitiveness of countries.

Legally, technical standards represent an enormous force despite being voluntary on paper. For example, the Agreement on Technical Barriers to Trade (TBT), among other pieces of world trade law, treats international standards as crucial benchmarks for the facilitation of international trade and as important qualifications of what accounts as a legitimate exception. This is more crucial than one might think

46. Information obtained by the author from the company.

given that approximately 80 percent of trade is affected by technical standards and associated technical regulations.[47]

Rather than being often enforced, the fact that international standards could be used as a benchmark under WTO law serves its purpose. One of the relatively few examples of disputes is the EU's conflict with Mexico over deviating standards contradicting ISO 6486-1/2 of ceramics.

Technical standards can also have extraterritorial effects. When a standard is referenced in a legally binding document of a major economy, global manufacturers need to adapt to that standard if they choose the easiest and cheapest way to gain market access. Companies try to avoid production redundancies based on different standards. Harmonizing global fabrication is the most efficient. Often, this results in the application of the strictest standard globally and beyond any given area of jurisdiction.

A famous example from Sweden is IKEA. To avoid producing slightly different furniture for different markets, IKEA's standardization and regulation department compares standards from around the world with the purpose of developing a global IKEA standard that is compliant with all relevant specifications in all markets. As a result, IKEA furniture complies with the strictest technical standards of the world in all of its markets.

In terms of *security*, technical standards can create lock-in effects. Standards generate interoperability only in the areas where they are applied. Hence, technical standards can create geographically bifurcated or fragmented technological corridors. Decades ago, economists were already studying lock-in effects resulting from dominant technologies, particularly if they enabled complementary technologies (network effects/externalities).[48] Such studies have convincingly demonstrated that the hurdles are high to change such dominant technical standards.[49] Countries that rely on a specific standard in a crucial technological field (e.g., for its critical infrastructure) find it hard to freely choose a supplier. In particular, when such lock-in effects create dependencies from state-owned enterprises, countries may find themselves in a situation where such dependencies undermine their ability to act autonomously and thereby affect their security. An example is the abovementioned case of Chinese railway standards along the BRI. For example, digital signaling

47. OECD (2019). "Regulatory Reform and International Standardisation. Working Party of the Trade Committee". TD/TC/WP(98)/FINAL (1999).
48. Bonardi, J.-P. and Durand, R. (2003). "Managing Network Effects in High-tech Markets", *The Academy of Management Journal,* 17.
49. Arthur, W. B. (1989). "Competing Technologies, Increasing Returns, and Lock-in By Historical Events", *The Economic Journal*, 99.

systems that require constant updating and that need to be interoperable can only be maintained by Chinese state-owned railway equipment suppliers.

Some observers further argue that those who develop a technology are likely to have a deeper knowledge of how it works, including its vulnerabilities. Once internationally standardized, a technology spreads globally. When this concerns critical digital infrastructure, the developer of the technology in question possesses prime knowledge of its flaws that can be used to undermine an adversary's (cyber) security.[50] Other observers counter that standardization is a process of maximum transparency in which it is hardly possible to hide security-relevant flaws from the eyes of the engineers of potential adversaries. From this perspective, a high degree of standardization increases (cyber)security by providing international transparency. Whichever perspective is more accurate, technical standardization influences the degree of (cyber)security in critical digital technologies.[51]

An example of the security implications of ambiguous technical standards is cameras in industrial cleaning robots. While such cameras and the data these cameras collect are required for their autonomous functioning, the pictures could contain information on the industrial equipment used in a factory, including sensitive information and intellectual property. While most consumers trust that the pictures being taken by the cameras are blurred and do not provide such information, the standards, in fact, are vague. Suppliers might rightly claim to comply with all relevant standards while collecting sensitive information that they could sell to or share with competitors. In state-directed economies such as China, such scenarios are not unthinkable.

Ideationally, technical standards can inscribe political and ethical values into technology. Technical standards shape what is perceived as "normal" technology. Therefore, several critical scholars have described technical standards as social institutions in their own right.[52] For instance, a technical standard can prioritize performance over privacy or vice versa. At a time when emerging technologies are increasingly penetrating all spheres of public and private life, ethical, political

50. Medin, M. and Louie, G. (2019). "The 5G Ecosystem. Risks & Opportunities for DoD". Online available at https://media.defense.gov/2019/Apr/03/2002109302/-1/-1/0/DIB_5G_STUDY_04.03.19.PDF (accessed: 30 January 2022).
51. Author interviews with European engineers involved in the development of 5G. February-November 2019, several cities.
52. Krislov, S. (1997). "How Nations Choose Product Standards and Standards Change Nations. Pittsburgh: Pittsburgh University Press". Tamm Hallström, K. (2004). *Organizing International Standarization. ISO and the IASC in Quest of Authority.* Cheltenham: Edward Elgar.

and security questions are playing a growing role in technical standardization. Algorithmic bias and data privacy are just two examples of ethical underpinnings in technical standardization.[53]

One prominent example is China's effort to make WAPI an alternative to Wi-Fi as the international standard for WLAN. While WAPI offered better performance, it had weaknesses in terms of privacy protection. Only the decision of international SDOs to accept only Wi-Fi as an international standard made the protection of privacy a norm built into WLAN technology.

In sum, the ability to shape technical standardization carries enormous power resources to states in economic, legal, security and ideational terms. China's state-centric links party-state interests closely to the standardization agenda. This makes the PRC an important driving force of the geopolitical turn of technical standardization with vast consequences for technological competitiveness for Europe and European businesses.

