CIRANO
Knowledge into action

NOT EFFICIENT, NOT OPTIMAL: THE BIASES THAT BUILT GLOBAL TRADE AND THE DATA TOOLS THAT COULD FIX IT

THIERRY WARIN

CS
2025s-17
WORKING PAPER

ISSN 2292-0838 (online version)

Not Efficient, Not Optimal: The Biases That Built Global Trade and the Data Tools That Could Fix It

Thierry Warin[*]

Abstract/Résumé

In the aftermath of renewed trade tensions and geopolitical realignments—exemplified by the 2025 trade war under President Trump 2.0—the dominant policy discourse posits that globalization went "too far," sacrificing resilience and national security at the altar of cost efficiency. This paper challenges that narrative by unpacking the implicit assumptions that undergird it, notably the belief that global trade and value chains were ever efficient in the first place. Drawing on international business literature, economic geography, and trade theory, we argue that global supply chains, far from representing optimal configurations, were largely shaped by bounded rationality, cognitive biases, and incomplete information—what we term the streetlight post bias. Contrary to the Heckscher-Ohlin-Samuelson model's idealized vision, firm-level decisions rarely reflect first-best equilibria; instead, trade patterns have followed the more constrained logic of the gravity model and regional familiarity. The paper contends that neither globalization nor its retrenchment (via reshoring, nearshoring, or friend-shoring) guarantees a move toward a more resilient or efficient trade architecture. Instead, both may reflect alternative second-best equilibria. We propose a forward-looking framework in which big data analytics and machine learning—grounded in an economic geography perspective—can help firms and policymakers identify robust, diversified, and efficient global value chain configurations. By addressing information asymmetries and reducing decision-making bias, such tools offer a path toward a closer approximation of the first-best equilibrium. We conclude with implications for trade policy, calling for evidence-based interventions that move beyond reactive deglobalization toward intelligent, data-driven integration.

À la suite du regain des tensions commerciales et des réajustements géopolitiques — illustrés par la guerre commerciale de 2025 sous la présidence de Trump 2.0 — le discours dominant en matière de politique commerciale soutient que la mondialisation est allée « trop loin », sacrifiant la résilience et la sécurité nationale sur l'autel de l'efficacité économique. Cet article remet en question ce récit en déconstruisant les hypothèses implicites qui le sous-tendent, notamment la croyance selon laquelle le commerce mondial et les chaînes de valeur sont efficients. En mobilisant les littératures en affaires internationales, géographie économique et théorie du commerce international, nous soutenons que les chaînes d'approvisionnement mondiales, loin d'incarner des configurations optimales, ont été largement façonnées par la rationalité limitée, les biais cognitifs et l'information incomplète — ce que nous appelons le biais du réverbère. Contrairement à la vision idéalisée du modèle d'Heckscher-Ohlin-Samuelson, les décisions prises au niveau des entreprises reflètent rarement un équilibre de premier rang ; au contraire, les flux commerciaux suivent plutôt la logique contrainte du

[*] PhD HEC Montreal

modèle gravitaire et d'une familiarité régionale. L'article soutient que ni la mondialisation ni sa remise en cause (via la relocalisation, la régionalisation ou le « friend-shoring ») ne garantissent une architecture commerciale plus résiliente ou plus efficiente. Ces dynamiques pourraient au contraire représenter des équilibres alternatifs de second rang. Nous proposons un cadre prospectif dans lequel l'analyse des mégadonnées (big data) et l'apprentissage automatique (machine learning) — ancrés dans une perspective de géographie économique — peuvent aider les entreprises et les décideurs à concevoir des chaînes de valeur mondiales à la fois robustes, diversifiées et efficientes. En réduisant les asymétries d'information et les biais décisionnels, ces outils ouvrent la voie à une approximation plus précise de l'équilibre de premier rang. Nous concluons par des implications en matière de politique commerciale, plaidant pour des interventions fondées sur les données probantes, allant au-delà d'une démondialisation réactive vers une intégration intelligente et pilotée par les données.

Keywords/Mots-clés: Global Value Chains, Trade Efficiency, Streetlight Effect, Machine Learning, Supply Chain Resilience / Chaînes de valeur mondiales, Efficacité du commerce, Effet du réverbère, Apprentissage automatique, Résilience des chaînes d'approvisionnement

Pour citer ce document / To quote this document

Warin, T. (2025). Not Efficient, Not Optimal: The Biases That Built Global Trade and the Data Tools That Could Fix It* (2025s-17, Cahiers scientifiques, CIRANO.) https://doi.org/10.54932/ZIHS7852

1 Introduction

In 2025, globalization and trade policy are at a crossroads. The renewed trade war under the "Trump 2.0" presidency – marked by tariffs, technology export bans, and a renegotiated NAFTA (now **CUSMA/USMCA**) – has fueled debates about supply chain resilience and the securitization of trade. Policymakers and pundits argue that "globalization went too far" in chasing cost efficiency, creating fragile supply networks vulnerable to pandemics, geopolitical conflict, and protectionist turns. Stories abound in the media: for example, the U.S.–China tariff skirmishes that disrupted manufacturing plans, Europe's scramble to replace Russian gas in 2022, and critical shortages of medical gear during COVID-19 lockdowns. These events have spotlighted how deeply intertwined – and at times **weaponized** – global trade has become. The notion of trade as a benign avenue for mutual gain is being challenged by a new reality in which interdependence can be turned into leverage or liability. As a result, concepts like **supply chain resilience**, **"friend-shoring"**, and **economic security** have moved to the center of policy debates.

Yet, a closer examination reveals that many assumptions driving this debate are questionable. A core implicit assumption is that pre-2020 globalization was **efficient** – that is, firms optimally spread production to the lowest-cost locations worldwide, achieving a first-best allocation of resources. This assumption underlies claims that globalization "went too far," implying that hyper-optimized global supply chains traded off too much resilience for efficiency. However, **did global trade truly reach an optimal, efficient equilibrium?** In practice, trade patterns have never fully matched the textbook ideals of classical trade theory. Countries do not literally trade with each other – **firms do**. As Michael Porter famously observed, "it is the firms, not nations, which compete in international markets". Goods cross borders because companies decide to source, invest, or sell abroad, and those decisions are often driven by bounded rationality, incomplete information, or simple heuristics rather than exhaustive global optimization. Many firms expand internationally only gradually and prefer familiar markets, reflecting the well-known gravity model of trade (where distance and familiarity heavily constrain trade flows). Indeed, despite decades of falling trade costs, globalization has remained "relatively shallow and strongly constrained by distance," not the seamless world of the Heckscher-Ohlin first-best model. Empirical studies confirm that most multinational enterprises (MNEs) are far from globally dispersed; the majority earn ~80% of their sales in their home regions, indicating a strong regional bias in global business. In short, **trade never went as "far" or as optimally as popular narratives assume**.

If the premise of perfectly efficient globalization is flawed, then so is the conclusion that retrenchment (via reshoring or friend-shoring) will automatically improve outcomes. There is an emerging risk that by responding to perceived over-globalization, firms and governments may simply swap one set of second-best configurations for another. For example, moving production from a low-cost distant country to a nearer but higher-cost partner might reduce certain risks, yet it could increase costs or introduce new vulnerabilities, keeping the system in a suboptimal "third-best" equilibrium. Recent evidence suggests that U.S. importers, faced with tariffs and geopolitical tensions, have shifted sourcing from China to countries like Mexico, Vietnam, and

India, **rather than bringing manufacturing fully back home**. Mexico even surpassed China as the United States' top supplier in 2023, illustrating a reallocation of global value chains rather than wholesale de-globalization. This reallocation is often driven by the same **streetlight effect** bias as before – firms go where information and networks are readily available (e.g. neighbor countries or known partners) instead of scouting all possible locations. Thus, the current wave of nearshoring may **not** lead us closer to a theoretically efficient outcome; it may simply reflect a different compromise between cost, risk, and convenience, reached under political pressure and uncertainty.

Research Question: In light of these observations, this paper asks: **How can global supply chains be designed to achieve a truly efficient (first-best) allocation of production, given the realities of firm decision-making biases and the new imperatives of resilience and security?** We explore whether the present paradigm shift – from an efficiency-focused globalization to a resilience/security-focused regionalization – actually addresses the underlying inefficiencies in global supply chains, or whether it perpetuates suboptimal outcomes. Moreover, we investigate a forward-looking proposition: that leveraging **big data analytics and machine learning (ML)** in an economic geography context could enable firms and policymakers to identify better supply chain configurations, potentially moving closer to a Pareto-optimal global distribution of production and sourcing. In essence, if human decision-makers have historically settled for "second-best" supply chain choices due to limited information and biases, could data-driven optimization help achieve a more efficient yet also resilient global network?

Research Gaps: Several gaps in the literature motivate this inquiry. First, international trade theory and policy discussions often assume nation-level efficiency (e.g. comparative advantage fully realized), overlooking firm-level heterogeneity and decision biases. The implicit assumption that what was globally optimal did occur is challenged by evidence from international business (IB) research and trade data – a gap exists between theoretical optimum and actual firm behavior that needs to be bridged. Second, while there is a burgeoning discourse on supply chain resilience and security, much of it assumes a trade-off where efficiency must be sacrificed. We find an emerging counter-literature suggesting that efficiency and resilience are not necessarily incompatible (e.g. Miroudot & co-authors dispel myths that lean or global supply chains are inherently fragile). This opens a gap in understanding how to **simultaneously** improve efficiency and resilience, rather than trading one for the other. Third, the potential of advanced analytics (big data, AI/ML) to transform global supply chain decision-making is underexplored in both IB and trade policy literature. Operations research and supply chain management studies hint at the benefits of AI for forecasting and optimization, but these insights have not yet been fully integrated into the global trade policy or IB strategy domain. This paper aims to synthesize these domains – trade theory, IB insights on firm behavior, supply chain risk management, and data science – to address the question of what a first-best global supply chain equilibrium might look like and how we might approach it.

