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Shared manufacturing and the sharing economy ideal: Strategic limits in a fragmenting world

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Abstract

This study offers a strategic critique of shared manufacturing (SharedMfg), a concept rooted in the broader sharing economy (SE) and promoted as a mechanism for optimizing industrial capacity through peer-to-peer coordination. While such frameworks emphasize digital platforms, scheduling efficiency, and resource pooling, they frequently neglect the deeper constraints that govern the real-world feasibility of manufacturing. In particular, SharedMfg models are often constructed atop idealized abstractions, treating manufacturing units as modular, cyber-physical assets within an Industry 4.0 ecosystem, while overlooking the material, energetic, and geopolitical foundations on which all manufacturing ultimately depends. Extending beyond critique, we explore the conceptual underpinnings of SharedMfg within its systemic context, a prelude to the layered pyramid model advanced in this study. This paper argues that manufacturing does not evolve autonomously, but rather reflects the socio-political order in which it is embedded. To address this oversight, we propose a layered conceptual framework – a manufacturing transformation pyramid – that begins not with coordination, but with the substrate: matter, energy, and institutional structure. We contend that genuine transformation in manufacturing systems must be grounded in these foundational realities, rather than in digital optimization alone. Absent this grounding, SharedMfg/SE risks becoming a transient theoretical exercise, bounded by the specific conditions of its historical moment and detached from the structural realities that shape industrial capacity.

Keywords: Sharing economy, Shared manufacturing, Industrial sovereignty, Manufacturing blocs, New World Order

1. Introduction

We focus on the concept of shared manufacturing (SharedMfg) as a salient case within the broader domain of the sharing economy (SE). In the wake of globalization's structural recalibration, the vision of SharedMfg has become increasingly strained. Once hailed as a transformative approach to industrial efficiency – promising to

reduce idle capacity, increase modularity, and democratize production – it now faces a world more fractured than unified. While the platform logic of the early 2000s thrived on openness and digital liquidity, enabling new forms of peer-to-peer coordination in services and logistics, the translation of this logic to manufacturing has proven structurally fraught. Unlike ride-sharing (e.g. Uber) or accommodation (e.g. Airbnb), manufacturing operates within deeply material, capital-intensive, and jurisdictionally constrained environments. As such, recent trends toward geopolitical realignment, technological decoupling, and supply chain sovereignty have not merely complicated SharedMfg – they have called its foundational premises into question. Indeed, some scholars argue that the sharing economy is misnamed, that it masks commodification under the guise of communalism [1]. Others frame it as a socialization of manufacturing processes through participatory design and distributed agency [2].

This paper does not approach SharedMfg/SE with a singular verdict. Instead, it adopts a dialectical framework, exploring both the aspirations embedded in the model and the constraints imposed by evolving political economies. Our aim is not merely to critique SharedMfg/SE, nor to replace it with a new orthodoxy, but to understand its conceptual anatomy within a system marked by contradiction and transition.

The sharing economy (SE) is variously defined as a new form of consumption [3], collaborative consumption [4], or as a peer-to-peer (P2P) economy [5, 6]. These interpretations converge on a common theme: the monetization of underutilized assets through digital platforms that facilitate exchanges among strangers. Popular examples include Airbnb, Uber, RentMojo, Furlanco, Bounce, and Vogo, platforms that enable more efficient use of privately held goods or services through internet-enabled coordination.

This IT-driven model has disrupted traditional service sectors by decoupling ownership from usage and by framing access as a substitute for possession. However, this dynamic does not generalize seamlessly to all industrial contexts, particularly manufacturing. While the SE model thrives in logistics, accommodation, and transportation, its translation into manufacturing sectors, especially those bound by strategic, regulatory, or national constraints, remains limited and often problematic.

Building on the logic of the SE, SharedMfg has been described as “a new mode of socializing manufacturing,” whereby production resources – labor, materials, machinery – are pooled and accessed on demand via P2P frameworks [7]. It shares conceptual space with cloud manufacturing (CMfg) and social manufacturing (SocialMfg), and is often discussed alongside the so-called “servitization” of manufacturing, in which firms are reimagined as service providers rather than mere product vendors.

Industry 4.0 technologies, including the Internet of Things (IoT), Internet of Services (IoS), and Cyber-Physical Systems (CPS), are commonly cited as enablers of this transformation. Platforms such as Floow2 [8], which allow firms to share idle manufacturing capacity, are held up as early exemplars. Case studies, such as the glove manufacturing example of Yu et al. [7], demonstrate the theoretical feasibility of modular, distributed manufacturing chains.

Yet, as we argue in this paper, these emerging models are often framed in abstraction, detached from the constraints and contingencies that shape actual manufacturing systems. The socio-political environment in which manufacturing occurs – marked by resurgent protectionism, geopolitical uncertainty, and industrial policy realignment – demands a more grounded evaluation of SharedMfg/SE’s prospects and limits.

Throughout, the paper seeks to maintain analytical balance: recognizing both the structural pressures that constrain global coordination and the emergent possibilities for modular, politically aligned alternatives. It also considers the subnational implications of these shifts – how they affect SMEs, labor, startups, and local communities – and highlights the dangers of innovation stagnation, techno-nationalism, and strategic overreach.

In short, this is neither a eulogy nor an endorsement. It is an inquiry into what forms of industrial cooperation remain viable – and under what conditions – in a world where manufacturing no longer evolves but is allowed

to evolve. We argue that such evolution is not driven solely by technology or efficiency, but permitted selectively by configurations of power, trust, and geopolitical constraint. In this sense, our treatment is best understood as a meta-study of manufacturing.

2. Aims of this study

This study aims to reframe the prevailing discourse on shared manufacturing (SharedMfg), which is frequently situated within a narrow optimization-oriented logic. Most existing literature emphasizes scheduling algorithms, platform coordination, and digital enablement as core enablers of SharedMfg – implicitly treating manufacturing as a modular, disembedded activity that can be flexibly orchestrated across space and time. Recent treatments emphasize platform logistics, scheduling algorithms, and cyber-physical integration [9], often neglecting the systemic substrates we highlight here.

Our central contention is that such treatments operate almost exclusively at the surface layer of manufacturing: the domain of software, logistics, and platform integration. While analytically sophisticated, these models are often agnostic to the physical, energetic, and geopolitical substrata that condition what manufacturing is – and what it can become. As a result, SharedMfg is often mischaracterized as a natural progression of industrial evolution rather than a historically contingent response to a specific socio-economic order.