5. CONCLUSIONS AND RECOMMENDATIONS

Technical standards, long a domain of cooperation and competition among private sector actors, have undergone a geopolitical turn in recent years. The US and the PRC, but also to a lesser extent the EU, have identified the power that underlies technical standards and aim to utilize it in the power struggle over high technology.

The European Commission has adapted to the new realities, proposing a new standardization strategy and suggesting an amendment to the standards regulation. In Germany, but even more so in Sweden, these changes have been met with plenty of skepticism. Critics worry that the new geopolitics of standard setting could jeopardize the entire system. Sweden's rather small but export-oriented economy fears that it might be squeezed into geopolitical frictions with heavy consequences.

These fears are not unfounded. The politicization of technical standards could lead to suboptimal solutions if technical criteria are not treated as decisive for adoption by the country of origin. This contradicts any principle of peer review underlying standard setting and hampers innovation, as technical standardization experts from Europe frequently underscore.

This politicization could further lead to a fragmentation of the spheres of technical standards. Political geographies could also turn into technological demarcation

53. Seaman, J. (2020). "China and the New Geopolitics of Technical Standardization". Online available at https://www.ifri.org/sites/default/files/atoms/files/seaman_china_standardization_2020.pdf (accessed: 30 January 2022).

lines. In other words, fragmentation into different technological spaces divided by political alliances and fault lines could deepen existing rivalries.

Such fragmentation has additional consequences for global competition, trade and innovation. A splintered technological world comes at the cost of interoperability and either reduces the market size for manufacturers or requires them to establish several distinct lines of production for different markets. In both cases, profits shrink, competitiveness shrinks and resources for innovation decrease.

For these reasons, critics of the European Commission's adaptation argue that public intervention and politicization could jeopardize a system that has worked to the benefit of all and, given Europe's stronghold in standard setting, to the EU's advantage in particular.

The critics overlook, however, that the geopolitical turn of standardization is already a reality. If nothing happens, the EU could fall victim to great powers, primarily China, utilizing the means at the disposal of its party-state not only to increase its impact on standard setting but also to further its political power. In other words, resisting adaptation to geopolitical realities will not prevent Sweden from becoming vulnerable to the politicization of standard setting. Only a constructive and cooperative approach in Europe in collaboration with the European Commission will serve Sweden's interests. At this stage, Sweden's business community and relevant government organs tend to be skeptical and stress the concerns they have with the European Commission's proposals. While Sweden's insistence on the value of the existing system is well grounded, it would be beneficial if geopolitical risks were to be taken more seriously. Swedish actors are comparatively slow in acknowledging these risks.

In this situation, the EU needs to strike the right balance between preserving the bottom-up system and allowing some top-down coordination and facilitation to avoid damaging European political interests. This is a delicate task that requires both policy-makers and industry to adapt to the new geopolitics of standard setting. Thus, I propose the following.

- *Make the high-level forum a success*: All stakeholders, public and private, share an interest in the coordination of strategic political goals responding to existing concerns and adapting them to the realities on the ground. For this, the European Commission has proposed a new high-level forum that will include a preparatory structure bringing together these stakeholders. Active participation, as well as mirroring such high-level forums at the national level within EU member states, would be helpful.

- *Coordinate with like-minded partners and avoid undermining the bottom-up approach*: Technical standardization has already turned into a central field of transatlantic policy coordination in the EU-US Trade and Technology Council (TTC). While such coordination is not least helpful in the context of information exchanges identifying potential security and ideational challenges and resulting from Chinese standard proposals, they should also not overshadow the fact that standard setting needs to remain in the private domain. Hence, formats such as the TTC could be expanded to other like-minded states, but expectations should be kept low.

- *Invest in standardization knowledge and involve different stakeholders*: To this day, policies tend to be crafted based on limited knowledge of technical standardization and how China's state-centric system works. Standardizers, in turn, are hardly aware of the political agenda driving the PRC's efforts. Investing in research and its popularization as well as establishing a "standards tracker" that combines technical with political expertise would be helpful.

- *Insist on transparency and establish fundamental values as benchmarks for standards*: With more political representatives taking an increasingly direct and prominent role in standard setting, fundamental human rights should be acknowledged as a criterion, at least in strategic sectors such as artificial intelligence. The EU could advocate SDOs and standard-developing industry consortia to adopt a self-commitment to basic human rights. For example, the Internet Research Task Force (IRTF) has already developed human rights guidelines, and the Internet Engineering Task Force (IETF) has a similar solution for privacy considerations. Targeted support for the involvement of civil society groups should also help ensure that human rights remain an active focus of standardization.

- *Continue cooperation with China but insist on reciprocity and further reform*: Europe has been advocating for its own standardization system in China in the past and has also continued to cooperate with the PRC on concrete standardization proposals. Despite the geopolitics of standards, such cooperation is helpful and should not be abandoned. Technical standardization is based on cooperation. However, the EU should condition such cooperation to further Chinese reforms and insist on strict compliance with the PRC's obligations under the treaties of the World Trade Organization.

