Executive Summary

The main theme of the *2023 Global Value Chain Development Report* is the resilience and sustainability of value chains in response to the diverse shocks of recent years. It provides an overview of the most recent trends in GVCs (chapter 1), in particular the effects of trade tensions and the COVID-19 pandemic (chapter 2), as well as geopolitical tensions on GVCs. It illustrates some of the effects by providing case studies on energy supply chains (chapter 3) and semiconductor value chains (chapter 4). The report then turns to challenges brought about by the climate crisis. It first shows results of different methods tracing CO_2 emissions through GVCs (chapter 5) and then offers a framework to help greening GVCs (chapter 6). The report concludes with emphasizing the immense potential of GVCs for supporting inclusive development (chapter 7).

Examining GVCs in Times of Global Shocks

Chapter 1 provides an overview of recent developments in GVCs from the perspective of recent major global shocks to international trade. Recent data showed some potential for recovery, with gross exports and GVC participation increasing from 2020—an oberservation that holds true in both nominal and real terms. However, the presence of ongoing global shocks – including the Russian war in Ukraine, lingering economic effects of the COVID-19 pandemic, and trade tensions between the United States and the People's Republic of China (PRC) – may threaten to derail this trajectory, thereby promoting the need to assess potential sources of the vulnerability that GVCs have towards shocks.

One such contributor is the trade in potential bottleneck products, which are characterized as having a limited number of suppliers, few substitutes, yet constituting a considerable share of international trade. A total of 1,075 (out of 5,384) analyzed products were identified as potential bottlenecks in 2021, which had an increasing share in total export value throughout the years. Another potential source of vulnerability is geographic concentration in value and frequency of trade. Considerable concentration in sources of foreign value added (FVA) in exports is seen even before the Global Financial Crisis (GFC) hit, though this persisted even beyond the shock and well into the post-pandemic onset world. From a frequency perspective, around 80 percent of all pass-throughs in supply chains were accounted for by only a handful of economies. Though this share decreased in 2020, which may be due to the restrictions imposed on trade and mobility, the change was only marginal and considerable concentration is still observed. The economies belonging atop the rankings in FVA sources were not necessarily the same ones that recorded the most pass-throughs, and vice versa.

The calls for GVC resilience were examined through an analysis of reshoring measures and other trajectories for GVC reconfiguration. Emphasis was placed on diversification of intermediate inputs as a potential risk mitigation strategy. There is still much room to diversify away from domestic sources of input, suggesting that there is already substantial home bias across economies, regions, and sectors. Looking at the case of the PRC, which recently enforced measures to encourage furthering the domestic content of its products, mixed results are seen across different types of exports, trade destinations, and sectors. Ambiguity surrounding the impact of such policies warrants further statistical analysis to unveil the facilitating factors as well as barriers for realizing the goal of localization. To complement this analysis, looking at MNEs' participation in GVCs through the lens of trade in factor income (TiFI) is suggested for future research. Several studies including Gao et al (2023) found that dissimilarities exist in the activities of domestic owned versus foreign owned firms along global supply chains. For example, regional characteristics of current GVCs were discovered to be mostly attributable to domestic owned firms in each economy and that these enterprises were mostly involved in the three regional centers of North America (centered on the US), Europe (centered on Germany), and East Asia (centered on PRC), serving as the driving force for the regionalization of current supply chains. On the other hand, the value-added creation of foreign-owned MNEs typically exhibited more global characteristics.

The calls for GVC resilience were also examined through an analysis of reshoring activities. Emphasis is placed on reshoring from the perspective of domestic agglomeration. Backward and forward agglomeration indices have been on the downtrend from 2019 to 2021 in many economies, providing little evidence of reshoring activities in this period. The United States, however, showed some signs of reshoring for some of its sectors that registered increases in their backward agglomeration indices.

Effect of Trade Tensions and the Pandemic on GVCs

Chapter 2 primarily focuses on the effects of trade tensions and the COVID-19 pandemic on GVCs, as well as the effects of digital technology on the recovery and trend toward reshoring. This chapter shows that both trade tensions and the pandemic have led to substantial changes in GVCs as they led to higher tariffs and non-tariff measures (NTMs). NTMs and tariffs can accumulate along GVCs as intermediate goods cross border several times, leading to higher costs for downstream producers. Global trade tensions have led to significantly higher trade costs since 2018 and pose a threat to the development of GVCs. Similarly, the shocks to GVCs caused by the COVID-19 pandemic has brought significant disruption to the global economy.