In this study, we propose a layered conceptual framework to ground the analysis of manufacturing transformation. This pyramid model begins with the material substrate – constraints imposed by physics, energy, and institutional order – and ascends through economic structures, political dynamics, and finally to coordination mechanisms such as those promoted by SharedMfg. The key premise is that coordination cannot be meaningfully optimized without first understanding the foundational conditions that govern feasibility. Many optimization models in supply chain and manufacturing theory assume fair-market conditions, symmetrical incentives, and rational pricing. However, real-world practices – such as strategic dumping [10], wherein countries sell goods below cost to capture market share – are often excluded from these models. These omissions create a dangerous analytical illusion: that optimization occurs in a vacuum, rather than within a contested geopolitical landscape.

This paper is therefore both diagnostic and prescriptive. It diagnoses a blind spot in the literature: the failure to theorize manufacturing within its political-economic context. It also prescribes a reversal in analytical perspective: beginning not with coordination, but with constraint, not with algorithms, but with realities. In doing so, we aim to reposition SharedMfg not as a universal paradigm, but as a limited – and increasingly fragile – artifact of the previous era of globalization.

3. WTO, globalization, COVID-19, and tariff wars: A contemporary case study

The concept of SharedMfg gained traction during an era when globalization was not merely a trend but an article of economic faith. The late 1990s and early 2000s marked the high tide of international liberalization, with the establishment of the World Trade Organization (WTO) [11, 12, 13], widespread reductions in trade barriers, and a broad consensus that global integration would yield mutual economic gains. Within this ideological climate, supply chains became increasingly transnational, and digital platforms promised to virtualize production, decoupling manufacturing from geography and embedding it in logistics and data.

This environment fostered the illusion that manufacturing could evolve into a globally fluid, modular, and digitally orchestrated activity. SharedMfg, as a conceptual model, emerged from and was shaped by these assumptions. However, recent developments point to a structural reversal. The COVID-19 pandemic did more than disrupt supply chains – it exposed their fragility. Lockdowns, port closures, and mismatches in supply and demand revealed the brittleness of globally distributed manufacturing networks [14]. In response, governments and firms alike began rethinking the strategic wisdom of overseas dependencies, giving rise to reshoring and near-shoring initiatives aimed at improving resilience.

This recalibration deepened with a series of protectionist measures. In April 2025, the United States announced sweeping tariffs on imported semiconductors, electric vehicle components, and critical minerals, citing national security and economic sovereignty [15, 16]. These actions triggered immediate volatility in global markets, particularly in sectors dependent on just-in-time manufacturing [17]. The tariffs were not isolated economic levers; they were instruments of a larger geopolitical doctrine.

Far from being temporary deviations, such moves signal a foundational shift in trade norms. They recall earlier disruptions, including the 2018–2020 U.S.-China trade tensions and post-pandemic supply chain fractures, but are now marked by sharper ideological clarity: manufacturing capacity is increasingly viewed as a sovereign asset, not a shared global utility. The implications for SharedMfg are profound. A paradigm that presumes open access, cross-border coordination, and resource pooling becomes structurally fragile in a world reorganizing itself around strategic autonomy and national industrial policy. This case study exemplifies our core thesis: manufacturing models must be grounded not only in technical feasibility but also in the geopolitical, institutional, and energetic substrata that determine what is possible, where, and by whom. Optimization remains important, but it is not a primary driver. When the substrate itself shifts, the architecture built atop it must be rethought.

While SharedMfg echoes the architectural logic of contemporary digital platforms, it must not be conflated with the commercial model commonly known as platform capitalism. The latter, epitomized by firms like Uber, Airbnb, and Amazon, relies on a matchmaking paradigm that minimizes asset ownership and externalizes operational burdens onto users, contractors, or third-party providers. These platforms optimize access, reputation systems, and transactional liquidity while masking deep asymmetries behind the rhetoric of participation. As Varoufakis has argued [18], such firms operate less as market participants than as digital rentiers, extracting value not through production but by monopolizing the infrastructure of exchange – a form of techno-feudalism. Srnicek [19] similarly observes that platform capitalism thrives by leveraging pre-existing infrastructure while evading ownership responsibilities and systemic accountability.

SharedMfg, by contrast, invokes a far deeper level of infrastructural entanglement. It presumes not merely transactional coordination but seamless interoperability among production capabilities, legal regimes, and supply chains across geopolitical boundaries. As such, it inherits the vulnerabilities of real industrial systems – material scarcity, regulatory friction, and political volatility – that commercial platforms typically abstract away. Applying the optimistic metaphors of platform capitalism to the physical demands of manufacturing is not merely misleading – it may be structurally irresponsible.

4. Current global economic and political trends to support domestic manufacturing sectors

Since 2018, global trade dynamics have been increasingly shaped by protectionist impulses, most visibly through escalating tariffs among major economies. What began as bilateral friction has matured into a systemic pattern: a realignment of trade policies toward national interest and industrial sovereignty. The United States has played a leading role in this shift. The Biden administration, for instance, imposed heightened tariffs on a range of Chinese imports, including electric vehicles, solar cells, and critical minerals, with the explicit aim of protecting domestic manufacturing capacity [20]. The 2024 presidential election further elevated tariffs as a bipartisan political strategy, with the Trump campaign proposing even broader measures, including tariffs on imports from neighboring Mexico and Canada. These moves signal not just tactical nationalism, but a broader redefinition of global integration's terms – one where political alignment becomes a precondition for industrial access.

These actions triggered direct retaliation. In 2025, China responded by raising tariffs on a wide array of U.S. agricultural products, from poultry and pork to soybeans, wheat, and dairy [21]. The European Union also joined the recalibration, increasing tariffs on Chinese electric vehicles as part of a broader realignment in its trade

policy [22]. Trade quotas and regulatory barriers have accompanied these tariff escalations, forming a multi-pronged strategy to reassert domestic control over manufacturing inputs and outputs.

These moves do not occur in isolation. They coincide with intensifying geopolitical instability – ongoing conflicts in Ukraine and Syria, institutional fragility in multilateral forums, and the growing uncertainty surrounding U.S.–EU relations. Together, these dynamics signal that the world economy is shifting from rules-based integration toward interest-based fragmentation.

Recent U.S. tariffs are now described as the most sweeping since the Smoot–Hawley Tariff Act of 1930 – legislation widely blamed for exacerbating the Great Depression [23]. The parallel is not merely rhetorical: once again, a global economic slowdown looms, driven by the use of trade policy as a blunt instrument of industrial strategy. Economists have raised concerns that such tariff regimes may undermine global efficiency and risk stagflationary pressure [24].

In addition to tariff measures, new legal frameworks – such as the CHIPS and Science Act in the U.S. [25] and the European Chips Act in the EU [26] – have further codified the shift toward domestic industrial prioritization. These initiatives impose regulatory and funding structures that favor local production of semiconductors, AI infrastructure, and other critical technologies. While framed as resilience-building, such frameworks also represent a departure from open-access principles in global manufacturing.