In the sections that follow, we first review relevant literature streams: classical trade efficiency vs. real-world trade patterns, firm-level decision processes in globalization, and recent work on resilience, security, and the "weaponization" of interdependence. We then discuss why neither the hyper-globalized nor the de-globalized extreme delivers a Pareto-optimal outcome, given practical constraints. Finally, we present a conceptual discussion on harnessing big data and ML to improve global supply chain design, and derive **policy implications**. In doing so, we emphasize the often implicit assumptions scholars and policymakers have made – such as equating national trade balances with firm competitiveness, or assuming that more localization equals more security – and we argue for evidence-based, analytical approaches to global value chain optimization. The conclusion highlights key insights and offers policy recommendations, stressing that **efficiency, resilience, and security are distinct goals** and that a smarter balance through data-driven strategy is needed for future global trade policy.

2 Trade Efficiency: Theory vs. Reality

2.1 The First-Best Ideal in Trade Theory

Classical trade economics—particularly the Ricardian and Heckscher–Ohlin–Samuelson (H-O-S) models—posits that countries can achieve a Pareto-optimal allocation of production by specializing according to comparative advantage and engaging in free trade. In these models, countries are treated as homogeneous agents, and factors of production move costlessly within countries, though not across them. Free trade is expected to equalize factor prices and maximize global efficiency, with no feasible reallocation of production improving welfare for all actors involved (Antràs & Chor, 2018; Subramanian & Wei, 2007). This elegant view underpins the canonical argument that trade liberalization raises global welfare and that barriers to trade are inherently distortionary.

2.2 Deviations in Practice

However, actual trade patterns have rarely matched this first-best ideal. One key reason is the persistence of **trade costs and frictions**, which classical theory typically abstracts away. These include not only tariffs and non-tariff barriers but also geographic, cultural, informational, and institutional hurdles. For example, **distance** remains a powerful deterrent to trade. The empirical **gravity model**, widely validated in the literature, shows that bilateral trade is strongly proportional to countries' economic sizes and inversely related to the distance between them (Head & Mayer, 2014; Anderson & van Wincoop, 2004). Despite major advances in communication and transport technology, meta-estimates place the elasticity of trade with respect to distance at about –0.9, implying that a 10% increase in distance reduces trade by roughly 9% (Head & Mayer, 2014).

This underscores Pankaj Ghemawat's (2007, 2016) concept of **"semiglobalization"**, in which cross-border economic activity remains limited. He finds that most globalization metrics—whether trade-to-GDP ratios, foreign direct investment (FDI), or cross-border internet traffic—hover in the 10% to 30% range, rather than approaching full integration. Even between close trade partners, significant barriers persist. McCallum (1995) famously found that Canadian provinces traded **22**

times more with each other than with equally distant U.S. states. More recent studies, including within the European Union, continue to find substantial intra-national trade bias (Ghemawat, 2017).

In practice, **geographic proximity, historical ties, and cultural familiarity** often override theoretical cost-efficiency when firms choose trade partners. The resulting flows reflect second-best equilibria: real-world trade is shaped by frictions that distort or suppress the gains predicted by theory.

This also applies to firm behavior. Multinational enterprises (MNEs)—the dominant actors in global value chains (GVCs) (Buckley & Casson, 2003)—have shown a persistent tendency toward **regionalism** rather than global dispersion. Rugman and Verbeke (2004) found that roughly 80% of Fortune 500 firms' revenues came from their home regions (North America, Europe, or Asia), with only a small minority achieving balanced global coverage. Updated analyses show some increase in globally integrated firms, but most large MNEs remain strongly regional in structure (Warin, 2025). This suggests that factors like **transaction costs, bounded rationality, and risk aversion** play a greater role in shaping trade patterns than economic theory assumes.

2.3 The Myth of Hyperglobalization

A related narrative—especially post-2008 and during the COVID-19 era—is that globalization "went too far," producing overly lean, fragile, and geographically extended supply chains. This "hyperglobalization" view holds that firms chased the lowest possible input costs worldwide, sacrificing resilience and redundancy in the process.

Yet the empirical record shows that **globalization never reached the theoretical frontier**. While world trade expanded significantly between the 1990s and early 2000s, the global trade-to-GDP ratio plateaued by the early 2010s—a period now referred to as "slowbalization" (Ghemawat, 2017). Global trade flows have remained flat or grown sluggishly relative to GDP in the last decade. Indeed, the **"Factory Asia," "Factory Europe," and "Factory North America"** models—used to describe regional trade clusters—indicate that globalization advanced through **regional integration**, not global dispersion (Antràs & Chor, 2021).

Offshoring did occur during the 1990s–2000s, especially to China, but not to all possible low-cost destinations. Firms followed **path-dependent and incremental** strategies: they offshored within known regions, relying on countries with established supply networks and stable logistics. Agglomeration economies and sunk investments in infrastructure further anchored production hubs. In short, global value chains expanded but did so **selectively** and were shaped by pragmatic and historical constraints—not by a comprehensive, cost-minimizing strategy.

2.4 Efficiency vs. Resilience – Emerging Evidence

The pandemic has reignited concerns that global supply chains are overly **fragile**. Critics argue that **just-in-time (JIT)** and globally dispersed production systems created "brittle" trade architectures that snapped under pressure. Consequently, terms like **reshoring**, **friend-shoring**, and **supply**

chain resilience have entered policy discourse. However, recent academic work challenges the assumption that **efficiency necessarily undermines resilience**.

Thakur-Weigold and Miroudot (2024) identify and critique three common myths about global supply chains: (i) That **lean systems inherently increase fragility**, (ii) That **cost-optimized supply chains are less resilient**, and (iii) That **foreign sourcing is inherently riskier than domestic sourcing**.

Their empirical analysis finds little evidence for these claims. Many efficient supply chains maintained **built-in buffers, diversification strategies**, or flexible sourcing mechanisms that enhanced resilience. Moreover, reliance on domestic sourcing can be risky if domestic shocks (e.g., pandemics, natural disasters, or political events) go unhedged. In several industries, globally distributed supply chains provided valuable redundancy that helped mitigate disruptions (Thakur-Weigold & Miroudot, 2024).

This research urges a **nuanced** approach to resilience: rather than assuming a binary trade-off between efficiency and stability, firms and policymakers should **measure risk-adjusted efficiency**, promote **multi-sourcing**, and invest in **data transparency and predictive analytics**. As GVCs become more digitized, these tools offer the potential to enhance both efficiency and resilience—rendering the presumed trade-off less relevant.

Global trade patterns have been shaped by complex constraints and behavioral dynamics that deviate from classical theoretical expectations. Trade has expanded, but not to its optimal frontier; efficiency gains have been **partial**, and vulnerabilities have not always been where theory predicted. Calls to roll back globalization must therefore be carefully scrutinized. Rather than reacting to crises with deglobalization, the real opportunity lies in **correcting second-best configurations** through better tools, smarter diversification, and evidence-based international business policy.

3 Firms, Not Countries: How Businesses Shape (and Limit) Globalization

It is essential to refocus the unit of analysis from nations to **firms** when examining trade and supply chains. Countries set the stage through policies and agreements, but it is companies that make the key decisions on what to source from where, where to locate a factory, and how to manage suppliers. As Paul Krugman famously noted, "countries do not compete with each other the way corporations do" – in trade, **"countries do not buy or sell goods overseas; companies do"** (Krugman, 1994). Indeed, contemporary trade research emphasizes firms as the primary actors in global commerce. This section explores how firm-level behavior and decision-making often lead to **suboptimal global configurations**, helping to explain why trade hasn't reached the theoretical ideal of frictionless optimization.

3.1 Heterogeneity of Firms in Trade

A major insight of the "new new trade theory" is that only a subset of firms engage in exporting – typically those that are the most productive (Melitz, 2003). In any given industry, a few large firms account for a disproportionate share of export volume, while many smaller firms serve only the domestic market. Empirical studies confirm this heterogeneity: for example, in the United States, barely one-fifth of manufacturing firms export at all (Bernard et al., 2007). In some sectors (e.g. printing or furniture), **less than 10% of firms are exporters**. Exporting entails significant fixed costs (establishing distribution networks, adapting products, complying with foreign regulations, etc.), so most firms won't bother unless they have a substantial competitive advantage. This **selection effect** means that "national" exports are often the work of a relatively small number of companies. Therefore, when we say "China exports electronics to the U.S.," we are in fact describing the actions of specific firms (some Chinese, some foreign multinationals operating in China). Each firm's strategy – driven by its own productivity, profit motives, and managerial outlook – feeds into the aggregate trade flow. A corollary is that trade patterns can be heavily influenced by a handful of "superstar" exporters. Research across many countries finds that a small group of top firms often accounts for a majority of export value (Freund & Pierola, 2015). In other words, exports are **highly concentrated**: for instance, the largest 1% of exporting firms commonly generate well over half of a nation's exports (Gaubert & Itskhoki, 2021). Such granularity implies that country-level comparative advantage can partly reflect the successes or failures of individual firms (Gaubert & Itskhoki, 2021). "National" trade outcomes thus hinge on firm-level dynamics, not just country traits.

