

Global Value Chains and Global Supply Chains at a Halt: How Can Data Science Help?

Thierry Warin

Abstract: Our contribution in this position paper is to reflect on the future of international trade in the context of the industrial revolution 4.0. We will not address the question of TradeTech from a public policy perspective, but rather we will use at how data and machine learning algorithms can help manage risks on global value chains (GVC) and global supply chains (GSC).

Keywords: data science; artificial intelligence; global value chains; global supply chains; TradeTech; digital twins; globalization 5.0

Introduction

As Churchill said, we should not let a good crisis go to waste. With this particular principle in mind, we need to analyze the current debate on re-shoring and near-shoring in international trade circles.

Churchill is saying first that a crisis is a sign that it is time to think about changes. He isn't saying that the change must be taken in the opposite direction... Binary thinking is very rarely the right way of thinking about complex matters. Complexity thinking is often the right way. Complexity means using a multidisciplinary approach, including methodologies, and not only domain-based thinking. In our context, the methodology is data science, i.e structured and unstructured data analyzed through the lens of machine learning estimation techniques.

Data science is a set of new techniques to analyze data, often called artificial intelligence (AI), though we prefer to use the more explicit machine learning (ML) concept. Leveraging ML in GVC and GSC means using advanced technologies to reduce processing times and improve cross-border movement efficiency. It can also be considered in the public policy context as the industrial revolution 4.0 helps improve the processes and diagnose and mitigate global risks. It is particularly important for policymakers to have this awareness and understanding in their TradeTech efforts notably.

Although this is not the core of this short article, we can signal here that another application of data science to analyzing multinational corporations (MNC)'s GVCs and GSCs is with the creation of scenario simulations based on MNCs' digital twins. Indeed, digital twins are an exciting technology. Digital twins are digital representations of corporations, including their suppliers (tier 1, 2, and 3) and consumers. Digital twins allow running ML-based simulations – the territory of data science – on the company's data to create evidence-based scenarios.

This short paper does not claim to be encyclopedic but instead seeks to bring the conversation further. It contributes to the literature by answering the questions of (1) what technology can bring to the GVC-GSC resilience and (2) globalization 5.0.

So how can data science help think in complex terms about international trade?

Context

Let us look at the first dimension of global trade here. International trade is about the global market economy with GVC-GSC put together by multinational corporations (MNC) and regulations at the national and international levels with international trade agreements.

Let us now look at a second dimension, which is a little more granular, and its implications. The GSC and GVC are decided by companies based on comparative advantages. These comparative advantages are often measured using tangible data such as a location's return on investment, but not always. More and more often, in the context of corporate social responsibility (CSR) and now the environment, social, and governance (ESG) criteria, MNCs consider the questions of climate change, human rights, corruption, and social impacts in local communities. Those are often intangibles, but not only. In the context of climate change, the questions related to local pollution, international waste trade (Bernard et al. 2014), and emissions created by transportation are more relevant than ever.

GSC-GVC Vulnerabilities

In this context, it is no surprise that we see our state of global capitalism being questioned. It is, by the way, almost routine and healthy. After the so-called global recession of 2008, several articles were published about the shift to re-shoring (Delis, Driffield, and Temouri 2017). According to these authors, there has been re-shoring activity in the aftermath of the 2008 crisis, particularly for companies with smaller distances between parents and subsidiaries. Several papers have also been published about the future of the GSC in a post-Covid-19 world (Panwar, Pinkse, and De Marchi 2022; Sytch, Kim, and Page 2022; Gereffi, Pananond, and Pedersen 2022). They both highlight the vulnerabilities of our GSC and the need to manage risks better. A couple of articles have studied, in particular, the critical GVC around the production of medical supplies (Gereffi, Pananond, and Pedersen 2022; Gereffi 2020).

The question of risks is an important one. In the context of a company, risk can be seen as following a normal distribution. It indeed can be true. However, it can also be a catastrophic risk with minimal probability of occurrence but enormous consequences. As Nassim N. Taleb has explained, "Our world is dominated by the extreme, the unknown, and the very improbable ... while we spend our time engaged in small talk, focusing on the known and the repeated" (Taleb 2010). Typically, this definition would apply to Haïti's earthquake in 2010, Iceland's volcanic eruption in 2010 (Fiksel et al. 2014), or Japan's tsunami in 2011.

Companies have been facing a perfect storm with a rise in political risks (President Trump's international trade agenda, Ukraine being invaded, etc.) accompanied by the SARS-CoV II pandemic in the aftermath of the global recession. In the post-Covid era, the world has indeed changed. We see at the same time an unprecedented increase in central banks' reserves to cope with the pandemic, a massive transformation of work with the great resignation, technological changes (cryptocurrencies and their impact on GPUs), and Ukraine reminding us that the planet is not free of political risks. For instance, Taiwan produces 63% of the world's semiconductors. Moreover, Taiwan Semiconductor Manufacturing Co (TSMC) is the world's largest foundry, with 54% of the world's market share (TrendForce 2021).