The case of lithium, a critical component in electric vehicle (EV) batteries, underscores the strategic importance of resource control. As EV adoption accelerates, global lithium demand is projected to quadruple by 2030 [27]. Currently, China dominates lithium refining, processing approximately 60% of the world's supply. This concentration poses significant risks to nations reliant on imported lithium for their EV industries. Efforts to diversify supply chains, such as the development of domestic lithium mining projects in the United States and Europe, are underway but face challenges related to environmental concerns, regulatory hurdles, and long lead times.

Economists warn that this resurgence of industrial mercantilism may produce long-term inefficiencies, global recessionary pressures, and structural imbalances – outcomes reminiscent of what Adam Smith famously criticized under the doctrine of "Beggar Thy Neighbor" economics [28]. In this emerging order, manufacturing is no longer seen as a site of cooperation but as a sovereign asset – weaponized, insulated, and reoriented around national advantage.

5. From sharing to shielding: The end of manufacturing neutrality

The foundational premise of SharedMfg was the neutrality of platforms, protocols, and participants. It emerged in an era that favored openness, interoperability, and efficiency as universal goods. That world is passing. As manufacturing becomes redefined through the lens of strategic autonomy, national security, and geopolitical alignment, the very notion of "sharing" industrial capacity becomes untenable. What follows is not simply a transformation of technical architecture, but a reconfiguration of global logic – one in which manufacturing is no longer coordinated globally, but fragmented along lines of power, interest, and ideology.

5.1. Manufacturing as sovereign policy

In the emerging geopolitical order, manufacturing is no longer merely an industrial function. It has become a sovereign concern. States now treat productive capacity, supply chains, and technical infrastructure not as market phenomena, but as instruments of national power. Strategic manufacturing – particularly in semiconductors, artificial intelligence, quantum computing, and biotechnology – is increasingly governed by export controls, investment restrictions, and technology embargoes.

A clear indicator that the era of a benign international environment is waning is the recent U.S. insistence that NATO allies assume greater responsibility for their own defense. U.S. Defense Secretary Pete Hegseth [29]

emphasized that European countries should increase their defense spending, cautioning that the U.S. military presence in Europe cannot be assumed to be indefinite. This stance underscores a broader strategic shift where the United States is recalibrating its commitments, signaling that it may no longer serve as the guarantor of a global order predicated on open access and shared security responsibilities.

This shift coincides with the European Union's declining share in the global economy. In 1992, the EU accounted for 29% of global output, but by 2022, this had diminished to 17% [30]. This relative decline reflects broader structural challenges, including demographic trends, energy costs, and lagging technological innovation, which collectively diminish the EU's capacity to uphold the liberal economic order that once underpinned SharedMfg. This trend reflects the return of industrial policy as a tool of statecraft. The logic of SharedMfg, built upon modularity and shared access presuming a benign international environment, no longer holds. Manufacturing sovereignty is now treated on par with energy independence or territorial integrity: not to be compromised, outsourced, or algorithmically scheduled across borders.

A historical precedent that supports this claim can be found in Japan's industrial strategy during the 1970s and 1980s. The Ministry of International Trade and Industry (MITI) [31] actively selected key sectors, such as automotive and electronics, and coordinated national industrial policies to develop them. Techniques like Total Quality Management (TQM), the Deming philosophy [32], and Taguchi methods [33] were not merely technical innovations but were state-promoted tools designed to reshape global perceptions of Japanese manufacturing. The Toyota Production System (TPS) [34], emphasizing just-in-time production and waste elimination, became a model of efficiency and quality. This transformation was not market-driven but orchestrated through long-term planning, institutional coherence, and determined political intent. Japan's quality revolution illustrates that manufacturing progress is not simply an engineering or economic exercise – it is a matter of strategic governance. In a sobering reminder of industrial impermanence, the U.S. state of California surpassed Japan in GDP in 2024[1] [35], underscoring that national economic stature is less a function of legacy than of continued strategic adaptation.

The influence of Japan's manufacturing strategies extended globally. In the United States, companies like Motorola adopted similar quality improvement methodologies. In 1986, engineer Bill Smith introduced Six Sigma [36] at Motorola to improve manufacturing quality by identifying and removing causes of defects and minimizing variability in processes. This data-driven approach to quality control was later embraced by other major corporations, including General Electric [37, 38], and became a cornerstone of process improvement strategies worldwide.

A historical reminder of this dynamic can be found in wartime production regimes, where manufacturing sovereignty is rendered explicit. During global conflicts such as World War II, civilian manufacturing was rapidly repurposed for defense needs, materials were rationed, and production schedules were dictated not by market demand but by strategic imperative. These periods reveal that manufacturing, under certain conditions, becomes an arm of sovereign will, coordinated through institutional mechanisms rather than decentralized exchange.

5.2. The shift in global economic gravity

The West's historical dominance in manufacturing and finance created a conceptual architecture built on efficiency, openness, and abstraction. But global economic gravity has been shifting. The Asia-Pacific region, particularly China, India, South Korea, and the broader ASEAN bloc, now leads in many dimensions of manufacturing capacity, rare earth processing, and industrial scaling.

[1]According to data from the International Monetary Fund and the U.S. Bureau of Economic Analysis, California's nominal GDP reached $4.1 trillion in 2024, surpassing Japan's $4.02 trillion, making it the world's fourth-largest economy.

As power rebalances, so too does the authority to define industrial norms. Countries that once consumed global manufacturing outputs now contest for control over supply chains. Intellectual frameworks that celebrated frictionless globalism, like SharedMfg, are increasingly seen as artifacts of a Western-centric world order. In contrast, the emerging order privileges resilience, autonomy, and asymmetrical advantage.

5.3. The strategic frontiers: Space and the Arctic

The competition for manufacturing sovereignty is no longer confined to terrestrial boundaries [39, 40]. The space economy, once the province of science fiction, is rapidly becoming a stage for geopolitical and industrial contestation. Lunar and asteroid mining are being pursued not as shared endeavors, but as claims – sovereign, extractive, and strategic. Off-Earth manufacturing may soon become a reality, and with it, the need for self-contained, autonomous production systems not reliant on shared protocols.

Simultaneously, the Arctic is undergoing a geoeconomic transformation [41, 42, 43]. Melting polar ice has exposed new corridors of trade, energy, and mineral wealth. Claims over Arctic sovereignty are intensifying, with Russia, Canada, the United States, and China all posturing for control. As with space, the Arctic's strategic value lies not just in resources, but in control over who gets to produce and transport goods. In both domains, manufacturing will follow, not lead, geopolitical assertion.

Recent U.S. interest in Greenland and strategic pressures on Canadian Arctic policy may be interpreted not merely as geopolitical posturing, but as early expressions of the emerging world-order economics, where territorial proximity to untapped resource corridors translates directly into manufacturing sovereignty. In this logic, Arctic claims are not only about sovereignty, but about securing the material substrates for future economic and industrial autonomy [44, 45].