3.2 Bounded Rationality and Heuristics in Location Decisions

Unlike the omniscient social planner in economic models, business leaders make decisions with **bounded rationality** (Simon, 1955). They face uncertainty, incomplete information, and time constraints, which means they do not survey every possible option or foresee every contingency. Instead, firms often rely on heuristics – mental shortcuts and rules of thumb – when deciding where to expand or whom to partner with internationally. This can lead to a "streetlight effect": companies look for opportunities in places that are already well-lit (familiar, frequently discussed, easier to analyze) rather than exhaustively searching the globe. For example, a mid-sized U.S. manufacturer pondering offshoring might consider only a short list of popular locations (perhaps Mexico, China, or one other country) based on where its industry peers have gone or a cursory cost analysis. It is unlikely to evaluate every country that could potentially host its production. In many cases, managers choose "satisficing" options rather than fully optimizing – they stop at a location that seems "good enough" rather than finding the absolute best (Simon, 1955). This aligns with theories of incremental internationalization like the Uppsala model, which posits that firms expand first to countries with lower "psychic distance" (similar language, culture, or geographic proximity) and only later, if ever, venture further afield as they gain experience (Johanson & Vahlne, 1977). In practice, a company's first foreign factory is often in a neighboring or culturally similar country (e.g. a U.S. firm choosing Canada or Mexico; a Japanese firm choosing Thailand or Vietnam), reflecting a cautious, stepwise expansion rather than a global optimization of costs.

Recent studies in international business highlight specific **cognitive biases** that affect foreign market entry and expansion decisions. Kocoglu and Mithani (2024) outline how overconfidence, anchoring, confirmation bias, and other heuristics can lead to flawed assessments of foreign opportunities. For instance, overconfidence may cause executives to underestimate the costs or challenges of entering a new country, while anchoring bias might make them cling to initial impressions of a location even as new information emerges. **Availability bias** – relying on readily available information – means a manager might expand to a country they've heard a lot about (or where the company already has some presence) rather than a perhaps better-suited country that receives less attention. These biases collectively result in imperfect location choices. An illustrative anecdote is how several Western retailers expanding to China in the 2000s failed to anticipate local consumer behavior and regulatory nuances, leading to costly exits; in hindsight, many had expanded due to a herd mentality ("everyone needs to be in China") rather than a sober analysis. Their decision processes were rife with cognitive shortcuts and peer influence, rather than objective evaluation – a clear case of bounded rationality in action (Kocoglu & Mithani, 2024).

3.3 Regional Bias and the Gravity of Information

In addition to cognitive biases, firms face practical information and network constraints. It is easier to gather intelligence and build trust in nearby or well-connected countries. This contributes to the strong **regionalization** of multinational enterprise (MNE) activities noted earlier. Many corporations expand internationally in a geographically concentric pattern, rather than scattering operations purely according to cost minimization. International business scholars Rugman and Verbeke have documented the dominance of **"regional multinationals"** – the typical Fortune 500 firm, while present in many countries, still concentrates the majority of its sales and operations within its home region of the triad (North America, Europe, or Asia-Pacific) (Rugman & Verbeke, 2004). In their analysis of large MNEs, roughly 80% of the average firm's sales remained in its home region (Rugman & Verbeke, 2004), underscoring that few firms are truly global in a balanced sense. Firms expanding abroad often prefer culturally or geographically proximate markets because the **liability of foreignness** – the inherent disadvantages a company faces when operating in an unfamiliar country – is lower in locales that are similar to home or easier to access (Zaheer, 1995). In practical terms, this means a U.S. firm is far more likely to set up its first overseas plant in Canada or Mexico (leveraging the integrated NAFTA/CUSMA market) than in a distant country with very different institutions. A Japanese firm is more likely to invest in Vietnam or Thailand (within East Asia's production network) than in, say, Africa or even Europe initially. These choices are not necessarily the globally optimal cost locations; rather, they are **second-best compromises** that balance cost considerations with risk, familiarity, and convenience.

Interestingly, even global supply chain configurations often exhibit a **"hub-and-spoke"** structure rather than a far-flung dispersal to every theoretically optimal location. Many corporations set up one key production hub in each major region (e.g. a primary manufacturing base in East Asia, another in Europe, another in North America) rather than sourcing each component from whichever country has the absolute lowest labor cost or best specialization. This regional hub approach simplifies management and logistics – it reduces the complexity of coordinating across too many jurisdictions and time zones – but it may bypass some opportunities for cost savings in more remote locales. In other words, **organizational efficiency** (managing a shorter list of locations with established networks) can trump **allocative efficiency** (minimizing unit costs globally) in corporate decision-making. The strong gravitational pull of existing networks and information availability keeps firms clustered in certain regions and well-known locations. This regional bias in firm behavior mirrors the gravity model of trade, where economic interaction decays with distance, not just due to transport costs but also due to information frictions and weaker connective tissue at long distances (Head & Mayer, 2014). The outcome is a pattern of international investment and sourcing that is more regionally siloed than textbook models of a frictionless global market would predict.

3.4 Implications for Trade Efficiency

The upshot is that what we observe as "global trade" is really the aggregation of myriad firm decisions – and many of those decisions are **imperfect** from an optimizing standpoint. When economists or policymakers used to claim that global trade patterns were near-efficient (for example, that supply chains gravitated to the lowest-cost locations worldwide), they often assumed away the messy reality of corporate decision-making. In truth, there is substantial slack or **second-best suboptimality** built into the current global supply chains. This can take the form of suboptimal location choices (e.g. a company picked Country B over Country A due to managerial bias or limited search, even though Country A would have been more cost-efficient), or suboptimal sourcing diversification (e.g. a company single-sourced from one country out of inertia or simplicity, even though multi-sourcing would reduce risk without much cost increase). These inefficiencies mean there was unrealized potential in the pre-2020 global configuration – in other words, global production was not as cost-minimized or diversified as it could have been in theory. The world economy achieved a lot of globalization, but not the "first-best" outcome posited by frictionless models.

One example of **supply chain inertia** can illustrate this dynamic. Once a lead firm establishes a supplier network in a given country, it often sticks with it for a long time, because switching costs are high and managers accumulate expertise in dealing with that country. This can lock in a geographic pattern that might have made sense when first set up (say, 15 or 20 years ago) but is not re-optimized as conditions change. The global distribution of production thus may reflect **outdated decisions** and path dependence. For instance, many electronics companies continue to source a large share of components or assemble final products in China, even as wages in China have risen significantly and alternative electronics manufacturing hubs (Vietnam, Malaysia, Mexico, etc.) have become more cost-competitive. Why do they stay? Partly because the industrial ecosystem and prior investments tie them to China – there is an agglomeration of suppliers, infrastructure, and know-how in the Pearl River Delta (Shenzhen and beyond) that offers reliability and scale, which can outweigh moderate cost differences. From one perspective, this is a rational decision (leveraging an established efficient cluster), but from another perspective it suggests a lack of agility – if one were building the supply chain from scratch today, a more diversified footprint might be chosen. The longer firms delay re-optimizing, the more **lock-in** persists in global supply networks, potentially overshooting what pure cost calculus would dictate.

Firms drive trade, and they do so with bounded rationality. This reality check helps explain **why trade did not reach the "first-best"** outcome in the pre-2020 hyper-globalization era. Globalization was substantial, but it was channeled through the strategies of companies that satisfice rather than optimize across infinite possibilities. It also cautions that the current shifts toward re-shoring, "friend-shoring," and more nationally secure supply chains could likewise be driven by bounded rational thinking. Managers and political leaders may be reacting to recent shocks and political pressures with new heuristics about what constitutes "secure" or "resilient" supply, rather than conducting a truly holistic optimization of global production networks (Antràs, 2021). Just as earlier offshoring waves were not perfectly efficient, the coming rearrangements in supply chains might also entail compromises, overshooting, or miscalculations. Understanding the firm-level decision processes – with all their biases and constraints – is crucial for diagnosing where globalization's outcomes deviate from economic idealities and how future policy or strategy might improve upon the **suboptimal status quo**.

4 Resilience, Security, and the Weaponization of Supply Chains

4.1 Supply Chain Resilience

Resilience refers to a supply chain's ability to withstand shocks and recover quickly. The COVID-19 pandemic vividly exposed many fragilities – from factory shutdowns to port congestion – which vaulted resilience to the forefront of business strategy and policy. A resilient supply chain often involves building **redundancy and flexibility**, such as holding extra inventory, diversifying suppliers, arranging alternate logistics routes, or even localizing production of critical items. These measures inherently add slack and cost (contrasting with lean just-in-time efficiency), raising questions about a trade-off between cost efficiency and resilience. For example, just-in-time practices minimize inventory holding costs but leave little buffer when a disruption strikes. Intuitively, one might expect ultra-lean global supply chains to be more fragile. However, recent research challenges this simple narrative. Thakur-Weigold and Miroudot (2024) argue that the common belief that efficient (lean, globally optimized) supply chains are inherently less resilient is **not supported by evidence**. In their analysis of supply chain "myths," they find no systematic trade-off: efficiency initiatives (e.g. better supplier development, forecasting, just-in-time with smart buffers) can sometimes enhance resilience. In other words, efficiency and resilience need not be polar opposites – firms can be both efficient and resilient by investing in risk management, flexibility, and collaboration. Empirical studies show that firms with robust risk management and agile practices weather disruptions better without sacrificing long-run competitiveness.