- *Strengthen the existing European standardization ecosystem*: Public investment in R&D should be further tied to technical standard proposals as deliverables. Academic training and support for small and medium-sized enterprises and civil society can further increase European strength in standard setting. Public funding for SMEs could be particularly helpful. While they tend to be overlooked in the geopolitics of standard setting, SMEs continue to be particularly successful in establishing their technical standards internationally if they decide to push for it. For

small and medium-sized enterprises in particular, participation in standardization is often prohibitively expensive. In addition to membership fees in standardization organizations, personnel and considerable travel costs are incurred. Standards are developed over months, if not years, in numerous meetings held around the globe. Subsidies and tax deductibility for standardization activities may help. While no concrete policies have been adopted yet, Germany is currently considering several of these instruments to support standardization efforts. Equally, companies should make technical standardization a strategic concern. For example, in recruitment, technical standardization expertise hardly plays a role for European companies at this stage. This should change to maintain the existing advantages.

Meeting the challenges resulting from the new geopolitics of standardization requires striking a balance between adaptation and preservation of the existing system. Furthermore, only concerted efforts of both public actors and industry will maintain the EU's stronghold in this field.

Much remains to be understood in terms of the geopolitical turn of standard setting. Standardization ecosystems deviate by sector, and knowledge of the role and approach of China in emerging and foundational technologies remains particularly anecdotal. Another field requiring further analysis is de facto standardization in the BRI. Since concrete projects that are often nontransparent are the most effective tool, tracing the spread of standards in the BRI is demanding.

The geopolitical turn of standard setting is on, and we have yet to learn the full implications of this unfolding picture to which we must adapt in real time.

LIST OF ABBREVIATIONS

BRI	Belt and Road Initiative
CCP	Chinese Communist Party
CCPCC	Central Committee of the Chinese Communist Party
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
DIN	German Institute for Standardization
ESOs	European Standardization Organizations
ETSI	European Telecommunications Standards Institute
EU	European Union
FRAND	Fair, reasonable and nondiscriminatory
hEN	Haromonized European Norm
IETF	Internet Engineering Task Force
IRTF	Internet Research Task Force
ITU	International Telecommunication Union
NDRC	National Development and Reform Commission
NSBs	National Standards Bodies
PRC	People's Republic of China
R&D	Research and Development
RED	Radio Equipment Directive
SAC	Standards Administration of China
SDO	Standard developing organization
SEPs	Standard-essential patents
SMEs	Small and medium enterprises
TBT	Technical Barriers to Trade
TC	Technical Committee
TTC	Trade and Technology Council
US	United States
WLAN	Wireless local area networking

REFERENCES

Arthur, W. B. (1989). "Competing Technologies, Increasing Returns, and Lock-in By Historical Events", *The Economic Journal*, 99.

Berstein, S. (2011). "Legitimacy in Intergovernmental and Non-state Global Governance", *Review of International Political Economy*, 18(1), 17-51.

Bishop, A. D. (2015). "Standard Power: The New Geopolitical Battle". Online available at https://nationalinterest.org/feature/standard-power-the-new-geopolitical-battle-14017 (ac-cessed: 9 September 2019).

Bonardi, J.-P. and Durand, R. (2003). "Managing Network Effects in High-tech Markets", *The Academy of Management Journal,* 17.

Boström, M. (2006). "Regulatory Credibility and Authority Through Inclusiveness. Standardization Organizations in Cases of Eco-labelling", *Organization* ,13(3), 345-367.

Brunsson, N. and Jacobsson, B. (2002). *A World of Standards*. Oxford: Oxford University Press.

Busch, L. (2011). *Standards. Recipes for Reality*. Cambridge: MIT Press.

Büthe, T. and Mattli, W. (2011). The New Global Rulers. The Privatization of Regulation in the World Economy. Princeton: Princeton University Press.

Center for Security and Emerging Technology (2022). "14th Five-Year" Plan for Promoting the High-Quality Development of the National Standards System."Online available at https://cset.georgetown.edu/publication/14th-five-year-plan-for-promoting-the-high-quality-development-of-the-national-standards-system/ (accessed 4 August 2022).

Chen, S.-Z. and Kang, S.-L. (2018). "A Tutorial on 5G and the Progress in China", *Frontiers of Information Technology & Electronic Engineering*, 19(3), 309-321.

Chinese State Council (2021). Online available at http://www.gov.cn/zhengce/2021-10/10/content_5641727.htm (accessed: 4 August 2022).

Crompton, P. (2020). "The new Global Committee on Lithium Standards Will Be Led by Chi-na". Online available at https://www.bestmag.co.uk/indnews/new-global-committee-lithium-standards-will-be-led-china (accessed: 24 April 2021).

de La Bruyère, E. and Picarsic, N. (2020). "China Standards 2035. Beijing's Platform Geopolitics and "Standardization Work in 2020"'. Online available at https://www.horizonadvisory.org/china-standards-2035-first-report (accessed: 30 January 2022).

Deron, L. G. (2022). "Chinese Standards and the New Industrial Markets". Online available at https://www.irsem.fr/institut/actualites/research-paper-no-98-2020.html (accessed: 30 January 2022).

Drezner, D. W. (2005). "Globalization, Harmonization, and Competition. The Different Path-ways to Policy Convergence", *Journal of European Public Policy*, 12(5), 841–859.

Eisenstark, R. (2018). "Why China and the US Are Fighting over 5G". Online available at https://technode.com/2018/03/30/5g/ (accessed: 11 April 2019).