5.4. Manufacturing blocs and the New World Order

As trust erodes and globalism retreats, a new structure emerges: strategic blocs. These are not merely trade alliances or regional partnerships. They are ideological and infrastructural enclosures. Manufacturing within each bloc will increasingly be tailored to internal needs, shielded from external dependencies, and governed by principles of alignment over efficiency.

This is not speculation. The CHIPS and Science Act [25], the European Chips Act [26], China's dual circulation strategy [46], and India's Atmanirbhar Bharat policy [47] all point to the same underlying trend: inward reconfiguration. In such a world, SharedMfg becomes structurally implausible. It cannot operate in a regime where data, labor, materials, and IP cannot flow freely. Even symbolic dependencies are being reconfigured: the European Union's Galileo [48] satellite navigation system is being developed at great cost despite the free availability of the U.S. GPS system. The decision reflects not inefficiency, but a strategic unwillingness to outsource even invisible infrastructure to geopolitical friends and foes alike.

What emerges may resemble Orwell's geopolitical vision [49]: distinct, semi-closed regions of production, each with its own protocols, rules, and manufacturing logic. In this context, neutrality is no longer a virtue – it is a vulnerability.

5.5. Geopolitical contingency and the possibility of re-integration

While the preceding sections chart a clear trend toward economic fragmentation and strategic enclosure, it is important to acknowledge that this trajectory is neither inevitable nor unidirectional. The return of manufacturing sovereignty reflects current incentives, but not structural permanence. It is a phase, not a fate.

The specter of Orwellian blocs – distinct, ideologically fortified zones of production – may indeed be emerging, but to treat this outcome as deterministic would be to surrender prematurely to pessimism. Historical precedent shows that periods of conflict, protectionism, and division have often been followed by phases of renewed

integration, enabled by new trust architectures and institutional frameworks[2]. The post-WWII emergence of the Bretton Woods [50] system and later the World Trade Organization (WTO) [51] exemplify this oscillation between fragmentation and coordination.

Moreover, emerging technologies and shifting political coalitions may enable hybrid collaboration models: distributed but trusted manufacturing alliances, federated production platforms under shared governance, or new multilateral agreements anchored not in globalism per se, but in modular reciprocity. Such outcomes remain contingent on political will, diplomatic dexterity, and the evolution of international norms.

Thus, while SharedMfg may be structurally constrained in the current climate, it should not be discarded wholesale. Its ideals – resource efficiency, modular flexibility, and digital coordination – might yet find expression in regional clusters or semi-open ecosystems. The challenge lies in grounding these ambitions within the pragmatic realities of power, rather than assuming a return to the frictionless liberal order of the past. Even if the future holds Orwellian blocs, the operational lessons and infrastructural principles of SharedMfg may still prove valuable, recast within bounded zones of alignment, trust, and compatibility.

5.6. Toward politically aligned coordination models

The critique of shared manufacturing (SharedMfg) must not culminate in intellectual paralysis. If the classic vision of frictionless, cross-border modularity proves untenable in a contested world, what alternative architectures might emerge? Rather than retreating to national autarky or conceding to geopolitical fatalism, some states and regions are exploring bounded coordination: models that combine selective openness with strategic alignment. One such model is friend-shoring [52], wherein supply chains are reorganized among countries with shared geopolitical, ideological, or legal frameworks. Friend-shoring seeks to retain some benefits of international coordination – efficiency, diversification, scale – while minimizing exposure to adversarial dependencies. The approach is not neutral. It is explicitly value-bound. The U.S. Indo-Pacific strategy and EU-Japan semiconductor cooperation are early examples of this shift.

Another model involves regional manufacturing clusters [53], wherein proximate states build tightly integrated industrial ecosystems anchored in mutual trust, historical ties, and regulatory harmonization. The Visegr´ad Group's coordination on automotive supply chains, ASEAN's gradual integration of electronics manufacturing, and the U.S.–Mexico–Canada Agreement (USMCA) framework all reflect variants of this principle. These clusters often pair distributed manufacturing with centralized policy instruments – e.g., shared R&D funds, regulatory convergence, or joint procurement schemes.

A third direction points to sovereign digital platforms: infrastructure layers designed to coordinate industrial capacity within ideologically coherent blocs or national domains. These platforms may employ blockchain for auditability, AI for predictive coordination, and strong data localization policies to retain strategic control. Rather than global neutrality, they are grounded in sovereignty-aware interoperability – open within bounds, traceable across nodes, and immune to foreign capture. China's emerging "national industrial internet" [54] and the EU's GAIA-X initiative [55] are early indicators of this trend.

These alternative models, as depicted in Table 1, share a common departure from the assumptions of the early sharing economy: neutrality, openness, and scale are no longer maximized in isolation. Instead, coordination is subordinated to alignment, and efficiency is redefined in terms of resilience, trust, and strategic congruence.

[2]From a systems science perspective, this oscillation may be seen through the lens of catastrophe theory, which models systems as moving through states of apparent continuity until critical thresholds are crossed—yielding sudden, often discontinuous transformations. Just as tectonic plates accumulate stress before a seismic rupture, geopolitical and industrial systems may experience long phases of latent pressure, followed by abrupt reconfigurations.

Table 1. Emerging models of industrial coordination

Model	Institutional Logic	Strategic Aim	Risks and Constraints
Friend-shoring	Geopolitical alignment	Supply chain resilience among allies	Fragmentation of global markets, reduced efficiency
Regional Manufacturing Clusters	Territorial integration	Economies of agglomeration; regional self-sufficiency	Vulnerable to regional shocks; coordination complexity
Sovereign Platforms	Digital and industrial sovereignty	Independence from foreign platforms and infrastructure	High cost, risk of isolation, and interoperability challenges
SharedMfg (Ideal)	Transnational techno-economic coordination	Global efficiency via open standards	Politically naïve; ignores geopolitical friction

Thus, while SharedMfg may not thrive in its original, universalist formulation, its component ideals – flexibility, reduced idle capacity, and agile orchestration – can be selectively adapted. The key lies in recalibrating them to serve not the abstraction of global efficiency, but the specificity of strategic compatibility.

5.7. The subnational dimension of industrial fragmentation

While the strategic reconfiguration of manufacturing is often narrated through the lens of statecraft, global blocs, and industrial policy, its effects cascade downward, ultimately shaping the fate of small and medium enterprises (SMEs) [56], local communities [57, 58], workers, and technological startups. These actors are not mere collateral. They are the living infrastructure of industrial society. Moreover, as critics of the sharing economy have noted [59], systemic externalities often fall on marginalized actors, exacerbating rather than resolving structural inequalities.

In the era of shared manufacturing (SharedMfg), SMEs were often envisioned as beneficiaries. Digital platforms promised them flexible access to idle capacity, shared machinery, and wider markets without requiring massive capital investment. However, this ideal was premised on seamless interoperability, legal uniformity, and open data flows – conditions that are evaporating in the current strategic environment.