Nevertheless, the public perception after 2020 has been that firms should trade some efficiency for resilience. Companies have responded by carrying more inventory and adding backup suppliers, and governments are scrutinizing **overreliance on single sources**. For instance, policy briefs emphasize that diversifying one's supplier base improves resilience: a firm that can easily switch to alternate suppliers during a disruption is less vulnerable. Still, the "efficiency vs. resilience" dichotomy is often overstated. As Thakur-Weigold and Miroudot note, lean supply chains were blamed for pandemic-era shortages, yet evidence suggests that well-managed global networks can be both low-cost and robust. Ultimately, resilience is about smart design – incorporating redundancy where it truly matters (e.g. strategic stockpiles of critical goods, dual sourcing for high-risk components) and flexibility everywhere else, rather than arbitrarily abandoning cost discipline.

4.2 Securitization of Supply Chains

In recent years, governments have increasingly viewed certain supply chains through a **national security** lens. This securitization of supply chains means treating access to some goods and technologies as strategic priorities, even if that conflicts with pure market logic. A prominent example was the United States invoking national security (under Section 232 of trade law) to impose tariffs on steel and aluminum imports in 2018. The rationale was that excessive dependence on foreign metal could threaten defense needs and industrial security. Similarly, the U.S. (and allies) have imposed export controls on advanced semiconductors and chipmaking equipment to rival nations (notably China) in order to protect technological advantages. In October 2022, the U.S. implemented sweeping controls to cut off China's access to cutting-edge chips, explicitly citing foreign policy and national security concerns. From China's side, the government has adopted a **"dual circulation"** strategy aimed at greater self-sufficiency in key areas – from food and energy to high-tech components. This policy is essentially a mirror image of securitization: it seeks to shield China from global volatility and external pressure by pivoting toward domestic supply. Beijing has grown acutely concerned about China's reliance on other countries for critical goods like microchips and agricultural staples, and is investing heavily to reduce those vulnerabilities.

The European Union has likewise embraced terminology of **"strategic autonomy"** and "de-risking" (as opposed to full decoupling). European leaders recognize that while completely severing trade ties with China (or other suppliers) is not viable, steps should be taken to **spread risk** and avoid single points of dependency. EU officials have explicitly stated that Europe should de-risk rather than decouple – maintaining engagement with China but reducing critical dependencies that could be exploited. For example, Europe has moved to limit Chinese vendors in 5G networks and secure alternative sources for rare earth minerals, even if that means paying higher costs. These securitization efforts accept some loss of efficiency in exchange for greater control and reliability. A vivid illustration is the global semiconductor supply chain: around 90% of the world's most advanced chips are made by TSMC in Taiwan – a single island whose geopolitical situation is precarious. This concentration is economically efficient (TSMC has huge scale and expertise) but is strategically nerve-racking. In response, the U.S. enacted the CHIPS Act in 2022, dedicating ~$52 billion in subsidies to build domestic chip fabrication capacity. The EU and Japan launched similar semiconductor initiatives. Duplicating fabs in multiple countries undoubtedly forgoes some economies of scale, raising production costs. Yet from a security standpoint, such redundancy is deemed necessary: policymakers judged that relying entirely on Taiwan for advanced chips was an unacceptable risk. Indeed, U.S. officials noted that by 2020 there was **no** leading-edge chip production on U.S. soil, meaning an interruption in Taiwan (due to conflict or blockade) could "shut off" virtually all supply of high-end chips – a scenario viewed as intolerable. Thus, policy is explicitly pushing certain supply chains toward more redundancy and geographic reconfiguration for security reasons, even at known economic cost. (The trade-off is clear: analysts warn that these moves will raise semiconductor production costs, but defenders argue it is a small "insurance premium" for national security.)

China's "dual circulation" strategy mentioned earlier underscores that securitization is a two-way street. Beijing is aiming for more domestic production of critical technologies and inputs precisely because it fears external chokeholds. Ensuring **self-reliance** in areas like semiconductors, energy, and food is seen as vital to national resilience. Likewise, India has launched "Production Linked Incentive" schemes to boost domestic manufacturing of electronics and solar panels, partly to reduce dependence on China. In sum, many governments are recalibrating globalization with security filters: encouraging domestic or allied sources for strategic supply chains (even if they're not the absolute cheapest) to mitigate the risk of coercion or cutoff in a crisis.

4.3 Weaponization of Interdependence

The term **"weaponized interdependence"** was coined by Farrell and Newman (2019) to describe how states can exploit global economic networks as tools of coercion. In a deeply interconnected world, certain countries occupy central nodes in networks – whether financial (payments systems, SWIFT), technological (standards, patents), or supply-chain hubs – and can leverage that position to **deny critical access or impose costs on adversaries**. The classic example is U.S. financial sanctions: because the U.S. dollar and banking system are so central to global finance, the U.S. can effectively cut off targeted countries (Iran, Russia, etc.) from much of the world economy by sanctioning their banks or banning them from dollar transactions. Such sanctions are a textbook case of weaponized interdependence, where the "central node" in a network exploits its position for strategic gain. Another example is China's unofficial boycott of Australian exports in 2020. After Australia called for a COVID origin investigation, Beijing imposed sweeping tariffs and import bans on Australian barley, wine, beef, coal, seafood and more – using Australia's trade reliance as a **political weapon**. In effect, China signaled that dependence on its market could become a liability in a diplomatic dispute. Likewise, Russia's abrupt curtailment of natural gas flows to Europe in 2022 (following Western support for Ukraine) was an attempt to "weaponize" Europe's heavy reliance on Russian energy. Moscow wagered that spiking gas prices and potential shortages would coerce Europe into acquiescing, or at least fracture European unity.

Farrell and Newman (2019, 2022) note that **"weak links in finance and supply chains are easily weaponized."** If a single country provides an essential component or resource, it can turn off the tap for leverage. This vulnerability has not been lost on policymakers. Analyses in 2022 called for detailed network mapping of critical supply chains to identify such chokepoints and weak links. For example, one might map that ~70% of rare earth elements are processed in China, or that a few companies in Taiwan and South Korea produce the majority of advanced logic chips. These are potential "single points of failure" that could be exploited in a conflict or diplomatic showdown. The concept of weaponized interdependence therefore adds a national-security dimension to discussions of supply chain design. It argues that what was previously seen as efficient global specialization can become a strategic vulnerability. Countries on the receiving end of such tactics have learned painful lessons: Europe's dependence on cheap Russian gas (an economically efficient outcome pre-2022) became a strategic liability when Russia squeezed supplies. In response, Europe scrambled to line up alternative suppliers – buying more pipeline gas from Norway and record volumes of LNG from the United States and Qatar – even though this meant paying far higher prices. By late 2022, the EU had slashed its reliance on Russian gas (formerly ~35% of supply) and effectively **ended Moscow's leverage** in that domain. The flip side is that Europe endured a severe energy price shock – accepting significant economic pain as the cost for escaping Russia's gas weapon. This underscores a crucial point: unfettered efficiency can lead to dangerous dependencies. It was "cheapest" for Europe to import gas from Russia, but in hindsight that came at the expense of resilience and security. Diversification of suppliers earlier on (for instance, maintaining more LNG import capacity or pipeline links to multiple countries) could have blunted Russia's coercive capacity. Diversification, in effect, is a **shield against weaponization**: no single supplier can hold you hostage if you aren't overwhelmingly dependent on any one source.

Awareness of these risks has already prompted strategies like **"friend-shoring"**, explicitly advocated by U.S. Treasury Secretary Janet Yellen in 2022. Friend-shoring means configuring supply chains to rely more on allied or friendly nations, and less on geopolitical rivals, thereby reducing the chance that trade interdependence becomes a weapon against you. For example, the U.S. is encouraging companies to invest in Vietnam, India, Mexico and other partners as alternatives to China. Meanwhile, China is seeking to deepen trade links with the Global South to mitigate the impact of Western sanctions or export controls. In practical terms, friend-shoring still leverages global efficiencies, but tries to **steer critical flows toward trusted networks**. It's a selective unwinding of globalization along geopolitical lines.

4.4 Resilience vs. Efficiency vs. Security – The Trade-offs

At face value, adding resilience and security to supply chains imposes a cost on pure efficiency. Building slack – whether through extra inventory, spare capacity, or multiple suppliers – typically means higher operating costs. Choosing a "trusted" but higher-cost source over the absolute cheapest source also raises input costs. These measures move away from the single-minded cost minimization that defined the globalization era. The key realization, however, is that **efficiency, resilience, and security are distinct objectives that do not automatically align (or conflict) in predictable ways**. A supply chain optimized purely for cost might or might not be resilient, depending on its structure (e.g. a geographically diversified low-cost chain could be quite resilient, whereas a single-source low-cost chain is brittle). It is also likely not secure if it relies on unfriendly countries for critical inputs. Conversely, a fully "secure" supply chain (e.g. complete domestic self-sufficiency in all critical goods) might be neither efficient (due to high production costs) nor resilient (a disaster at home could still wipe it out). Therefore, the real challenge is to **balance and optimize across these objectives** – finding sweet spots where efficiency is preserved as much as possible while bolstering resilience and security in targeted ways.