The trade tensions increased the tariff burden of global production, especially for downstream producers. The tariffs of some intermediate inputs imported by the PRC jumped 47%, due to the PRC's retaliatory measures and cumulative effect along GVCs. The US and the PRC incurred an additional indirect tariff burden of 10 and 6.5 billion dollars, respectively, while third-party countries incurred additional indirect tariff burden of 30%–70%. Interestingly, indirect tariffs in most sectors in the PRC increased by around 50%, while they increased by more than 150% in the US. Additional non-tariff burdens induced by the trade tensions and the COVID-19 pandemic mainly affected less-flexible firms.

While the trade tensions do not appear to have affected total global trade volumes, they led to significant changes in the geographical patterns of GVCs. The PRC shifted its export focus to East Asia and Pacific region and Europe and Central Asia region, while the US forged closer trade ties with Canada and Mexico. Both the PRC and the US reorganized their imports from the Europe & Central Asia region, the East Asia and the Pacific region, and Latin America & Caribbean region.

In contrast, the COVID-19 pandemic led to sharp decline in global trade volumes, but the process reversed quickly. Numerical modeling suggests that all economies should have fully recovered by 2025, albeit at different speeds. The data also shows that non-GVC trade and trade-related activities significantly contracted during the COVID-19 pandemic, leading to an increase in pure domestic consumption. Meanwhile, cross-border trade involving MNEs slightly increased as a result of stronger links between MNEs and domestic firms.

The effects of digitalization on the recovery were also analyzed and further evidence was obtained in support of the hypothesis that economies with superior digital infrastructure were less affected than other economies during the COVID-19 pandemic. Global demand for digital technology led to increased investment in high-tech industries, thereby boosting FDI-related activities.

Disruptions of World Energy GVCs

Chapter 3 takes up the issue of how these shifts in value chains affect the world energy transition and climate governance. One major possibility is that the EU countries may use the Russian war in Ukraine as an opportunity to speed up the development of renewable energy and realize energy transition earlier than expected. On the other hand, due to the energy crisis and the huge energy demand, some economies gave up their phasing-out-coal policy and began to increase the use of coal and to restart coal-fired power generations. These shifts led to a temporary increase of carbon emissions and may delay the UN's net-zero emission strategy and carbon neutrality timetables.

The long-lasting PRC-US trade tensions and the ongoing Russian war in Ukraine are fueling geopolitical tensions. These geopolitical tensions have made geopolitical concerns surpass economic interests and become the dominant factor affecting world energy trade and economic development. All these dynamic movements are giving huge impacts on global energy supply chains.

Our CGE scenario analyses demonstrate that the Russian war in Ukraine and various sanctions against Russia will reshape the patterns of the world energy trade and formulate some new regional energy supply chains: the EU-US energy supply chain, the Eurasia energy supply chain, and the diamond shaped energy supply chains of US-Japan-Australia-India.

The Semiconductor Supply Chain

In 2023, the global semiconductor industry has clearly reached a new critical juncture, where supply chain resilience, national security, and competition for technology leadership are challenging the highly popular and efficient "fabless" model through which chip design and semiconductor manufacturing (known as wafer fabrication in "fabs") can be separated organizationally and geographically. The recent COVID-19 pandemic, global chip shortages, and the US export restrictions on semiconductor technologies have accentuated worldwide attention to this important high-tech sector and its supply chain configurations. Many national governments in advanced economies have now placed far greater urgency on, and enacted specific industrial policies for, (re)building their domestic semiconductor manufacturing capacity. The rise of this new techno-nationalism is transforming the highly internationalized semiconductor industry into the age of "real nation-states should have fabs".

Chapter 4 provides substantial empirical evidence for several key observations on the global semiconductor supply chain. We find that vertical disintegration has driven the globalization of semiconductor production over time. The rise of fabless chip design firms and their manufacturing suppliers, known as foundry fabs, represents one such key driver. This "fabless revolution" starting in the US since the 1980s can be explained by high costs in chip design and production, financial market pressures for short-term profits, and the rise of efficient foundry fabs in East Asia. We show that government support was crucial in the initial development of East Asian memory chip producers (e.g. Samsung) and foundry fabs (e.g. TSMC) in the 1980s. Since 2010s, important market shifts in industrial applications towards computers/data storage and wireless communications have been crucial in explaining the rapid growth of leading fabless firms, foundry producers, and integrated manufacturing firms in microprocessors and memory chips.