Semiconductors are produced using several elements, one of which comes from Ukraine and is present in 80% of the semiconductors. The Ukraine invasion is thus adding up to the bottleneck's risks. So, it is no surprise that inflation is rising from monetary policies and economic disruptions. Moreover, it is no surprise that companies think about near-shoring in the region or re-shoring in their country.

GSC-GVC Resilience

| What resilience is not about

Resilience is not about near-shoring/regionalization or re-shoring as a principle to mitigate risks. Let me be more explicit here. Regionalization or re-shoring can result from better risk planning based on Data Science, but it is not a solution. A government that would promote re-shoring would dismantle global supply chains and require a radical overhaul of the global economic system. Let us remember that face masks and other critical medical supplies were produced in massive amounts at the beginning of the pandemic thanks to our GSC-GVC, not the leverage of local capacities. The latter might have helped, but the bulk came from the world (Panwar, Pinkse, and De Marchi 2022).

Near-shoring and re-shoring are not principles that will make the GSC-GVC resilient. Risks can even be more significant when produced locally as shortages (labor and capital) are likely to occur.

So, resilience is not about blindly trusting the government. Nevertheless, it is not about blindly trusting the market economy to mitigate risks. The market adjusts, no doubt about that. When some resources are scarce, prices go up. And then, the price mechanism creates incentives to address the shortage. However, we can do better than an ex-post adjustment once the risk has occurred. When futures markets exist, then it is true that it is a beneficial mechanism to reduce ex-post adjustments. Companies can anticipate based on the futures market prices. With Data Science, it can leverage data and build predictive models. These causal models help make better decisions and thus mitigate risks.

| What resilience is about

Resilience is about using the technology we have access to nowadays. It is not about updating the trade system but rather about upgrading it to a new technological paradigm (Ivanov, Dolgui, and Sokolov 2019), the AI one, which encompasses data science, TradeTech, and digital twins.

1. So, resilience is about using modern tools and building digital twins to diagnose risks. It is the first time in human history that we have so much data – structured and unstructured -and the computing power and new analytical methods in the name of artificial intelligence and the whole machine learning toolbox.

2. It is also about using modern tools and building digital twins to mitigate risks. Data Science and its arsenal of techniques allow MNCs to see through the fog of war (De Marcellis-Warin, Munoz, and Warin 2020a). These tools and techniques allow the creation of predictive models based on real-time and geolocated data. Moreover, it is not only about real-time data; models can also change in real-time. Inferential approaches such as neural networks can create on the fly real-time models. The leadership in MNCs or governments can now use *augmented intelligence* (Jablokov and Warin 2022).

3. It is also about using modern tools and building digital twins to find bottlenecks. Data Science can help build a digital twin of an MNC's GSC-GVC. A company or a government can then know the fragilities on tier 1, 2, or 3 as well as on its client-side. Integrating political, environmental, human, and technological risks in its new enterprise

risk management (ERM) plan allows an MNC to predict probability distributions and build better scenario planning to avoid potential bottlenecks.

4. It is also about building digital twins to analyze the benefits of supplier diversification. The previous example will require action plans. Equipped with the correct real-time and geolocated data and suitable ML models, an MNC can predict the importance of, for instance, suppliers' or even customers' diversification. It goes beyond Redistributed Manufacturing (RDM) (Srai et al. 2016).

5. It is also about internalizing negative externalities. We are talking about pricing the carbon emissions due to the transportation of merchandise. Most of the world's trade in merchandise in volume is made through ships. On average, they use cheap oil, increasing even more carbon emissions. We are also talking about child labor, human rights, etc., by putting a price or a penalty on these negative externalities. Leveraging Data Science techniques to automatically track this aspect, we can thus increase the cost of international trade to its actual value, not subsidized artificially by the planet or human beings living in weaker institutional places where their fundamental human rights are not respected. I am not saying that every MNC does this, but for the great majority that do not do it, they would benefit from being able to penalize the free riders. A direct consequence would be a near-shoring or even re-shoring. However, again, it would be a consequence, not a policy. The difference is that each company would make the adjustments in its context. Our global capitalism is a savant mix of market economy, government, and international regulations, creating a very complex mapping of comparative advantages being different across industries and locations. We must consider internalizing negative externalities, including reputational risks (de Marcellis-Warin and Teodoresco 2012). This can be done with our new technologies. This is globalization 5.0.

So resilience goes beyond mitigating risks. When a risk occurs, it is about using our modern technologies to pivot rapidly, faster than the competition. Moreover, policymakers should accompany this resilience in the context of Trade-Tech. Technology is not the goal, but it should be the heart of the new system. In particular, technology helps reduce uncertainty. A lot of uncertainties are the result of a lack of information or an abundance of information. In either case, neural networks diving into massive amounts of data undoubtedly help filling the gaps and extract and share the relevant information for a better decision.

Conclusion

We need to leverage our existing technologies. The goal is not to let a good crisis go to waste. In this day and age, it is an unprecedented opportunity to put the right international trade policies in place to create the most efficient system based on cutting-edge technologies. For companies, it is to use these cutting-edge technologies to become resilient.

The first foundation is new globalization that will consider negative externalities, i.e., the so-called ESG, but with pricing to benefit from the market economy as an incentive mechanism.