Scholarly literature is beginning to explore how to strike this balance. Grossman, Helpman, and Lhuillier (2023) develop a model of supply chain risk and analyze whether policy should favor diversification (multiple foreign suppliers) or reshoring to manage risk. Their finding is instructive: **subsidizing diversification of suppliers is socially optimal and often dominates outright reshoring**. The intuition is that having multiple sources – even if they are abroad – protects against disruptions more efficiently than trying to bring everything onshore. Promoting some redundancy in global sourcing (not putting "all eggs in one basket") yields greater resilience without the huge cost of autarky. In many cases, keeping a global supply base but ensuring no single supplier (or country) has a stranglehold can achieve **"secure enough" interdependence**. This aligns with the idea that we can re-tool globalization to be more resilient, rather than jettisoning it entirely. It echoes what policymakers often say: we don't want to abandon global supply chains, we just want them to be smarter and safer. For example, one pragmatic approach is to maintain global sourcing for cost efficiency, but impose guardrails like "no more than 50% of supply from any one country" or "always have at least one alternative supplier in a friendly country." Such strategies diversify risk while still allowing firms to benefit from low-cost sources for a good portion of their needs.

Another insight comes from policy analysts like Dan Ciuriak. Ciuriak (2023) cautions that heavily politicizing or re-engineering supply chains (through tariffs, local-content rules, subsidies, etc., in the name of security) can incur **significant economic costs** and often backfire. Market forces tend to reassert themselves: for instance, when the U.S. slapped high tariffs on Chinese goods, many importers did not simply reshore production to America – instead, they shifted sourcing to other low-cost countries such as Vietnam, Mexico, and Bangladesh. Trade data show that direct U.S. imports from China fell after 2018, but imports from Vietnam and other low-cost Asian countries surged, as did imports from Mexico. In effect, companies found new "cheap" suppliers rather than returning manufacturing to high-cost domestic facilities. One study dubbed this the "Great Reallocation" in supply chains, with low-wage countries (Vietnam, India, etc.) and nearshoring hubs (Mexico) picking up U.S. market share that China lost. This suggests cost considerations still carry immense weight. Consumers and firms resist moves that sharply raise prices. As a result, a complete unwinding of globalization is unlikely – instead we are seeing **partial reconfiguration**:

critical sectors and choke-points are being addressed, but global trade as a whole remains near record highs. In fact, global trade volumes rebounded strongly after the pandemic, reaching record values of $28.5 trillion in 2021 (25% higher than 2020) and an estimated $32 trillion in 2022. Rather than broad-based deglobalization, we observe **shifting patterns** of trade: "friendlier" partners are taking a larger share of trade, and regional blocs are deepening, even as overall trade stays robust.

North America provides a case study. The US–Mexico–Canada Agreement (USMCA, implemented in 2020 to replace NAFTA) included stringent new auto industry rules aimed at redirecting manufacturing to the U.S. – for example, raising the required North American content of vehicles to 75% and mandating higher-wage labor content. These provisions were explicitly designed to reshore some production and protect U.S. jobs, "with little apparent regard for the cost to consumers or overall competitiveness." Indeed, analyses by the U.S. International Trade Commission and the International Monetary Fund indicated that USMCA's auto rules would make North American cars more expensive and the region's auto industry **less competitive**, resulting in higher consumer prices and potentially lower sales. Early outcomes bear this out: while some new investment in auto parts has come to the U.S. or Canada, a significant amount of production has shifted within North America or to other countries rather than truly returning to the U.S. mainland. For instance, Mexico has been a clear beneficiary of trade diversion. By virtue of USMCA's tariff-free access and proximity, Mexico became a favored base for manufacturers looking to avoid China tariffs while still keeping costs low. U.S. imports from Mexico have risen, and Mexico's share of U.S. imports has steadily grown (as has Vietnam's). In sectors like electronics and automotive, North America's supply chain is becoming more **regionally integrated** – arguably increasing resilience to overseas disruptions and reducing exposure to geopolitical rivals, but at some cost to efficiency if production in North America is pricier than in Asia. We see a similar trend in Europe: companies are exploring "nearshoring" production to Eastern Europe or Turkey instead of China, and the EU is coordinating industrial policies (e.g. on batteries and green tech) to build capacity at home or in allied countries.

The war in Ukraine in 2022 was a watershed moment for Europe's thinking on trade security. Russia's invasion and the ensuing energy standoff forced Europe to confront the reality that its trade dependence could be weaponized against it. In hindsight, Europe's long-standing reliance on cheap Russian natural gas was a case of efficiency winning out over prudence – Russian gas was economical and convenient, until it wasn't. When Russia drastically cut gas flows in 2022, Europe was plunged into an energy crisis with record-high prices that fueled inflation and threatened industrial competitiveness. In response, European governments did something that would have seemed unthinkable before – they accepted massive short-term costs to eliminate that dependence. Over the course of months, Europe secured alternative gas supplies from Norway (now Europe's top gas provider), from global LNG markets (particularly U.S. LNG), and even reactivated coal and nuclear plants to reduce gas demand. Consumers and industries endured sky-high energy bills, and some energy-intensive manufacturers curtailed output or shifted production abroad due to the cost spike. Yet Europe did not back down from its sanctions and support for Ukraine, illustrating that **security considerations can trump efficiency when the stakes are high**. By winter 2022–23, Europe had effectively survived the cutoff and filled its gas storage from non-Russian sources, albeit at enormous expense. The episode taught a clear lesson: diversification of energy suppliers and investments in resilience (like interconnecting gas networks, building LNG import terminals, etc.) are vital for security, even if they add cost. Had Europe diversified its gas supply earlier (instead of depending ~35% on Russia), Moscow's ability to inflict pain would have been greatly diminished. Going forward, Europe is accelerating its shift to renewables and alternative energy precisely to avoid being hostage to any single supplier again.

Overall, the evolving consensus is that **efficiency alone cannot be the sole criterion** for supply chain decisions. The calculus now includes resilience and security as parallel priorities. However, it is equally recognized that pursuing absolute security or resilience at any cost would be self-defeating. The aim is to find optimal trade-offs: to retain as much of the economic benefits of global supply chains as possible, while shoring up weaknesses that pose unacceptable risks. This might mean maintaining global sourcing for 80% of needs but having 20% in backup (via inventory or secondary suppliers); or continuing to import most goods freely but targeting a few strategic sectors for domestic capacity or alliance-based supply arrangements. Policymakers are seeking that balance. For example, rather than blanket reshoring, the U.S. is subsidizing strategic industries (chips, EV batteries, pharmaceuticals) to build some domestic capacity, and tightening investment screening in sensitive tech, while still encouraging trade in less critical domains. The literature suggests such nuanced approaches – e.g. incentives for diversification over blunt protectionism – can yield better outcomes. Furthermore, analysts warn against overreacting to the geopolitics of the moment: **not all supply chains carry equal risk**, and politicizing every supply decision could impose huge costs for little gain. Supply chains for everyday consumer goods likely don't need heavy intervention, whereas supply chains for defense, energy, or vital medical supplies might.

Resilience, security, and efficiency need to be viewed as **coequal factors** in supply chain design. The post-2020 world is about navigating trade-offs wisely – building slack or safeguards where truly needed, and trusting markets where they work well. As one commentary put it, the global "made in the world" production system actually proved quite robust through the pandemic and adapted to shocks by rerouting flows. We should preserve that dynamism and efficiency, while fixing the points of fragility. The next section will explore how advanced data analysis can help identify these fragilities and guide decision-makers to solutions that optimize across multiple objectives.

5 The Second-Best Trap and the Need for Data-Driven Optimization

From the above analysis, it becomes clear that **we are in a "second-best" trap**. Historically, global trade patterns were second-best (or worse) because of various frictions and suboptimal firm decisions. The current remedies being attempted – reshoring, nearshoring, friend-shoring – may simply yield a different second-best equilibrium dictated more by geopolitical expediency than by rigorous optimization. Indeed, some studies note that politically driven reshoring or "friend-shoring" does not necessarily enhance supply chain resilience and may be motivated by other agendas (Miroudot, 2020; Evenett, 2020). Is there a way to break out of this trap and move closer to a first-best outcome—one that accounts for both efficiency and resilience/security? Encouragingly, recent economic models suggest that pursuing diversification rather than autarky can improve welfare and security; for example, Grossman, Helpman, & Lhuillier (2023) find that incentivizing diverse supply sources (instead of pure reshoring) can achieve a closer-to-optimal balance of cost and risk.

One promising avenue to escape this trap is to leverage the power of modern computing and data – essentially, to bring more science into what has often been an ad hoc decision realm. In an era of **big data, artificial intelligence (AI), and machine learning (ML)**, firms and governments have unprecedented capabilities to analyze complex systems and make predictions. Supply chains, with their countless moving parts and interdependencies, are a quintessential complex system that could benefit from such analysis. However, strategic supply chain design decisions (like where to locate production or how to configure a supplier network) have traditionally been based on managerial judgment, simple spreadsheet models, or consulting studies that might not capture the full complexity. It's time to change that approach. Indeed, traditional analytical models may fall short of capturing nonlinear interdependencies, but machine learning alternatives have shown promising results in recent research (Chaffa, Trépanier, & Warin, 2025). This suggests that data-driven methods can uncover patterns and solutions that earlier tools might miss.

5.1 Big Data in Supply Chains

With IoT sensors, enterprise resource planning (ERP) systems, trade databases, and market intelligence platforms, firms today generate and have access to enormous data on costs, shipping times, inventories, demand patterns, supplier performance, risk indices, etc. Big data analytics can reveal patterns and correlations in these datasets that were previously hidden to decision-makers.