Meanwhile, massive innovations in semiconductor technologies have resulted in extremely high costs of cutting-edge chip design and manufacturing since 2010. Only a few market leaders from the US, the EU, and East Asia now dominate in the different segments of semiconductor global value chains, from design software and intellectual properties to materials and equipment suppliers. By the turn of 2020s, the ever-more sophisticated processes of chip design and production and their concomitant ecosystems of highly specialized firms mean that no single economy can be self-sufficient in the entire semiconductor value chain. In this context, semiconductor GVCs in the post-pandemic era are in transition as more national economies want to have their own fabs for national security and risk mitigation reasons. Nevertheless, we note that this pursuit of "fabs everywhere" through technological sovereignty is unlikely to be realistic because of the complex organization of existing semiconductor GVCs and the extreme demand for technological capabilities and capital investment in cutting-edge chipmaking. It will likely result in a fragmented rather than integrated global semiconductor market, which would inevitably undermine the sector's economies of scale and trust relationships and, even worse, lead to excess capacity, underutilized fabs, and technological bifurcation worldwide.

GVCs and Climate Change

Chapter 5's point of departure is that GVCs have led to a surge in CO_2 emissions from international production sharing through both trade and investment (e.g., FDI) channels. The GVC phenomenon, which involves multiple cross-border flows of intermediate goods, may complicate the implementation of the Paris Agreement, which relies on a patchwork of national policies. A persistent challenge in international climate change negotiations is how to allocate responsibility for global warming among various participants in GVCs, such as producers, consumers, exporters, importers, investors, and investees.

This chapter presents a consistent GVC accounting framework (Meng et al, 2023) that allows us to trace the CO_2 emissions responsibility of different country-sector-bilateral combinations through various trading routes. Our results show that the emissions from production processes in developing countries, based on their own responsibility for CO_2 emissions, have accounted for a large share of global emissions growth since 2001 and reached a peak in 2019. This is worrisome because most developing countries have weaker environmental regulations and lower enforcement levels. Given the fact that GVCs are rooted in domestic sources, it is imperative to curb these emissions with more effective tools including environmental regulation, taxation, and the introduction of carbon trading schemes (ETS) domestically. Taking the PRC as an example (see Tang et al. 2020), if more balanced regulations coverage and more equal access to the financial system for heterogeneous firms (no matter they are large-scaled or SMEs, state-owned, foreign-invested, or private firms) could be introduced, the PRC's 2030 commitment to reduce carbon emissions could be achieved more efficiently with less GDP loss (its

green investment would be 64% lower, and its energy efficiency would be 71% higher than in the business-as-usual scenario). Once the PRC can get "greener" in its domestic production, its exports via GVCs will also be greener.

Although the carbon intensity of GVCs, as measured by emissions per unit of value-added, has decreased in both developed and developing countries between 1995 and 2021, generating GDP through international trade is still a more carbon-intensive process than generating GDP through purely domestic value chains. In this regard, introducing a Carbon Border Adjustment Mechanism (CBAM) in the context of a trade-investment-environment nexus, should be an option to promote the formation of green GVCs in the Paris Agreement era. However, a well designed CBAM at the global level is crucial for getting consensus to increase carbon cost and reduce carbon leakage. For example, applying a GVC-based CGE simulation analysis to the EU's CBAM, (Qian et al. 2023) show that GDP would rise in several EU countries, while CO_2 emissions outside the EU would be reduced. However, the EU's CBAM would also trigger a slight increase in total CO_2 emissions within EU due to the "rebound effects" and carbon leakage across EU countries; most countries, especially the non-EU countries, would suffer a larger decline in consumers' welfare. Therefore, our suggestion is that carbon border adjustment should be designed along GVCs at the country-sector-bilateral level, based on each country's share of responsibility for CO_2 emissions, rather than a simple one-way imposition like a trade tariff.

In addition to looking at responsibility at the country level, we also examine the roles of MNEs, who are the main actors in GVCs. Based on MNEs' complex production arrangements, global CO_2 emissions are transferred not only between investing countries (home countries) and producing countries (host countries), but also among other consuming countries (third countries) in the GVC network, which adds to the complexity of global carbon transfer. From a global perspective, about 30%-40% of MNEs' carbon emissions are embodied in their exports to third countries, but these shares vary across different economies due to different FDI motivations and GVC production arrangements of MNEs. Of all these third-country induced emissions, nearly 80% of them are related to GVC activities, but this share is only 60% in India and over 90% in Australia, and the GVC position of host countries is an important factor for this difference. In the textile sector, for example, nearly 1/3 of MNEs' emissions are generated in the PRC, and 50% of them are induced by third countries, while this share is only 14% in the US and more than 90% in Viet Nam. In the motor vehicle sector, the largest emissions of MNEs are generated in South Africa, followed by the PRC and Mexico; however, in South Africa, over 50% of MNEs' emissions are induced by third countries, while in the PRC, this share is merely 20%, and in Mexico, nearly half of MNEs' emissions are induced by their home countries.