European Commission (2022a). An EU Strategy on Standardisation - Setting global standards in support of a resilient, green and digital EU single market. Online available at https://ec.europa.eu/docsroom/documents/48598 (accessed 4 August 2022).
European Commission (2022b). New approach to enable global leadership of EU standards promoting values and a resilient, green and digital Single Market. Online available at https://ec.europa.eu/commission/presscorner/detail/en/ip_22_661 (accessed: 3 August 2022).
European Commission (2022c). Proposal for a Regulation amending Regulation (EU) No 1025/2012 as regards the decisions of European standardisation organisations concern-ing European standards and European standardisation deliverables. Online available at https://ec.europa.eu/docsroom/documents/48599 (accessed 4 August 2022.
European Commission (2022d). Commission Implementing Decision on a Standardisation Re-quest to the European Committee for Standardisation and the European Committee for Electrotechnical Standardisation as regards Radio Equipment in Support of Directive 2014/53/EU of the European Parliament and of the Council and Commission Delegated Regulation (EU) 2022/30. Online available at https://ec.europa.eu/transparency/documents-register/detail?ref=C(2022)5637&lang=en (accessed 10 September 2022).
Farrell, H. and Newman, A. L. (2019). "Weaponized Interdependence: How Global Economic Networks Shape State Coercion", *International Security,* 44.
Fouilleux, E. and Loconto, A. (2017). "Voluntary Stnadards, Certification, and Accreditation in the Global Organic Agriculture Field. A Tripartite Model of Techno-politics", *Agriculture and Human Values*, 34(1), 1-14.
Friedman, T. (2005). *The World Is Flat: A Brief History of the Twenty-first Century.* New York: Straus and Giroux.
Graz, J.-C. (2019). *The Power of Standards. Hybrid Authority and the Globalisation of Services.* Cambridge: Cambridge University Press.
Henson, S. and Reardon, T. (2005). "Private Agri-food Standards: Implications for Food Policy and the Agri-food System", *Food Policy* 30(3), 241-253.
Kleinhans, J.-P. and Baisakova, N. (2020). "The Global Semiconductor Value Chain. A Technology Primer for Policy Makers". Online available at https://www.stiftung-nv.de/sites/default/files/the_global_semiconductor_value_chain.pdf (accessed: 30 January 2022).
Krasner, S. D. (1991). "Global Communications and National Power. Life and the Pareto Fron-tier", *World Politics*, 43(3), 336Ğ66.
Krislov, S. (1997). *How Nations Choose Product Standards and Standards Change Nations.* Pittsburgh: Pittsburgh University Press.
Medin, M. and Louie, G. (2019). "The 5G Ecosystem. Risks & Opportunities for DoD". Online available at https://media.defense.gov/2019/Apr/03/2002109302/-1/-1/0/DIB_5G_STUDY_04.03.19.PDF (accessed: 30 January 2022).
Milhaupt, C. J. and Zheng, W. (2015). "Beyond Ownership: State Capitalism and the Chinese Firm", *The Georgetown Law Journal*, 103(3), 665-722.

Murgia, M. and Gross, A. (2020). "China and Huawei Propose Reinvention of the Internet". London: Financial Times. Online available at https://www.ft.com/content/c78be2cf-a1a1-40b1-8ab7-904d7095e0f2 (accessed 30 April 2020).

Nicolaidis, K. and Egan, M. (2001). "Transnational Market Governance and Regional Policy Externality: Why Recognize Foreign Standards?", *Journal of European Public Policy*, 8(3), 454-473.

OECD (2019). "Regulatory Reform and International Standardisation". Working Party of the Trade Committee. TD/TC/WP(98)/FINAL (1999).

Office of the Leading Group for Promoting the Belt and Road Initiative (2019). The Belt and Road Initiative. Progress, Contributions and Prospects. Online available at www.chinaembassy.se/eng/zgxw/t1675676.htm (accessed: 22 September 2019).

O'Rourke, D. (2006). "Multi-stakeholder Regulation: Privatizing or Socializing Global Labor Standards?", *World Development*, 34(5), 899Ğ18.

Pohlmann, T. et al. (2020). "Studie zur Untersuchung und Analyse der Patentsituation bei der Standardisierung von 5G". Studie im Auftrag des Bundesministeriums für Wirtschaft und Energie. Berlin: IPlytics.

Pop, V. et al. (2021). "From Lightbulbs to 5G, China Battles West for Control of Vital Tech-nology Standards". Online available at https://www.wsj.com/articles/from-lightbulbs-to-5g-china-battles-west-for-control-of-vital-technology-standards-11612722698 (ac-cessed: 4 August 2022).

Rühlig, T. (2020). "Who Controls Huawei? Implications for Europe". Online available at https://www.ui.se/globalassets/butiken/ui-paper/2020/ui-paper-no.-5-2020.pdf (accessed: 30 January 2022).

Rühlig, T. and Björk, M. (2020). "What to Make of the Huawei Debate? 5G Network Security and Technology Dependency in Europe". Stockholm: The Swedish Institute of Interna-tional Affairs.

Rühlig, T. (2022a). "Chinese influence through technical standardization power", *Journal of Contemporary China*, Online available at: https://doi.org/10.1080/10670564.2022.2052439 (accessed: 4 August 2022).

Rühlig, T. (2022b). "The Rise of Tech Standards Foreign Policy. Brussels Goes Strategic". DGAP Online Commentary. Online available at https://dgap.org/en/research/publications/rise-tech-standards-foreign-policy (accessed: 3 August 2022).

Rühlig, T. and ten Brink, T. (2021). "The externalization of China's technical standardization approach", *Development and Change*, 52(5), 1196-1221.

SAC (2015). Action Plan to Connect "One Belt, One Road" through Standardization (2015-2017). Online available at www.followingthemoney.org/wp-content/uploads/2017/06/2015_Leading-Group-for-the-BRI_Action-Plan-to-Connect-BRI-through-Standardization-2015-2017_E-1.pdf (accessed: 19 February 2019).