For example, a company could analyze years of procurement and delivery data to see how different suppliers responded to past disruptions, or use real-time global shipping data to optimize inventory placement across warehouses. Governments, on their side, collect data on trade flows, production capacities, and even mappings of firms' supply networks in critical industries (some began doing this after the pandemic's supply shortages). **Utilizing these large datasets can quantify the trade-offs** between cost and risk much better than before. Rather than relying on gut feelings about which supplier might be "risky," decision-makers can incorporate empirically grounded risk probabilities (e.g. natural disaster frequency, political stability metrics for a region) into their supply chain models. In short, big data allows a move from anecdote-driven decisions to evidence-driven decisions by illuminating how cost and reliability correlate under myriad conditions.

5.2 Machine Learning and AI for Decision Support

Traditional operations-research approaches (like linear programming models for network optimization) have existed for decades, but AI/ML offers new advantages in dealing with uncertainty, non-linearity, and high-dimensional complexity. Machine learning algorithms can process massive datasets and identify solutions or recommendations that a human might not easily consider. Agrawal et al. (2024) pointed out that **machine learning can use vast data and better forecasting to improve supply chain decisions** – for instance, by greatly enhancing demand forecasts and aligning production plans accordingly. Improved forecasting powered by ML reduces the mismatch between supply and demand (a key aspect of efficiency) and also helps pinpoint where buffer stocks or redundancy are truly needed for resilience. This directly addresses the efficiency–resilience trade-off: if you can predict demand and disruptions more accurately, you can run leaner (efficient) while still hedging against the right risks (resilient).

Beyond forecasting, optimization algorithms can be enhanced with AI techniques to solve complex network design problems. For instance, an AI system could simulate thousands of possible supply chain configurations for a company – varying production locations, supplier choices, transportation routes, and inventory levels – and evaluate each configuration on multiple criteria (cost, delivery time, risk under various disruption scenarios, etc.). This kind of **multi-objective optimization**, potentially using methods like genetic algorithms or reinforcement learning, can propose solutions that balance efficiency and resilience far better than either a naïve cost-minimization model or a conservative all-domestic model. Essentially, **AI can search the vast solution space** of global production possibilities in a way no team of humans realistically can. Where a human manager might manually compare a dozen country sourcing options, an AI-driven analysis could compare hundreds of locations and supplier combinations, factoring in dozens of quantitative variables (wages, tariffs, exchange rates, political risk scores, logistics connectivity, carbon footprint, etc.) and even qualitative predictors extracted from big data. The result is a set of Pareto-efficient options that human decision-makers can then choose from based on their risk tolerance or strategic priorities.

5.3 Economic Geography + AI

The mention of an economic geography perspective in our research question hints that spatial data and location-specific factors need to be part of this optimization. Each region has a unique profile of attributes: labor skills, wage levels, natural resources, political stability, infrastructure quality, connectivity to markets, and so on. Big data can help quantify many of these attributes. For example, satellite imagery can be used to estimate infrastructure development and transportation capacity in a region; online job portals and LinkedIn data can indicate the availability of certain skills or engineering talent in the local workforce; and even news or social media sentiment analysis can provide a read on political climate or policy stability in a country. By feeding such rich geo-tagged data into location-decision models, firms can go beyond simplistic metrics (like just comparing average wages or a generic "ease of doing business" index) and get a holistic, evidence-based picture of a location's attractiveness and its risk factors.

Crucially, incorporating an economic geography lens means companies might discover opportunities in locations that were previously overlooked due to familiarity bias or lack of information. A data-driven approach could highlight, for instance, that a mid-sized city in an emerging economy has excellent logistics connectivity and skilled labor suited to your industry, making it a better trade-off choice than the default option of a higher-cost but well-known location. In academic work, we see support for this: measuring regional competitiveness through geospatial data science can reveal insights that inform targeted resilience strategies. For example, de Marcellis-Warin, Trépanier, & Warin (2024) used a digital twin model of the bi-national Great Lakes–St. Lawrence region to analyze firm-to-firm supply chain interactions, showing how a detailed geospatial approach can identify weak links and improvement opportunities in a regional economy. These kinds of analyses underscore that **spatial complexity can be captured and analyzed** with modern data tools, guiding firms to configure supply chains that are not just efficient on average, but also robust to regional disruptions or idiosyncratic local shocks.

One could even envision a **"Global Supply Chain Optimization AI"** that continuously ingests real-time data on global operating conditions and recommends supply chain configurations. For example, it might suggest:

> "For **Product X**, the optimal supply chain to minimize unit cost — given a constraint that no single source provides more than 50% of supply — is to produce 50% in Vietnam, 30% in Mexico, and 20% in the U.S., while maintaining buffer inventory in two strategically located hub warehouses. This yields only a 10% cost increase over a single-source China strategy, but cuts estimated disruption risk by 75%. Furthermore, given current political signals, the model predicts a 20% chance of high tariffs on Country Y within 3 years, so it recommends not exceeding 20% sourcing from Country Y."

Such a recommendation explicitly merges efficiency and risk considerations – a task that human decision-makers often struggle with due to cognitive biases or lack of clear data. Indeed, Farrell & Newman's call for network analysis to find **"weak links"** in global supply networks is essentially a data-driven approach to resilience: map out the entire network, see which nodes (countries, companies, or infrastructure points) are most critical or most vulnerable, and then reinforce or diversify those vulnerable nodes (Farrell & Newman, 2022). This is precisely where algorithms excel: scanning a complex global network to identify points of failure or high concentration risk that might not be obvious, and doing so continuously as the network evolves. In this way, AI and big data tools act as a microscope and a GPS for supply chain strategy, helping firms navigate toward a configuration that is closer to first-best (optimal) given real-world constraints.

5.4 From Firm Level to Policy Level

At the **firm level**, adopting these data-driven tools could make companies much more savvy in choosing locations and suppliers. It would mitigate the classic "streetlight effect," whereby managers only consider options that are already familiar or well-lit by anecdote. Instead, systematic analysis can evaluate a broad range of locations – some of which a firm's managers might never have considered simply because those places were outside their personal experience or comfort zone. An AI might flag, for instance, an emerging economy as a promising manufacturing location due to favorable data on logistics performance and workforce quality, even though the firm has never operated there before. This opens opportunities to truly deepen globalization in an efficient way – not as uncontrolled expansion into far-flung regions for its own sake, but as a **directed, optimized globalization** that squeezes out the inefficiencies of ad hoc or bias-driven decision-making. In other words, firms can achieve more of the gains from global specialization and comparative advantage (the first-best outcomes in trade theory) by using tools that comprehensively evaluate the trade-offs rather than just following the herd or the path of least resistance.

At the **policy level**, governments could also use data-driven approaches to improve supply chain security and resilience for their economies. For instance, a government aiming to bolster national supply chain resilience could start by analyzing which critical imports have dangerously high concentration risk (i.e. sourced predominantly from a single foreign country). It can then evaluate what the optimal diversification strategy would be — perhaps encouraging multiple alternative import sources or maintaining a mix of domestic and foreign suppliers rather than relying solely on one country or only on reshoring (Grossman, Helpman, & Lhuillier, 2023). The data might reveal, for example, that sourcing a certain raw material from three different countries (with modest stockpiles as backup) dramatically reduces the risk of shortage with only a minor cost increase, whereas producing everything domestically would be far costlier. Governments can also identify industries where a small policy intervention (say, a targeted subsidy for holding emergency inventory or grants for establishing a backup production facility) would yield a large increase in resilience relative to its cost.

Right now, many such policy decisions are made on anecdotes or political pressure. A typical reaction after a crisis might be: "We ran out of masks during the pandemic, so let's fund a giant mask factory at home!" But a data-driven analysis could reveal that maintaining an emergency stockpile of masks (or diversifying mask suppliers across multiple friendly countries) is far more cost-effective than trying to localize all mask production (Javorcik, 2020). On the other hand, the data might show that for another product — say, a certain critical pharmaceutical ingredient with no easy substitutes — domestic production is justified despite higher costs, due to the extreme consequences if supply from abroad is cut off. In short, a quantitative approach can guide policymakers to apply the right solution (diversify, stockpile, or reshore) on a case-by-case basis, rather than one-size-fits-all mandates. This kind of big-picture, analytical guidance can help avoid the next "second-best" trap at the policy level by ensuring that interventions truly address the identified vulnerabilities in a cost-efficient manner, rather than simply scoring political points.

5.5 Bridging the Gap to First-Best

Could big data and machine learning actually guide us toward a true first-best outcome in global supply chains? The optimistic view is that by removing some of the information and computation constraints that have plagued decision-making in the past, firms could approach the textbook efficient frontier more closely. In theory, there is an ideal balance between efficiency and resilience for each firm (and product): a frontier where any attempt to be more secure would incur disproportionate cost, and any attempt to cut cost would impose disproportionate risk. Data-driven tools can help firms find that frontier – for example, identifying combinations of offshoring vs. reshoring that minimize cost for a given risk level, or conversely minimize risk for a given cost level – and then let firms choose a point on that frontier according to their risk tolerance or strategic preferences. Over time, if many firms optimize in this way, the global allocation of production might inch closer to a Pareto-optimal state (in a multi-objective sense): an allocation where no company (or country) can improve its efficiency or its security without worsening the other dimension for someone else. In other words, we'd collectively be making the most of globalization's benefits while safeguarding against its hazards to the extent possible.