Under friend-shoring and sovereign platform regimes, SMEs may instead face increased compliance burdens, national origin requirements, and access asymmetries. Unlike multinationals, they often lack the legal infrastructure, diplomatic channels, or logistical flexibility to navigate fragmented regulatory ecosystems. What was once a global supplier base may become a gated archipelago.

For tech startups, especially those in advanced manufacturing or hardware-centric AI applications, the trend toward strategic enclosure introduces paradoxes. On one hand, sovereign platforms and reshoring policies may open new funding and procurement opportunities tied to national industrial agendas. On the other hand, startups may find themselves unable to scale beyond their home markets, hemmed in by export restrictions, IP firewalls, or a lack of cross-border capital mobility.

Local communities, especially those dependent on a single anchor manufacturer or export hub, may experience economic whiplash from sudden policy realignments. A re-shored facility may not replace the diversified supplier base it once depended on. And a tariff war waged in distant capitals may shutter a fabrication plant in a small town.

Workers, too, are caught in the geopolitical wake. Skills that were once mobile across borders – precision machining, electronics assembly, prototyping – may now need to be recertified under national frameworks.

Labor standards, previously harmonized through multilateral treaties, may regress to patchworks. The cosmopolitan promise of a global maker economy gives way to local credentialism and uneven protections.

If manufacturing is to remain both strategically sovereign and socially cohesive, then future policy must consider not just where things are made, but who is enabled – or excluded – in the making. A resilient system is not merely one that insulates its supply chains. It is one that sustains the fabric of its industrial citizenry.

5.8. The mixed modalities of contemporary industrial policy

The preceding analysis has emphasized the strategic reassertion of sovereignty, enclosure, and geopolitical alignment in shaping the manufacturing landscape. While this trend is empirically robust, it is important not to overstate its coherence or inevitability. Industrial policy rarely conforms to pure forms. Instead, it operates in a field of negotiated contradictions.

Many states today do not choose between globalism and protectionism, but rather navigate between them. As Rodrik [60] notes, successful industrial policy in the twenty-first century is often experimental and adaptive, less about choosing between market and state, and more about strategically blending the two to suit context-specific needs.

This hybrid logic is driven less by ideology than by structural necessity. No country, however sovereign, can produce everything. Interdependence, even if politically bounded, remains a fact of the industrial condition. Farrell and Newman [61] have shown how this weaponized interdependence allows powerful states to leverage open networks for coercive ends, exemplifying the simultaneous utility of openness and control.

Policy instruments themselves reveal this ambiguity. Tariffs are combined with research grants. Export controls coexist with free trade zones. Industrial subsidies are rationalized through WTO-compatible language even as their underlying strategic intent is unmistakable. As Evenett and Fritz [62] document, many states publicly affirm globalism while quietly erecting layers of protection.

Even at the discursive level, states often code-switch, invoking global cooperation in multilateral fora while preaching resilience and independence to domestic audiences. This duality is not contra contradiction – it is political technology. It enables states to be market-facing and sovereignty-protecting simultaneously, depending on the audience and moment.

Therefore, SharedMfg should not be dismissed as a relic of naïve globalism, nor should sovereignty-based models be seen as ascendant orthodoxy. The future of manufacturing coordination may lie in modular hybridity: systems that enable cooperation within delineated domains, with protocols for trust, escape, and recalibration. These are neither fully open nor fully closed. They are structured, not by ideology alone, but by contingency, competence, and calculated compromise.

5.9. Risks, regressions, and the shadow side of industrial sovereignty

While the turn toward industrial sovereignty may offer short-term strategic benefits – resilience, control, security – it also risks triggering longer-term regressions with profound systemic consequences. Just as uncritical globalism ignored power asymmetries, uncritical statism may ignore the perils of fragmentation and closure.

First, innovation may suffer. Economic history suggests that isolation, even if well-intentioned, can stifle innovation. Aghion et al. [63] demonstrate that competition is a primary driver of innovation, especially in industries near the technological frontier. When industrial borders are fortified and national champions shielded from external pressure, the incentives to experiment, adapt, and improve often diminish.

Second, economic nationalism may reawaken old dangers. Helleiner [64] warns that economic nationalism is rarely just economic – it is cultural, ideological, and geopolitical. When states frame industrial sovereignty as a nationalistic imperative, trade wars, politicized standards, and retaliatory decoupling often follow. The interwar

period's move toward autarky, as Eichengreen and Irwin [65] note, intensified rather than alleviated global instability.

Third, coordination may decay. Even well-intentioned sovereignty initiatives may produce conflicts in standards, incompatible protocols, and redundant infrastructures. Baldwin [66] argues that the complexity of global value chains requires shared coordination frameworks. Absent these, the cost of re-integration, even among allies, rises exponentially.

Fourth, smaller economies may face marginalization. While larger states can build sovereign platforms, many others cannot. They risk falling into new forms of dependency – either as peripheral suppliers to dominant blocs or as isolated economies with no access to key industrial capabilities. The logic of non-alignment resurfaces, not militarily but industrially.

Finally, social cohesion may fray. Strategic re-shoring may protect national interests in aggregate, but its benefits may be unevenly distributed. Without inclusive policy design, central regions with access to capital and infrastructure flourish, while peripheral zones, SMEs, and informal workers fall further behind. The illusion of national sovereignty conceals an internal stratification.

In sum, industrial sovereignty is not a pure good. It is a strategic response with strategic risks, requiring constant recalibration and institutional self-awareness. As Rodrik [67] notes, effective industrial policy is not about control, but about learning – about building the capacity to adapt to unintended consequences while maintaining a broader vision of inclusive growth.

6. Conclusions

This study began with a critical examination of shared manufacturing (SharedMfg), a concept born of optimism and constructed atop the scaffolding of the sharing economy. Promoted as a pathway to optimize industrial capacity through peer-to-peer coordination, SharedMfg presumed a world characterized by openness, trust, and digitally mediated neutrality. Yet the world has changed. What once appeared as a natural evolution of manufacturing now reveals itself as an artifact of a transient geopolitical condition.

We have argued that manufacturing does not evolve in a vacuum. It evolves only within the constraints – material, political, and institutional – that define its feasibility. The logic of SharedMfg belongs to a particular historical moment: one in which global integration was ascendant, liberal economic doctrines reigned, and coordination platforms were imagined to exist above politics. That moment is receding. In its place, we observe the rise of a new order – less benign, more contested, and fundamentally incompatible with the assumptions embedded in SharedMfg.

In this emerging landscape, manufacturing is no longer a neutral economic function. It has become a sovereign instrument of national strategy. Technologies once treated as commercial commodities – semiconductors, AI infrastructure, advanced robotics – are now governed by export controls, investment restrictions, and knowledge firewalls. National security is no longer peripheral to industrial policy. It is its organizing principle. Coordination platforms and optimization algorithms, hallmarks of the SharedMfg vision, are now subordinate to the imperatives of defense, autonomy, and ideological alignment.