SAC (2018). Online available at www.sac.gov.cn/zt/ydyl/bzhyw/201801/t20180119_341413.htm (accessed: 26 October 2018).

SAC (2020). Online available at: www.sac.gov.cn/sxxgk/zcwj/202101/t20210122_347055.html (ac-cessed: 6 February 2021).
Schepel, H. (2005). *The Constitution of Private Governance. Product Standards in the Regulation of Integrating Markets*. Oxford: Hart Publishing.
Seaman, J. (2020). "China and the New Geopolitics of Technical Standardization". Online available at https://www.ifri.org/sites/default/files/atoms/files/seaman_china_standardization_2020.pdf (accessed: 30 January 2022).
Shi-Kupfer, K. and Ohlberg, M. (2019). "China's Digital Rise. Challenges for Europe". Berlin: Merics.
Tamm Hallström, K. (2004). *Organizing International Standarization. ISO and the IASC in Quest of Authority*. Cheltenham: Edward Elgar.
Tate, JA. (2001). "National Varieties of Standardization", in Hall, P. A. and Soskice, D. (eds.). *Varieties of Capitalism. The Institutional Foundation of Comparative Advantage*. Ox-ford: Oxford University Press, 442-473.
Timmermanns, S. and Epstein, S. (2010). "A World of Standards but not a Standard World: Towards a Sociology of Standards and Standardization", *Annual Review of Sociology*, 36(1), 69-89.
United States Congress (2022). United States Innovation and Competition Act of 2021. Online available at https://www.congress.gov/bill/117th-congress/senate-bill/1260/text (ac-cessed 4 August 2022).
Werle, R. and Iversen, E. J. (2006). "Promoting Legitimacy in Technical Standardization", *Science, Technology & Innovation Studies,* 2(1), 19-39.
Yan, X. (2020). "Bipolar Rivalry in the Early Digital Age", *Chinese Journal of International Politics,* 13, 318.
Yap, C.-W. (2019). "State Support Helped Fuel Huawei's Global Rise". Online available at www.wsj.com/articles/state-support-helped-fuel-huaweis-global-rise-11577280736 (ac-cessed: 9 February 2020).

CHAPTER 7

AN OPTIMISTIC OUTLOOK ON TROUBLED TIMES

A conversation with Hal Varian about the future of the digital economy

JOAKIM WERNBERG

During the spread of internet access in the 1990s and early digitalization in the 2000s, policy and technological innovation both contributed to increased economic integration across borders. In the last decade, we have seen growing tensions between on the one hand continued digital interconnectivity and market expansion, and on the other hand national and territorial sovereignty. As the economic impact of cross-border digital markets increases, so does the push and need for legislation. Nationalism and protectionism are on the rise and the number of regulatory initiatives is growing exponentially. Policymakers are facing a fork in the road, either moving towards disconnect and economic disintegration or adapting regulatory frameworks for an even more interconnected future.

Against this background, I had the privilege to sit down and have a conversation with Hal Varian, Chief Economist at Google and professor emeritus at the University of California at Berkeley. Varian is known to many as the author of one of the main textbooks on intermediary economics used in university courses around the world, but he has also written extensively and oftentimes ahead of his time about the digital information economy.

The conversation took place across borders and time zones via video conferencing, which turned out to be quite suitable given professor Varian's positive outlook on the economic and technological opportunities associated with the future of the digital economy.

REGULATING TECH COMPANIES AND SHAPING DIGITAL MARKETS

Joakim Wernberg (JW:) Looking across the globe, especially in Europe, there is a push for regulating digital markets in general, and large tech companies in particular. The Digital Markets Act (DMA) and the Digital Service Act (DSA) have recently been passed into law and proposals for an AI Act and a Data Act are being processed in the parliament. Some of these regulations imply a significant increase in protectionism and nationalism. There is an ongoing debate about how to secure digital sovereignty, which is essentially about reinforcing geographical borders in digital space. From my point of view, this could challenge the way new firms, both in tech and other sectors, grow, scale up their business and interconnect across national borders. How is this regulatory shift going to affect digital markets in a long-term perspective?

Hal Varian (HV): Well, I think you are right that the regulators certainly are playing a larger role than they did a few of years ago. And there are a number of issues that I think are very short-sighted in terms of innovation, progress, efficiency, all those good things that economics is supposed to deliver. I think there is a need for deeper dialogue. The parties that are discussing these regulatory issues are not always very familiar with computer engineering or the technical side of things and there is a lot of unnecessary worry.

When you think about it, throughout history there have been numerous technological developments that have really shaken up society at the time. They were all eventually settled, and I think the same will turn out to be true in this case. For example, we had similar debates about privacy when people started using smartphones with cameras as we do today.

JW: A recurring motive for regulating digital markets is to safeguard and promote competition, innovation and new market entry which are believed to be endangered by the presence of large digital tech companies, despite evidence to the contrary. You have written a paper on this theme titled "The Seven Deadly Sins of Tech?", in which you address common criticism against large tech companies related to competition, innovation, acquisitions, entry, switching costs, entry barriers and size and provide evidence to the contrary of that criticism.[1]

In the face of increased regulation, companies like Google, Meta or Amazon have the resources to convert the resulting compliance costs into a competitive advantage. However, an increased regulatory moat may limit future competition and the

1. Varian, H. R. (2021). "Seven deadly sins of tech?". *Information Economics and Policy*, 54, 100893.

potential for the type of combinatorial innovation that digital technologies have typically enabled.[2] Is there not a risk that rising transaction costs in digital markets brought on by regulation could realize the very fears that motivated many of these legislative initiatives to start with? Yet, some policymakers seem convinced that new legislation will pave the way for what the French president referred to as "European champions" in the tech sector.