However, it is not enough. We cannot be satisfied with an upgraded market economy, as the inherent ex-post nature of the market is not satisfactory for mitigating global risks.

This is why we need to leverage our current technology. The industrial revolution 4.0 is not science fiction. It is a reality in many domains: fintech, health tech, etc. It should be a reality in MNCs' new enterprise risk management (ERM) and government 4.0 (de Marcellis-Warin and Warin 2020; De Marcellis-Warin, Munoz, and Warin 2020b).

As aforementioned, technology should be the heart of the system. It makes policymaking better and GVC-GSC more

resilient. It improves the market mechanism by being more predictive. It puts first and foremost ESG objectives. Data and the technology behind it will help. Time is of the essence. In our AI era, we make right what we measure right.

References

Bernard, Sophie, Arthur Claire, Guillaume Vergne, and Thierry Warin. 2014. "Un État Des Lieux Sur Le Commerce International Des Déchets." CIRANO.

De Marcellis-Warin, Nathalie, J. Mark Munoz, and Thierry Warin. 2020a. "AI in Business: Seeing through the Fog of War." *California Management Review Insights*. <https://cmr.berkeley.edu/2020/02/ai-fog-of-war/>.

———. 2020b. "Government 4.0 and the Pandemic." *California Management Review*. 2020. <https://cmr.berkeley.edu/2020/06/government/>.

Delis, Agelos, Nigel Driffeld, and Yama Temouri. 2017. "The Global Recession and the Shift to Re-Shoring: Myth or Reality?" SSRN Scholarly Paper. Rochester, NY. <https://papers.ssrn.com/abstract=3091855>.

Fiksel, Joseph, Mikaella Polyviou, Keely L. Croxton, and Timothy J. Pettit. 2014. "From Risk to Resilience: Learning to Deal With Disruption." *MIT Sloan Management Review*, December. <https://sloanreview.mit.edu/article/from-risk-to-resilience-learning-to-deal-with-disruption/>.

Gereffi, Gary. 2020. "What Does the COVID-19 Pandemic Teach Us about Global Value Chains? The Case of Medical Supplies." *Journal of International Business Policy* 3 (3): 287–301. <https://doi.org/10.1057/s42214-020-00062-w>.

Gereffi, Gary, Pavida Pananond, and Torben Pedersen. 2022. "Resilience Decoded: The Role of Firms, Global Value Chains, and the State in COVID-19 Medical Supplies." *California Management Review* 64 (2): 46–70. <https://doi.org/10.1177/00081256211069420>.

Ivanov, Dmitry, Alexandre Dolgui, and Boris Sokolov. 2019. "The Impact of Digital Technology and Industry 4.0 on the Ripple Effect and Supply Chain Risk Analytics." *International Journal of Production Research* 57 (3): 829–46. <https://doi.org/10.1080/00207543.2018.1488086>.

Jablokov, Igor, and Warin. 2022. "How Augmented Intelligence Is Bringing the Focus Back on the Human." *California Management Review Insights*. <https://cmr.berkeley.edu/2022/05/how-augmented-intelligence-is-bringing-the-focus-back-on-the-human/>.

Marcellis-Warin, Nathalie de, and Serban Teodoresco. 2012. "Corporate Reputation: Is Your Most Strategic Asset at Risk?," 48.

Marcellis-Warin, Nathalie de, and Thierry Warin. 2020. "Government 4.0 and Evidence-Based Policies: AI and Data Analytics to the Rescue." In *Handbook of Artificial Intelligence and Robotic Process Automation*, edited by AI Naqvi and J. Mark Munoz, 31–40. Policy and Government Applications. Anthem Press. <https://doi.org/10.2307/j.ctv20pxz2v.7>.

Panwar, Rajat, Jonatan Pinkse, and Valentina De Marchi. 2022. "The Future of Global Supply Chains in a Post-COVID-19 World." *California Management Review* 64 (2): 5–23. <https://doi.org/10.1177/00081256211073355>.

Srai, Jagjit Singh, Mukesh Kumar, Gary Graham, Wendy Phillips, James Tooze, Simon Ford, Paul Beecher, et al. 2016. "Distributed Manufacturing: Scope, Challenges and Opportunities." *International Journal of Production Research* 54 (23): 6917–35. <https://doi.org/10.1080/00207543.2016.1192302>. Sytch, Maxim, Yong Kim, and Scott Page. 2022.

"Supplier-Selection Practices for Robust Global Supply Chain Networks: A Simulation Of The Global Auto Industry." *California Management Review* 64 (2): 119–42. <https://doi.org/10.1177/00081256211070335>.

Taleb, Nassim Nicholas. 2010. "The Black Swan." PenguinRandomhouse.Com. 2010. <https://www.penguinrandomhouse.com/books/176226/the-black-swan-second-edition-by-nassim-nicholas-taleb/>.

TrendForce. 2021. "Progress in Importation of US Equipment Dispels Doubts on SMIC's Capacity Expansion for Mature Nodes for Now." TrendForce. 2021. <https://www.trendforce.com/presscenter/news/20210305-10693.html>.