These trends coincide with a broader shift in global economic gravity. The traditional industrial centers of the transatlantic world are ceding influence to the Asia-Pacific region. Simultaneously, new industrial frontiers are emerging: the space economy, with its lunar and asteroid mining prospects, and the Arctic, with its untapped corridors of energy and mineral wealth. In each case, sovereignty over resources, not mere access to platforms, will define the contours of manufacturing possibility.

Moreover, the rise of strategic manufacturing blocs may be anticipated: inward-facing, ideologically aligned, and structurally insulated. Within such blocs, SharedMfg becomes untenable. It's lying logic – resource pooling,

modular access, cross-border trust – fragments under the pressures of national interest and strategic autonomy. As in Orwell's imagined superstates [49], the economy becomes a function of political identity, and manufacturing follows suit.

Thus, what emerges is not a pyramid of coordination crowned by digital elegance, but a structure inverted by necessity, where the weight of real materials, energies, and institutions presses against idealized abstractions from below.

Our central claim may now be stated plainly: manufacturing does not evolve – it is allowed to evolve. And what grants that permission is not efficiency, but order – an order shaped by power, politics, and the contours of ever-competing geopolitical ambitions and designs.

Absent this recognition, models like SharedMfg risk becoming elegant solutions to problems the world no longer permits. The way forward lies not in universalizing abstraction, but in contextual humility – grounding any theory of manufacturing in the realities of matter, energy, and the institutions that govern them.

History offers us repeated reminders that progress, whether in science, technology, or production, is rarely continuous. In physics, the rise of quantum mechanics shattered classical assumptions of smooth causality, revealing that nature often proceeds through discrete jumps rather than gradual flows [68, 69]. In economics, Schumpeter [70] argued that technological change arrives in non-congruent waves, driven by innovation bursts and the creative destruction of prior industrial logics. In epistemology, Kuhn famously demonstrated that scientific advancement is not a linear accumulation of knowledge, but a series of paradigm shifts that redefine what questions are even thinkable within a given era [71].

Manufacturing, viewed in this light, is not an exception to these patterns – it is an expression of them. It unfolds not as an ever-improving human endeavor but as a continuum punctuated by distinct paradigms, each aligned with the institutional, technological, and geopolitical structures of its time. From Fordism to lean production, from digital platforms to sovereign industrial architectures, manufacturing has repeatedly redefined itself in accordance with external forces rather than intrinsic logic.

This recontextualization invites a new posture for the manufacturing engineer. No longer a neutral optimizer on a monolithic path to perfection, the contemporary engineer must instead become a student of paradigms; a practitioner who understands when a method belongs to an era, and when to adapt. Not a conductor of a fixed orchestra, but a session musician of paradigms: technically versatile, attuned to changing key signatures, and capable of contributing harmoniously across arrangements without presuming to control them.

This reconceptualization has implications beyond engineering practice – it also challenges the institutions that educate and accredit engineers. If manufacturing unfolds through paradigmatic shifts rather than linear optimization, then the traditional curricula that emphasize stability, predictability, and closed-form solutions may be insufficient. Accordingly, the pedagogies and institutions that shape engineers must also evolve – not as neutral disseminators of technical skill, but as forums for paradigm literacy, geopolitical awareness, and adaptive strategic reasoning. To prepare engineers for a world shaped as much by geopolitical shifts as by technical constraints, we must equip them not merely with tools, but with sensibilities: to recognize when a paradigm ends, and to act skillfully in the interregnum before the next begins.

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The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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References

[1] Eckhardt, G. M. and Bardhi, F., *The sharing economy isn't about sharing at all*, 2015 https://hbr.org/2015/01/the-sharing-economy-isnt-about-sharing-at-all, Accessed: 10.03.2025.

[2] F. Tao, Y. Cheng, L. Zhang, and A. Nee, *Advanced manufacturing systems: Socialization characteristics and trends*. Journal of Intelligent Manufacturing, 28, 1079–1094. https://doi.org/10.1007/s10845-015-1042-8, 2015.

[3] L. A. Kaushal and A. P. Anupama, *Determinants of service consumers' attitudes and behavioural intentions towards sharing economy for sustainable consumption: An emerging market perspective*, 2022. https://www.doi.org/10.1080/1097198X.2022.2062993.

[4] R. Botsman and R. Rogers, *What's Mine Is Yours: How Collaborative Consumption Is Changing the Way We Live*. New York: Harper Collins, 2010.

[5] T. Hennig-Thurau, V. Henning, and H. Sattler, *Consumer file sharing of motion pictures*. Journal of Marketing, 71(4), 1–18. [Online]. Available" https://www.marketingcenter.de/sites/mcm/files/downloads/research/lmm/literature/hennig-thurau_et_al._2007_jm_consumer_file_sharing_of_motion_pictures.pdf, 2007.

[6] Z. W. Lee, T. Chan, M. Balaji, and A. Chong, *Why people participate in the sharing economy: An empirical investigation of Uber*, 2018.

[7] C. Yu, X. Xu, S. Yu, Z. Sang, C. Yang, and X. Jiang, *Shared manufacturing in the sharing economy: Concept, definition and service operations*, 2020. https://doi.org/10.1016/j.cie.2020.106602.

[8] FLOOW2, *Floow2: The b2b sharing marketplace*, Accessed: 2025-04-19, 2025. [Online]. Available: https://www.floow2.com/.

[9] E. Duran, C. Ozturk, and B. O'Sullivan, "Planning and scheduling shared manufacturing systems: Key characteristics, current developments, and future trends," *International Journal of Production Research*, 2024. https://www.doi.org/10.1080/00207543.2024.2442549.

[10] World Trade Organization, *Anti-dumping – technical information*, Accessed: 2025-04-19, 2025. [Online]. Available: https://www.wto.org/english/tratop_e/adp_e/adp_info_e.htm.

[11] A. L. Sari, Irwandi, Gusmailina, L. Judijanto, and T. Hendarto, "The role of the world trade organization in shaping international relations and trade diplomacy," International Journal of Science and Society, vol. 6, no. 3, pp. 523–528, 2024. https://doi.org/10.54783/ijsoc.v6i3.1279. [Online]. Available: https://ijsoc.goacademica.com/index.php/ijsoc/article/view/1279.

[12] D. Ikenson, *The world trade organization: Myths vs. reality*, Accessed: 2025-04-19, 2020. [Online]. Available: https://www.cato.org/publications/world-trade-organization-myths-versus-reality.

[13] J. E. Stiglitz and A. Charlton, "Fair Trade for All: How Trade Can Promote Development," Oxford, UK: Oxford University Press, 2005, ISBN: 9780199290901.