HV: Yes, I think it is quite clear that this is definitely a danger. It is a bigger danger in Europe than it is in the US. The relevant companies are homegrown heroes in the US. They are viewed with pride and a little bit of anxiety, but when you look at the European situation, these companies are viewed as foreign intruders and as a result you have a more hostile environment for creating a good regulatory regime.

I think there is a certain amount of envy there among some European policymakers who would like to have their own digital champions, but this perspective is a bit short-sighted. If you take a closer look at Europe, the World Wide Web (www) was invented by Tim Berners-Lee while working in CERN in Switzerland and the operating system Linux came out of Finland, just to mention two examples. There is already a lot of talent, a lot of innovation going on and a lot of people doing remarkable things in Europe. The biggest difference between the US and the EU is on the commercial side, which is partly explained by what has been going on in Silicon Valley but also partly by the fact that US companies have a larger and more coherent domestic market in which to scale their businesses.

To the point, you do not want too much regulation. It stops innovation in its tracks. Legislators need to look at disruptions brought on by technological developments and see what harm, if any, it is causing and then they must deal with it. If they react by setting up too overly strong barriers these will also inhibit innovation.

JW: The regulatory efforts also to some degree reflects rising tensions between on the one hand cross-border digital markets and on the other hand national sovereignty and jurisdiction. Do you think that we are moving towards a world of splinternets in which internet access and what you can access on the internet is increasingly subject to national borders?

HV: We certainly see it in China and Russia, but there are also similar tendencies in the rest of the world. At one time, Russia had a relatively open internet, and it

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2. Varian, H. R. (2003). "Innovation, components and complements". *University of California, Berkeley, October*,
Varian, H. R. (2010). "Computer mediated transactions". *American Economic Review,* 100(2), 1-10.

had quite a significant role in disseminating information about what was actually going on. Now that possibility has been closed off. The government would like to control it, but I do not think that they are able to. A lot of state control depends on the architecture of internet access in each country. Russia has had a more open architecture than China, for example. Chinese leaders treated an open internet as a threat from the start and has been more successful than any other country I am aware of in controlling internet access.

There are other countries that I think will move to join the splinternet model, especially if you consider the rise of extremism in politics. It is politics that I think is driving the splintering, not economics. But I do not think you can put the genie back in the bottle. You can try, but typically it is going to be futile. And with the rise of wireless communication, it becomes harder in some respect since everyone has their own access point.

ARTIFICIAL INTELLIGENCE AND DATA ECONOMIES

Advances in artificial intelligence (AI) and data science hold great economic potential, but have also become a focal point of policymaking, regulation and geopolitical competition. AI development is oftentimes cast as a modern space race with countries competing to be at the forefront, while it is also subject to regulatory initiatives such as the proposal for an AI Act currently under negotiation within the EU which restricts the development and use of AI. Data governance exhibits a mix of regulation of cross-border data flows to protect national sovereignty, data protection legislation to safeguard privacy, and promoting competition and innovation through mandated data sharing. Many of the applications of AI and data-driven innovation are developed by large tech companies that are also subject to other types of regulation aimed at digital markets. Looking beyond the technical development of new applications, the changing regulatory landscape is likely to have a significant impact on businesses that use these applications, especially small and medium-sized companies.

JW: In your essay "Artificial intelligence, economics and industrial organization" from 2018, you describe the economic benefits of small companies and startups being able to access technological capacity and software-based services like machine learning at variable costs rather than fixed costs through cloud services.[3] Apart from lowering the threshold for accessing these technological capabilities, your argument also implies a changing industrial structure with increased digital interdependencies between firms. These interdependencies are in turn shaped by how platform

3. Varian, H. (2018). "Artificial intelligence, economics, and industrial organization". In *The economics of artificial intelligence: an agenda* (pp. 399–419). University of Chicago Press

companies and software-based services adapt to current geopolitical shifts and new regulation. How do you think current developments in this area will affect smaller firms who are leveraging these services but also becoming dependent on them in the longer term?

HV: Artificial intelligence holds great potential for innovation. I think we can take that as a given because of AI's tremendous contribution recently in biological engineering, computational biology, and improved weather forecasts, just to mention a few examples.

JW: How can small companies survive in an economy or in a sector where a few big firms – the Big Five – control a lot of the infrastructure that enables artificial intelligence to work?

HV: First, you must remember there are several such companies, not just one. There is Amazon, there is Microsoft, there is Google, IBM, and HP and more. Other companies are also moving into this area of AI infrastructure and there is going to be intense competition among these companies.

Second, a lot of work in AI is dedicated to trying to utilize less compute resources in order to run AI applications. While a lot of AI applications are already available at an attractive cost, many of them require substantial computational resources and we are moving towards reducing the demands on this compute infrastructure both in terms of monetary costs and the need for large amounts of data. That will contribute to decreased dependence on large infrastructures controlled by a few actors.

JW: Which suggests it is important to have a market large enough to maintain that level of competition between providers of centralized compute infrastructure. This in turn raises the question of what constitutes a large market for AI applications, and that in turn depends on the demands for and advantages of collecting large volumes of data. So, what about data as an economic resource and data economies?