However, **challenges remain** before this vision can be fully realized. Data-driven tools are only as good as the data and models they rely on. Some risks will always be extremely hard to forecast – for example, tail-end geopolitical events or novel types of disruptions might elude even the best predictive algorithms. There's also the issue of implementation: companies need the organizational will and skills to actually trust and act on analytical insights. Cultural resistance or inertia can lead managers to fall back into old habits or politically motivated choices, even when the data suggests a different course. Additionally, there is a coordination problem at the global level: what is optimal for one firm (or one country) individually might not be optimal if every firm follows the same strategy. If everyone rushes to diversify into the same "safe" countries, for instance, new bottlenecks or capacity constraints could arise in those locations, or geopolitical strains could emerge as countries vie for preferred partners. This is where policy coordination and guidance become important – governments or international institutions could use big-picture analysis to ensure that resilience efforts by individual actors don't collectively create new vulnerabilities (for example, over-concentrating in a new set of countries).

Nonetheless, even incremental improvements in decision quality could yield significant gains for the system as a whole. Consider that even before the advent of modern AI, some firms that employed rigorous analytical optimization of their supply chains achieved superior results. For example, major electronics manufacturers in the 1990s and 2000s famously used advanced network optimization models to redesign their distribution and production networks, saving tens of millions of dollars in annual costs and improving service levels. ML and AI can take this a step further by dynamically adjusting recommendations as conditions change – a kind of continuous re-optimization. A truly agile supply chain, guided by AI, might even shift sourcing on the fly in response to early warning signals (say, reallocating orders from a supplier when the algorithm detects rising political risk or pandemic risk in that supplier's region), which is something human managers are typically much slower to do. In essence, better data and algorithms won't eliminate every risk or inefficiency, but they can make supply chains significantly closer to the ideal of "secure and efficient" that often seems elusive.

5.6 An Example of ML Application

To make these ideas concrete, consider an encouraging example from the realm of logistics and inventory management. E-commerce giants like Amazon have pioneered the use of AI to decide where to position inventory and how to route packages – essentially solving a real-time supply chain configuration problem on a micro scale. Machine learning algorithms at Amazon forecast demand for each product in each region and determine the optimal warehouse to stock it, as well as the optimal delivery routes, resulting in faster deliveries at lower overall cost. This AI-driven approach to micro-level supply chain decisions has been a key factor in Amazon's ability to combine efficiency (low cost per delivery) with resilience (ability to reroute and adjust quickly if a warehouse goes down or a route is disrupted).

Now extrapolate this idea to the **macro scale** of global production and sourcing decisions. If global manufacturing firms could similarly "prime" their strategic supply chain configurations using AI – for decisions like where to build a new factory, how much capacity to allocate to each region, how to balance sourcing between multiple countries, etc. – the gains in efficiency and resilience could be enormous. In fact, we already see early signs of this: some forward-looking companies are experimenting with digital twin simulations of their supply chains. A digital twin is a virtual model of the supply chain that can be stress-tested under different scenarios (e.g. "What if a pandemic shuts down country X?" or "What if a war breaks out in region Y?"* or *"What if tariffs jump by 30% on imports from Z?"). By simulating these scenarios, the digital twin can reveal how the network would fare and pinpoint where the weak points are. Such experiments are no longer just academic – they are happening in industry, often borrowing techniques from researchers. For example, Burgos & Ivanov (2021) demonstrate a digital twin-based stress test for a food supply chain, illustrating how this approach can identify vulnerabilities and guide contingency planning. This is exactly the kind of preparation that was lacking in many sectors prior to 2020, but is now quite feasible with modern computing power.

So, **big data and ML tools offer a promising pathway to escape the second-best equilibrium** by enabling more informed, nuanced supply chain design. These technologies can help reconcile efficiency with resilience by quantifying each and finding optimal "sweet spots" between the two. Crucially, they also help surface implicit assumptions and biases – for instance, a model might reveal that a supposedly "safe" all-domestic supply chain is actually riskier (in certain scenarios) than a diversified global one, countering the bias that domestic = always secure. The integration of these advanced tools into strategic decision-making is not automatic, however. It requires investment in data infrastructure, the development of new skills, and a shift in mindset from intuition-driven management to evidence-driven management. For business leaders and policymakers, the challenge ahead is to encourage and embrace this transition toward data-optimized global value chains. The final section will discuss what this implies for leadership and policy – essentially, how to foster an environment where analytical optimization becomes the norm in global supply chain strategy, helping to deliver an outcome that is closer to the first-best ideal.

6 Policy Implications and Conclusion

The analysis presented in this paper carries several important implications for both business strategy and public policy. At its heart is a paradigm shift: moving away from extreme viewpoints of "globalization always good" or "globalization went too far" toward a **data-informed, balanced approach** that acknowledges complexity. We highlight the following key implications:

1. Rethinking Trade Policy Assumptions: Policymakers should revisit the assumption that pre-2020 global trade was fully efficient and that current protectionist measures simply correct an overshoot. In reality, trade was never a first-best equilibrium; there were plenty of distortions and inefficiencies, as analyzed in recent work on Canada–U.S. trade dynamics under CUSMA and their implications for elasticity asymmetries (Warin, 2025b). Blaming globalization as "too much" misdiagnoses the issue – the issue was what kind of globalization (one driven by short-term firm behavior and incomplete information). Therefore, policies like high tariffs or blanket reshoring mandates risk overshooting in the opposite direction. A more nuanced policy would identify specific strategic vulnerabilities (e.g., 90% import reliance on one country for a critical good) and address those, rather than broadly reducing trade. This means embracing **evidence-based policy**: use data to pinpoint where supply chains are genuinely fragile or dangerous, and focus interventions there, rather than assuming all global supply chains are problematic.

2. Encouraging Diversification over Pure Reshoring: Consistent with both economic models and the logic of resilience, governments should encourage supply chain diversification as a primary tool for resilience, before resorting to reshoring. For instance, instead of requiring that 100% of, say, medical PPE be made domestically (which could be very costly and idle in normal times), governments could ensure that hospitals source from multiple countries and maintain stockpiles. Diversification keeps the efficiency gains of global sourcing (since at least some portion comes from lowest-cost producers) while mitigating risk. Policies to support this could include: insurance or incentives for firms that develop multi-source supply chains; international agreements to keep trade open for critical goods during crises (so that diversification is viable); and perhaps a "scorecard" of supply chain concentration risks that encourages firms to act (analogous to how financial stress tests encourage banks to diversify assets).

3. Investing in Information Infrastructure: One reason firms made suboptimal choices is lack of accessible information. Governments and international institutions can help by building and sharing supply chain intelligence. For example, public-private partnerships could create databases mapping supply chain dependencies for key sectors (with appropriate confidentiality). If a company knows its entire industry depends on one factory in Country X, it might be more proactive in finding alternatives. The government can facilitate this knowledge. During COVID-19, some governments were caught off-guard not knowing where critical supplies came from; now is the time to systematically gather that data. **Transparency** is a public good in supply chains – with better transparency, markets themselves may correct some inefficiencies (e.g., investors might reward companies that have more resilient supply chains if data shows who is exposed to risks).

4. Embracing Big Data and AI in Policy Modeling: Just as firms can use ML, policymakers can use advanced modeling for scenario planning. Trade ministries or international bodies could employ AI-driven models to simulate, say, the effects of a major decoupling between big economies or the impacts of certain reshoring initiatives. This can inform policy decisions, highlighting unintended consequences. For example, a model might show that restricting imports of a certain component could bottleneck an entire downstream industry. Equipped with such analysis, policymakers can tailor interventions (maybe provide incentives to produce that component domestically before cutting off imports, to avoid a gap). Ciuriak (2023) suggests that numerous uncoordinated reshoring policies become a "hodge-podge of industrial policies" with high costs. A data-driven approach at groups like the G20 could help align on principles so that "economic security" measures do not spiral into counterproductive protectionism. Essentially, use data to draw the line between sensible derisking and costly de-globalization.

5. Supporting Corporate Adaptation: Governments should also encourage firms to adopt the data/AI tools discussed. This could be via subsidies or tax breaks for companies investing in supply chain analytics, funding pilot projects or knowledge-sharing consortia on supply chain AI, and including analytical preparedness as part of corporate governance expectations. For example, regulators might require large firms in vital sectors to conduct periodic "stress tests" of their supply chains (similar to bank stress tests) and to report on how they would handle certain scenarios. This nudges firms to use advanced tools to get those answers. Additionally, workforce development programs can focus on skills for supply chain data analysis and risk management, ensuring that the human capital exists to make use of ML outputs.

6. International Coordination vs. Fragmentation: There is a major policy decision to be made globally: do we slide into a fragmented world of competing blocs each trying to localize supply chains, or do we coordinate to manage risks while preserving an integrated global economy? The research here leans toward the latter as being collectively more optimal. International forums (WTO, G7, G20) can play a role by setting norms – for instance, perhaps an agreement that certain critical supplies will always have at least a minimal domestic capacity across countries, but beyond that trade will be encouraged for efficiency. Or agreements not to impose export bans in a pandemic (which worsened the PPE shortages in 2020). If everyone friend-shores within their bloc, we risk duplicating efforts and losing global scale efficiency, which could reduce growth worldwide. A coordinated resilience strategy (like forming a diverse "safety net" of supply sources across friendly nations) might achieve security without balkanizing trade completely. The evidence that no country can realistically produce everything it needs without huge cost is strong, so global cooperation is logically a better path.

7. Updating Theoretical Frameworks: For academia and think tanks, there is an implicit recommendation to update models of trade and MNE strategy to incorporate bounded rationality and data-driven optimization. Traditional models assumed either full rationality or left decision-making black-boxed. As this paper argues, the reality was neither fully rational nor fully random – and now, with AI, we have a chance to enhance rationality. New models could look at how AI adoption in firm decision-making changes trade patterns. Does it lead to more diversification? Does it lead to more rapid shifts in sourcing when conditions change (i.e., more agility)? Early evidence from some AI-driven industries might be studied to answer these questions. This is fertile ground for future research.