[14] OECD, "Covid-19 and global value chains: Policy options to build more resilient production networks," *Organisation for Economic Co-operation and Development*, 2021, Accessed: 2025-04-19. [Online]. Available: https://www.oecd.org/en/publications/covid-19-and-global-value-chains-policy-options-to-build-more-resilient-production-networks_04934ef4-en.html.

[15] Penn Wharton Budget Model, "Economic effects of President Trump's tariffs," University of Pennsylvania, Tech. Rep.., 2025, Accessed: 2025-04-19. [Online]. Available: https://budgetmodel.wharton.upenn.edu/issues/2025/4/10/economic-effects-of-president-trumps-tariffs.

[16] G. Magnus, "Sky-high US–China tariffs are a mutual trade embargo that will hurt both sides," *The Guardian*, 2025, Accessed: 2025-04-19. [Online]. Available: https://www.theguardian.com/business/2025/apr/14/sky-high-us-china-tariffs-are-a-mutual-trade-embargo-that-will-hurt-both-sides.

[17] World Trade Organization, "WTO slashes 2025 trade growth forecast, warns of deeper slump," *Reuters*, 2025, Accessed: 2025-04-19. [Online]. Available: https://www.reuters.com/markets/wto-slashes-2025-trade-growth-forecast-warns-deeper-slump-2025-04-16/.

[18] Y. Varoufakis, *Technofeudalism: What Killed Capitalism*. Brooklyn, NY: Melville House, 2023, ISBN: 1685891241.

[19] N. Srnicek, *Platform Capitalism*. Cambridge, UK: Polity Press, 2017, ISBN: 9781509504879.

[20] K. Lobosco, "Biden finalizes increases to some of Trump's China tariffs," *CNN*, 2024, Accessed: 2025-04-19. [Online]. Available: https://www.cnn.com/2024/09/13/politics/china-tariffs-biden-trump/index.html.

[21] E. Buchwald, "China and Canada immediately retaliate against Trump's tariffs," *CNN*, 2025, Accessed: 2025-04-19. [Online]. Available: https://www.cnn.com/2025/03/04/economy/trade-mexico-canada-china-tariffs-trump-hnk-intl/index.html.

[22] Financial Times, "EU presses ahead with tariffs on Chinese electric vehicles," *Financial Times*, 2024, Accessed: 2025-04-19. [Online]. Available: https://www.ft.com/content/c8e27f70-358b-48ea-a23e-3100319af459.

[23] Encyclopædia Britannica, "Smoot-Hawley Tariff Act," *Encyclopædia Britannica*, 2025, Accessed: 2025-04-19. [Online]. Available: https://www.britannica.com/event/Smoot-Hawley-Tariff-Act.

[24] R. Schneid, *Why economists are horrified by Trump's tariff math*, Accessed: 2025-04-19, 2025. [Online]. Available: https://time.com/7274651/why-economists-are-horrified-by-trump-tariff-math/.

[25] United States Congress, *Chips and science act of 2022*, https://www.congress.gov/bill/117th-congress/house-bill/4346, Accessed: 2025-04-19, 2022.

[26] European Commission, *European chips act*, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-chips-act_en, Accessed: 2025-04-19, 2023.

[27] J. L, *Lithium is driving the EV boom: Demand to quadruple by 2030*, Accessed: 2025-04-19, 2023. [Online]. Available: https://carboncredits.com/lithium-is-driving-the-ev-boom-demand-to-quadruple-by-2030/.

[28] A. Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations*. London: W. Strahan and T. Cadell, 1776.

[29] B. Erling, "Hegseth tells Europe to spend on defense, warns us presence may not be forever," *Reuters*, 2025, Accessed: 2025-04-20. [Online]. Available: https://www.reuters.com/world/europe/hegseth-tells-europe-spend-defence-us-presence-continent-may-not-be-forever-2025-02-14/.

[30] H. Dixon, "What to do about the EU's relative decline," *Reuters*, 2024, Accessed: 2025-04-20. [Online]. Available: https://www.reuters.com/breakingviews/what-do-about-eus-relative-decline-2024-04-22/.

[31] C. Johnson, *MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925–1975*. Stanford

University Press, 1982.

[32] W. E. Deming, *Out of the Crisis*. MIT Press, 1986.

[33] G. Taguchi, *System of Experimental Design*. UNIPUB/Kraus International, 1987.

[34] T. Ohno, *Toyota Production System: Beyond Large-Scale Production*. Productivity Press, 1988.

[35] Office of Governor Gavin Newsom, California is now the 4th largest economy in the world, https://www.gov.ca.gov/2025/04/23/california-is-now-the-4th-largest-economy-in-the-world/, Accessed: 2025-05-18, Apr. 2025.

[36] B. Smith, "Six sigma: A quality improvement strategy," *Motorola University*, 1986, Accessed: 2025-04-20.

[37] G. Eckes, *The Six Sigma Revolution: How General Electric and Others Turned Process into Profits*. John Wiley & Sons, 2001.

[38] A. Francis, "Case study of General Electric: Six sigma implementation," *MBA Knowledge Base*, 2024, Accessed: 2025-04-20. [Online]. Available: https://www.mbaknol.com/management case-studies/case-study-of-general-electric-six-sigma-implementation/.

[39] NASA, "In-space manufacturing (ism)," NASA, Tech. Rep., 2023, Accessed: 2025-04-20. [Online]. Available: https://ntrs.nasa.gov/api/citations/20230013381/downloads/ISM%20Brochure%2020230913.pdf.

[40] European Space Agency, *Off-earth manufacturing: Using local resources to build a new home*, Accessed: 2025-04-20, 2023. [Online]. Available: https://www.esa.int/Enabling_Support/Preparing_for_the_Future/Discovery_and_Preparation/Off-Earth_manufacturing_using_local_resources_to_build_a_new_home.

[41] A. H. Lynch and C. H. Norchi, "Melting arctic ice could transform international shipping routes," *Proceedings of the National Academy of Sciences*, 2022, Accessed: 2025-04-20. [On line]. Available: https://www.brown.edu/news/2022-06-22/arctic.

[42] M. Bradley, "Melting arctic to open up new trade routes and geopolitical flashpoints," *Bradley Arant Boult Cummings LLP*, 2023, Accessed: 2025-04-20. [Online]. Available: https://www.bradley.com/insights/publications/2023/08/melting-arctic-to-open-up-new-trade-routes-and-geopolitical-flashpoints.

[43] Arctic Ocean Conference, Ilulissat declaration, Adopted at the Arctic Ocean Conference,

Ilulissat, Greenland, 27–29 May 2008, May 2008. [Online]. Available: https://arcticportal.org/images/stories/pdf/Ilulissat-declaration.pdf.