You have previously argued that there are mature markets for knowledge (the labor market) and information (books or videos, for example), but not for data in terms of bits.[4] You have also put forward the possibility of thinking about data in terms of access rather than ownership. Some of the new legislation under way within the EU is geared towards promoting and even mandating data sharing, especially requiring the largest tech companies to share data in some form. Where do you think we are headed with the current developments and debates in this field?

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4. Ibid

HV: First, I think that up until now the data discussion has gotten all tied up with the discussion surrounding privacy. I think that is a mistake because a lot of data – in fact, I would say most data – are concerned with non-private information and should be regulated as such.

Second, the Digital Markets Act (DMA) is quite explicit on data sharing. The prevailing view seems to be that access to certain data is necessary to create a so-called level playing field. What data this entails is still under negotiation. I think we will come out with more mandated data sharing in the future, at least in European countries. My view is that it is important to make sure that if you are required to provide certain data, it has to be relevant not just in an antitrust setting but for society at large. If you are forced to share data, let us make sure that the data is available for useful purposes, not just to create the level playing field which legislators have been referring to.

JW: What you are describing could on the other hand be achieved by demanding that companies structure data according to predefined formats and then make them available, rather than to share their own structured data which potentially constitutes trade secrets. This would also make it possible to pool data from different actors and markets to generate public data resources for academic research, policy development or innovation.

HV: Furthermore, I am not sure that data volume is, or if it is that it will remain, a bottleneck in data-driven innovation. The machine learning literature of the last decade has shown diminishing returns to data volume for model performance. With the foundation models currently under development, we have yet to run into diminishing returns to data but attempts to reduce demands for training data and generating synthetic data are very active lines of research. Against this background, I do think we will see diminishing returns to data volume in AI applications even for the type of foundation models currently being developed.

Finally, it is worth pointing out that there is already a lot of open source data being released for public use and some of it is at the cutting edge of research.[5] For example, Deepmind, after designing the software that successfully predicts how proteins fold, has released a catalog of data on protein folding for anyone to download and use.[6] No licensing, no requirements, no legal baggage, it has just been made available because it is very important for the progress of computational biology. And it is not just data. You can download the open-source code for Android or Chromium and

5. https://blog.google/technology/research/open-source-and-open-data/
6. https://www.deepmind.com/open-source/alphafold-protein-structure-database

create your own operating system on a Raspberry Pi or any piece of hardware you want.

JW: That is an important point. There are already economic incentives for making data as well as software-based tools available. It is beneficial for companies like Google because you encourage people to learn how to use them, like Tensorflow for machine learning applications. This not only provides feedback and user statistics which Google can use to improve its toolbox but as more people become familiar with them it also promotes a type of soft standard setting.

HV: Right, and then when you start working at Google you hit the ground running. And even if you do not, you can study some of the latest research in machine learning and become more productive that way.

TAKING THE OPTIMISTIC VIEW

JW: Let me circle back to the issue of how current geopolitical shifts affect the overall digital economy and digital markets. You seem to remain an optimist about the future. Are there any threats to technological progress we should be worried about or is this all just going to be a bump in the road?

HV: There are possible threats we should be concerned about, but most are economic issues or business issues and not social issues. Businesses come and go. Established companies are increasingly seeing threats to their competitive position from new entrants and the services they provide. Kodak used to be one of the ten largest companies, highly innovative, had lots of creativity and a huge market, and then within a few years they pretty much vanished because of digital photography – technology that Kodak had invented. Newspapers are meeting similar challenges today.

JW: All other things being equal, that could be rounded up to creative destruction, but in addition to this we are seeing legislation and policymaking that is partly promoted by nationalist or protectionist interests and partly driven by an increasing skepticism towards technological progress. The techno optimism of the late 1990s and early 2000s has been surpassed by a growing techlash in the last decade. How is this going to affect us for the coming ten years?

HV: We see this happening over and over again. In the US, the Robinson Patman Act from 1936 was designed to prevent supermarkets from competing with small suppliers and corner grocery stores. Although supermarkets had a huge efficiency advantage compared to smaller stores, the Federal Trade Commission (FTC) pursued this issue and fought supermarkets for nearly thirty years. If regulators get involved

in the market and start playing favorites, something that we are seeing in digital markets in both the US and EU, the effects could potentially last for a long time.

If incumbents feel entitled to their returns – and they will – they will find a way to communicate that to legislators and policymakers. We are facing the very same problem with digital markets today, and the very same arguments that were used almost a 100 years ago are being cited again today. We thought that was all behind us, but apparently not.

JW: At the same time, this is not just about the new entrants and the incumbents. Digital innovation and entrepreneurship leverage the size of the market and the ability to interconnect within that market. A local bakery can use targeted advertising or social media supplied through international digital platforms and cloud providers to reach customers around the corner just as easily as a graphic designer can attract customers in other countries. With digitalization, the industrial organization is becoming increasingly complex, and firms are linked to each other by mutual interdependencies in new ways. With regulation that reinforces geographical borders, we are at risk of not only breaking up exchanges between foreign platforms and domestic firms, but also between firms and customers within the domestic market.

HV: This is a potential risk, for sure. Historically, most companies were country specific. It is only after World War II that we see this big movement towards globalization. And just as some firms rely on advertising or other services supplied by digital platforms, we can expect to increasingly see the use of video conferencing, supplied as Software as a Service (SaaS), proliferating across all lines of business for meetings, communication, and remote working. These technological advances also further enable firms to hire people to work remotely for them from other countries, building on what we are already seeing happening in India because of work being outsourced there.