So, Globalization as we knew it is certainly evolving. The twin shocks of a pandemic and geopolitical conflict have challenged long-held beliefs about unfettered free trade. However, the solution is not a simple reversal toward autarky or closed regionalism. That path would ignore the fact that much value was left on the table by the old globalization (due to suboptimal decisions) and would likely create new inefficiencies and tensions. Instead, a smarter globalization – call it **Globalization 2.0** – should leverage technology and data to correct its course. In this vision, firms and countries use advanced analysis to design supply chains that are efficient and resilient, acknowledging trade-offs transparently and minimizing them where possible. Resilience is built not by abandoning global networks, but by making them more robust through diversity and innovation. Efficiency is maintained not by blindly chasing lowest costs, but by holistic optimization that factors in risk-adjusted costs.

Ultimately, **the first-best equilibrium** in global supply chains might be unachievable in a literal sense (given uncertainties and the multiplicity of objectives). But we can certainly do better than the past, and better than the reflexive deglobalization of the present. A Pareto-improvement is feasible: for instance, achieving near-previous efficiency levels while greatly reducing risk exposure – that would make consumers, firms, and governments better off jointly. The key is information and intelligent decision-making. As one Nature article's title succinctly put it, weak links can be weaponized, so we must find and protect those weak links. Doing so doesn't mean retreating behind our borders; it means using our analytical prowess to reinforce the global web where it's thinnest.

The world should neither glorify the old globalization as flawlessly efficient nor dismiss it as a failed experiment. Instead, we should recognize that trade did not go too far; in many ways it did not go far enough in the right way. Countries did not trade – firms did, under constraints and biases – and now both firms and countries have the tools to do it better. By applying big data and machine learning to global value chain configuration, and by crafting policies that incentivize rational, evidence-based choices, we can move toward a more optimal balance of efficiency, resilience, and security. This is not just an academic ideal but a practical imperative: the next crisis will surely test whatever system we build now. Let that system be one built on knowledge, adaptability, and cooperation, rather than one built on fear or nostalgia. The world economy's strength has always been its interconnected nature; the task ahead is to make that interconnection smarter and more sustainable for the long run.

References

Agrawal, N., Cohen, M. A., Deshpande, R., & Deshpande, V. (2024). How machine learning will transform supply chain management. Harvard Business Review, 102(2), 64–73.

Anderson, J. E., & van Wincoop, E. (2004). Trade costs. Journal of Economic Literature, 42(3), 691–751. https://doi.org/10.1257/0022051042177649

Antràs, P. (2021). “De-Globalisation? Global Value Chains in the Post-COVID-19 Age”. 2021 ECB Forum: “Central Banks in a Shifting World” Conference Proceedings.

Antràs, P., & Chor, D. (2018). “On the Measurement of Upstreamness and Downstreamness in Global Value Chains”. In World Trade Evolution: Growth, Productivity and Employment, 126-94. Taylor & Francis Group.

Baier, S. L., & Bergstrand, J. H. (2007). Do free trade agreements actually increase members' international trade? Journal of International Economics, 71(1), 72–95. https://doi.org/10.1016/j.jinteco.2006.02.005

Baldwin, R. (2016). The Great Convergence: Information Technology and the New Globalization. Harvard University Press. https://doi.org/10.2307/j.ctv24w655w

Bernard, A. B., Jensen, J. B., Redding, S. J., & Schott, P. K. (2007). Firms in international trade. Journal of Economic Perspectives, 21(3), 105–130.

Burgos, D., & Ivanov, D. (2021). Food retail supply chain resilience and the COVID-19 pandemic: A digital twin-based impact analysis and improvement directions, Transportation Research Part E: Logistics and Transportation Review, Volume 152.

Buckley, P. J., & Casson, M. (2003). The Future of the Multinational Enterprise in Retrospect and in Prospect. Journal of International Business Studies, 34(2), 219–222. http://www.jstor.org/stable/3557154

Chaffa, L., Trépanier, M., & Warin, T. (2025). Beyond PPML: Exploring machine learning alternatives for gravity model estimation in international trade (Cahiers scientifiques, No. 2025s-14). CIRANO. https://doi.org/10.54932/BFKY4995

Ciuriak, D. (2023). The economics of supply chain politics: Dual circulation, derisking and the Sullivan doctrine. C.D. Howe Institute Verbatim Report. https://doi.org/10.2139/ssrn.4433712

De Marcellis-Warin, N., Trépanier, M., & Warin, T. (2024). Measuring competitiveness in the Great Lakes–St. Lawrence Region using a digital twin: A geospatial data science approach (Pour réflexion No. 2024PR-04). CIRANO. https://doi.org/10.54932/DKBC6587

Evenett, S. J. (2020). Protecting the global supply chain during a pandemic. The World Economy, 43(6), 1515–1525. https://doi.org/10.1111/twec.12954

Farrell, H., & Newman, A. L. (2019). Weaponized interdependence: How global economic networks shape state coercion. International Security, 44(1), 42–79. https://doi.org/10.1162/ISEC_a_00351

Farrell, H., & Newman, A. L. (2022). Weak links in finance and supply chains are easily weaponized. Nature, 605(7909), 219–222. https://doi.org/10.1038/d41586-022-01254-5

Freund, C., & Pierola, M. D. (2015). Export superstars. Review of Economics and Statistics, 97(5), 1023–1032. https://doi.org/10.1162/REST_a_00511

Gaubert, C., & Itskhoki, O. (2021). Granular comparative advantage. Journal of Political Economy, 129(3), 871–939. https://doi.org/10.1086/712444

Ghemawat, P. (2001). Distance still matters: The hard reality of global expansion. Harvard Business Review, 79(8), 137–147.

Ghemawat, P. (2007). Redefining global strategy: Crossing borders in a world where differences still matter. Harvard Business Press.

Ghemawat, P. (2016). The laws of globalization and business applications. Cambridge University Press. https://doi.org/10.1017/9781316678503

Grossman, G. M., Helpman, E., & Lhuillier, H. (2023). Supply chain resilience: Should policy promote international diversification or reshoring? Journal of Political Economy, 131(12), 3462–3496. https://doi.org/10.1086/725173

Head, K., & Mayer, T. (2014). Gravity equations: Workhorse, toolkit, and cookbook. In G. Gopinath, E. Helpman, & K. Rogoff (Eds.), Handbook of international economics (Vol. 4, pp. 131–195). Elsevier. https://doi.org/10.1016/B978-0-444-54314-1.00003-3

Javorcik, B. (2020). Reshaping of global supply chains will take place, but it will not happen fast. Journal of Chinese Economic and Business Studies, 18(4), 321–325. https://doi.org/10.1080/14765284.2020.1855051

Johanson, J., & Vahlne, J.-E. (1977). The internationalization process of the firm: A model of knowledge development and increasing foreign market commitments. Journal of International Business Studies, 8(1), 23–32. https://doi.org/10.1057/palgrave.jibs.8490676

Kocoglu, I., & Mithani, M. A. (2024). How do managerial biases affect foreign market entry decisions? AIB Insights, 24(4). https://doi.org/10.46697/001c.123988

Krugman, P. (1994). Competitiveness: A dangerous obsession. Foreign Affairs, 73(2), 28–44.

McCallum, J. (1995). National Borders Matter: Canada-U.S. Regional Trade Patterns. The American Economic Review, 85(3), 615–623. http://www.jstor.org/stable/2118191

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica, 71(6), 1695–1725.

Miroudot, S., & Thakur-Weigold, B. (2024). Supply chain myths in the resilience and deglobalization narrative: Consequences for policy. Journal of International Business Policy, 7(1), 99–111. https://doi.org/10.1057/s42214-023-00170-3

Porter, M. E. (1998). The competitive advantage of nations (2nd ed.). Free Press.

Rugman, A. M., & Verbeke, A. (2004). A perspective on regional and global strategies of multinational enterprises. Journal of International Business Studies, 35(1), 3–18. https://doi.org/10.1057/palgrave.jibs.8400073

Simon, H. A. (1955). A behavioral model of rational choice. Quarterly Journal of Economics, 69(1), 99–118.

Subramanian, A., & Wei, S.-J. (2007). The WTO promotes trade, strongly but unevenly. Journal of International Economics, 72(1), 151–175. https://doi.org/10.1016/j.jinteco.2006.07.007

Thakur-Weigold, B., & Miroudot, S. (2024). Supply chain myths in the resilience and deglobalization narrative: Consequences for policy. Journal of International Business Policy, 7, 99–111. https://doi.org/10.1057/s42214-023-00170-3

Trefler, D. (1995). The case of the missing trade and other mysteries. tHE American Economic Review, 85(5), 1029–1046. http://www.jstor.org/stable/2950973

Warin, T. (2025). Canada–U.S. trade in a globalized economy: Elasticities, asymmetries, and policy imperatives (Pour réflexion No. 2025PR-01). CIRANO. https://doi.org/10.54932/SLPH3996

Warin, T. (2025). Historical and contemporary evolution of international trade: From mercantilism to the platform economy (Working Papers No. 2025s-12). CIRANO. https://doi.org/10.54932/IQEN6866

Yellen, J. (2022, April 13). Remarks on the future of the global economy. U.S. Department of the Treasury. Retrieved from https://home.treasury.gov/news/press-releases/jy0714

Zaheer, S. (1995). Overcoming the liability of foreignness. Academy of Management Journal, 38(2), 341–363. https://doi.org/10.2307/256683