[44] G. Friesen, "Why Trump wants Greenland and Canada: Strategic and economic goals," *Forbes*, 2025, Accessed: 2025-04-20. [Online]. Available: https://www.forbes.com/sites/garthfriesen/2025/01/26/why-trump-wants-greenland-and-canada-strategic-and-economic-goals/.

[45] The Arctic Institute, "Greenland during Trump 2.0: Is America poised for an historic arctic territorial expansion?" *The Arctic Institute*, 2025, Accessed: 2025-04-20. [Online]. Available: https://www.thearcticinstitute.org/greenland-during-trump-2-0-america-poised-historic-arctic-territorial-expansion/.

[46] A. Cainey and C. Prange, Xiconomics: What China's Dual Circulation Strategy Means for Global Business. Agenda Publishing, 2023.

[47] S. Bhardwaj and S. Sharma, "Role of atmanirbhar bharat abhiyan in transforming the indian economy:

An explorative study," *International Journal of Financial Management and Eco nomics*, vol. 7, no. 1, pp. 344–352, 2024, Accessed: 2025-04-20. [Online]. Available: https://www.theeconomicsjournal.com/article/view/312/7-1-88.

[48] "Galileo satellite navigation system: Space applications on earth," European Parliamentary Research Service, Tech. Rep. PE 614.560, 2018, Accessed May 2025. [Online]. Available: https://www.europarl.europa.eu/RegData/etudes/STUD/2018/614560/EPRS_STU(2018)614560_EN.pdf

[49] G. Orwell, *Nineteen Eighty-Four*. London: Secker & Warburg, 1949.

[50] B. M. Hoekman and M. M. Kostecki, *The Political Economy of the World Trading System: WTO and Beyond*, 3rd. Oxford, UK: Oxford University Press, 2009, ISBN: 9780199553761.

[51] G. J. Ikenberry, *After Victory: Institutions, Strategic Restraint, and the Rebuilding of Order after Major Wars*. Princeton, NJ: Princeton University Press, 2000, ISBN: 9780691050911.

[52] V. Vivoda and R. Matthews, "Friend-shoring" as a panacea to western critical mineral supply chain vulnerabilities," *Mineral Economics*, vol. 37, no. 3, pp. 463–476, 2024. https://www.doi.org/10.1007/s13563-023-00402-1.

[53] R. Baldwin and M. Kawai, *Multilateralizing Regionalism: Challenges for the Global Trading System*. Cambridge, UK: Cambridge University Press, 2013, ISBN: 9781107033363.

[54] C. Jiang et al., "Rethinking development and major research plans of industrial internet in China," *Fundamental Research*, vol. 4, no. 1, pp. 3–7, 2024, ISSN: 2667-3258. https://doi.org/10.1016/j.fmre.2023.06.017.

[55] European Central Bank, *ECB joins European data and cloud network initiative*, https://www.ecb.europa.eu/press/pr/date/2022/html/ecb.pr221117~78120d41f0.en.html, Accessed: 2025-05-06, 2022.

[56] "Meeting of the council at ministerial level: Enhancing the contributions of SMEs in a global and digitalised economy," Organisation for Economic Co-operation and Development (OECD), Paris, Tech. Rep. C/MIN(2017)8, 2017, Presented at the OECD Council at Ministerial Level, 7–8 June 2017. [Online]. Available: https://one.oecd.org/document/C/MIN(2017)8/en/pdf.

[57] G. P. Pisano and W. C. Shih, "Restoring American competitiveness," *Harvard Business Review*, vol. 87, no. 7-8, pp. 114–125, 2009. [Online]. Available: https://hbr.org/2009/07/restoring-american-competitiveness.

[58] D. Bailey and L. De Propris, "Manufacturing reshoring and its limits: The uk automotive case," *Cambridge Journal of Regions, Economy and Society*, vol. 7, no. 3, pp. 379–395, Sep. 2014, issn: 1752-1378. https://www.doi.org/10.1093/cjres/rsu019.

[59] M. Mosaad, S. Benoit, and C. Jayawardhena, *The dark side of the sharing economy: A systematic literature review of externalities and their regulation*, Nov. 2023.

[60] D. Rodrik, "Industrial policy for the twenty-first century," Harvard Kennedy School, Working Paper RWP04-047, 2004. [Online]. Available: https://drodrik.scholar.harvard.edu/publications/industrial-policy-twenty-first-century.

[61] H. Farrell and A. L. Newman, "Weaponized interdependence: How global economic networks shape state coercion," *International Security*, vol. 44, no. 1, pp. 42–79, Jul. 2019, issn: 0162-2889. https://www.doi.org/10.1162/isec_a_00351.

[62] S. J. Evenett and J. Fritz, "Going it alone? trade policy after three years of populism," Tech. Rep.., 2019, Accessed: 2025-05-06. [Online]. Available: https://www.wita.org/atp research/going-it-alone-trade-

policy-after-three-years-of-populism/.

[63] P. Aghion, N. Bloom, R. Blundell, R. Griffith, and P. Howitt, "Competition and innovation: An inverted-u relationship," *The Quarterly Journal of Economics*, vol. 120, no. 2, pp. 701– 728, 2005. https://www.doi.org/10.1093/qje/120.2.701.

[64] E. Helleiner, "Economic nationalism as a challenge to economic liberalism? lessons from the 19th century," *International Studies Quarterly*, vol. 46, no. 3, pp. 307–329, Dec. 2002, issn: 0020-8833. https://www.doi.org/10.1111/1468-2478.00235.

[65] B. Eichengreen and D. A. Irwin, "The slide to protectionism in the great depression: Who succumbed and why?" *The Journal of Economic History*, vol. 70, no. 4, pp. 871–897, 2010. https://www.doi.org/10.1017/S0022050710000756.

[66] R. Baldwin, *The Great Convergence: Information Technology and the New Globalization*. Cambridge, MA: Harvard University Press, 2016, ISBN: 9780674660489.

[67] D. Rodrik, *One Economics, Many Recipes: Globalization, Institutions, and Economic Growth*. Princeton, NJ: Princeton University Press, 2007, ISBN: 9780691129518.

[68] M. Planck, "On the law of distribution of energy in the normal spectrum," *Annalen der Physik*, vol. 4, pp. 553–563, 1901, English translation available in Planck's collected works. [Online]. Available: https://strangepaths.com/files/planck1901.pdf.

[69] N. Bohr, "On the constitution of atoms and molecules," *Philosophical Magazine*, vol. 26, no. 151, pp. 1–25, 1913. https://www.doi.org/10.1080/14786441308634955.

[70] J. A. Schumpeter, *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*. New York, NY: McGraw-Hill, 1939, ISBN: 1578985560.

[71] T. S. Kuhn, *The Structure of Scientific Revolutions*, 1st. Chicago, IL: University of Chicago Press, 1962, ISBN: 9780226458120.