THE FUTURE OF INTERCONNECTED WORK

JW: The idea of cross-border remote work really challenges the relation between technological and geographical borders. We are used to thinking about labor markets as something that is geographically localized, just as most businesses used to be country specific. How do you think geopolitical shifts like the ones we are seeing now will affect the future of work?

HV: I think that because the rise in video conferencing and remote work in the wake of Covid coincides with the demand for scaling business, the problem of attracting talent and rising immigration issues, we are likely to see a substantial rise in global work. We have already seen this happening with digital platforms and tech companies like Google, but I think we will see similar developments in

all sorts of industries and companies in the future. I also think we will continue to see flexibility in work hours. The five-day work week is not written in stone, and it has been around well over a hundred years, so it is due for a change. Employees in Silicon Valley are reluctant to go back full time to the office following the Covid pandemic – they love their jobs, but they hate the commute.

JW: And expanding the notion of remote work from just working at home to actually being located somewhere else completely also provides the opportunity to choose where you live independently from where you work. That would challenge rising housing costs in places like Silicon Valley.

HV: In my case, I have people on my team working in San Francisco, in Mountain View, in Switzerland and in the UK. They are all over the place and it is very rare for us to meet physically because we can get almost everything that we need done by video conferencing.

JW: What you are describing bears some similarities with other less optimistic accounts of the interaction between globalization and automation. For example, Richard Baldwin's description of a "Robotics Upheaval" where the combination of global tele-migrant white-collar work and automation of analytical tasks threatens the foundations of the geographically defined welfare state. Baldwin argues that these developments will lead to protests and ultimately policies to protect geographically local jobs.[7] This narrative seems to run counter to what you are essentially describing as something positive.

HV: I guess I am more optimistic, but that is perhaps more my nature than my analysis. Although I do believe that what I am describing is the dominant force in play, there are of course other counterforces that will play out in the background. There is a study from Microsoft showing that remote work is fine for routine tasks, while non routine tasks like generating new ideas, brainstorming or being creative work better with face-to-face interactions. I believe this is mostly a technical limitation right now and we will be able to improve the means for improving the spontaneous interactions with colleagues that we all know and love. It is a challenge, but I do not think it is an insurmountable challenge. More importantly, I do not think you necessarily have to give up remote work to preserve geographical co-location. It is a question of reorganizing work and we have not explored that yet.

Furthermore, the impact of automation on the labor market is not determined solely by its effects on labor demand but also on how the supply of labor changes over time. Demographic shifts, as well as conventions like the five-day work week are set

7. Baldwin, R. (2019). *The globotics upheaval: Globalization, robotics, and the future of work*. Oxford University Press.

to change the supply of labor significantly in the coming 50 years. These supply-side effects appear likely to outweigh demand side effects due to automation at least in the coming decade.[8] I would recommend that we put more effort into thinking about the aging population. We are moving toward a world where the developed countries are increasingly old and the undeveloped countries are young. There is a natural gain from trade to be had here, but it is oftentimes overlooked.

JW: And even in the face of increasing nationalism and protectionism, you envisage a digitally interconnected world of emerging global remote work?

HV: Yes, I think inherently I tend to be optimistic. If you look back at history, you see the same type of shocks that we are experiencing now come up and they have been dealt with. I think we can get through this, although we do need to be alert and aware about some of the current political issues as they might be blown out of proportion.

The mobile phone revolution is a quite impressive example of how new technology is made universally available around the world through the interaction between innovation and regulation. It can be done but it requires a lot of planning and work. Perhaps most importantly, it was built primarily by engineers and secondarily by governments. Policymakers recognized the need for and potential for global interoperability, even though they wouldn't have been able to invent the entire mobile infrastructure on their own.

Putting the pen down and reflecting on our conversation, professor Varian's view of the future reminds me of the Swedish entrepreneur and business leader Jan Stenbeck who is attributed with having said that technology beats politics. Stenbeck introduced commercial television in Sweden via satellite broadcast – effectively disrupting Swedish television - and in doing so initiated a legislative change. We know for a fact that technology does not always beat politics and regulation plays an increasingly important role in shaping digital markets for both local and global exchanges. What Varian's optimistic outlook highlights to me, and what makes me think about Stenbeck's quote, is that the future is an outcome of the interaction between on one hand technological innovation and on the other hand how we use and govern new technologies – neither fully determines the outcome of the other. Regardless of whether policymakers raise national borders or promote cross-border exchanges in the short run, the history of our digital and economic integration is far from over. Whatever we do now, provides ample opportunities for learning in the future.

8. https://cepr.org/voxeu/columns/automation-versus-procreation-aka-bots-versus-tots

Increasing global economic integration and digital interconnectivity have paved the way for geoeconomic shifts and given rise to geopolitical tensions. The actions of foreign states as well as the changing nature of international markets have challenged national sovereignty in new ways, giving tailwind to protectionism and regulatory initiatives aimed at crossborder digital markets. The struggles are spanning across the regulation of digital markets, rising cyber security threats, technical standardization as well as the transition towards sustainable energy sources. The fourteenth edition of SEF Dialogues offers several starting points for continued dialogue on how to navigate an interconnected and ever changing geoeconomic landscape.

In *Rethinking boundaries and revisiting borders - Conditions for innovation, entrepreneurship and economic integration in an interconnected world* the authors examine how the conditions for future innovation, entrepreneurship and economic integration are being shaped by geopolitical power tensions and changing geo-economic realities. The contributors in this volume provide unique perspectives and insights into how the balance between digital interconnectivity, boundaries for economic and social exchanges, and national borders is changing.

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