The transnational investment of MNEs also affects the distribution of emission responsibility and economic benefits across countries. Overall, during 2005-2016, the factor income-based accounting (FIBA) value-added and CO_2 emissions of advanced

economies are underestimated by 415.37 billion USD to 489.63 billion USD and 287.23Mt to 766.50Mt, respectively, while those of emerging markets and developing economies are overestimated. The latter bears some of the emission responsibility of the former, which partly supports the pollution haven hypothesis. From the national perspective, major FDI-outflowing economies receive more factor income and incur less environmental cost, while major FDI-inflowing economies receive less factor income and incur more environmental cost. As of 2016, the cumulative net carbon transfers from advanced economies to emerging markets and developing economies through MNEs' investment amounted to 1800.80 Mt. If this environmental cost is converted into incentive funding, it would provide an additional 26.61 billion USD to supplement the Green Climate Fund (GCF). Our research provides a useful reference point for future negotiations of carbon responsibility sharing across countries and offers a feasible way for financing the GCF, which will facilitate the achievement of the net-zero emission target consistent with the Paris Agreement.

Although there is a general agreement on the principle of "common but differentiated responsibilities" (CBDR) among the international community, many challenges remain in implementing it effectively. Given the increasing difficulty of limiting global warming to 1.5°C and the fact that most developing countries have no absolute emissions reduction targets and relatively weak environmental regulations, it is crucial to help these countries set appropriate and ambitious targets for reducing carbon emissions and/or achieving carbon neutrality, which could help curb the current rapid rise in global CO_2 emissions. The Paris Agreement allows countries to start from different points and pursue different ambitions toward their own carbon neutrality goal, and uses production-based accounting to measure their emissions (e.g., the original idea of carbon neutrality at the individual country level means taking full responsibility for all direct and indirect emissions), without explicitly considering the responsibility sharing of carbon leakage caused directly and indirectly by international trade and investment. This implies that a net carbon exporting country and a net FDI inflow country might bear more responsibility in achieving its own carbon neutrality goal, while a net carbon importing country and a net FDI outflow country might bear less responsibility than needed. In this sense, negotiating about responsibility sharing for carbon leakage across countries is inevitable if we want to achieve the global goal of net-zero emissions.

GVC Greening: A Conceptual Framework for Policy Action

The environmental impact of GVCs can be decomposed into three different mechanisms. First, a *scale effect*, whereby an increased level of production leads to increased transport volumes and travels, waste production, and overexploitation of scarce resources, with detrimental effects on the environment. The second mechanism is the *composition effect*, whereby GVCs break up the production process into tasks that can be shifted from one location to another. This leads to environmental benefits

when production tasks are relocated where it is the most efficient, or environmental costs when carbon-intensive tasks are relocated to jurisdictions with lax regulations. The third and last mechanism is the *technique effect*, whereby knowledge flows among firms along a value chain facilitate the development, adoption, and adaptation of environment-friendly production techniques. The phenomenon of net environmental gains from the introduction of environmental innovation into GVCs is commonly referred to as 'GVC greening.'

Chapter 6 presents a conceptual framework to investigate: (i.) why GVC greening occurs; (ii.) the types of environmental innovation undertaken in GVCs; (iii.) the actors involved; (iv.) how the greening occurs in GVCs and their different stages; and (v.) the outcomes of GVC greening. The framework lays the foundation for a discussion of policy actions aimed at maximizing net environmental gains through the technique effect (GVC greening) and establishing strong accountability mechanisms to discourage pollution outsourcing.

The chapter reaches three key conclusions. First, while GVC greening has institutional, market, and technological drivers, institutional drivers still play the leading role. New policies and legislation related to domestic or global sustainability transformation agendas are central to GVC greening. Market and technological drivers are also important, but tend, ultimately, to be driven by institutional issues.

Promoting such drivers requires a shared effort among institutional actors at national and global levels. However, as advanced economies are increasingly competing to gain competitive advantage in new green technologies, domestic policies play a greater role than global concerns.

Governments turning sharply away from multilateral cooperation may pose a major challenge to promoting environmentally friendly GVCs. A way forward to safeguard multilateralism and global institutional drivers sustaining GVC greening is to invest in initiatives developed among smaller groups of like-minded economies. One example is the Breakthrough Agenda, involving 45 economies and the private sector to accelerate the shift to green technology in different industries. Coordination at the global level, e.g., a single international carbon tax rate, might also help promote the transition towards the net-zero emission goal.

The second key message is that several actors, not only lead firms but also suppliers, national and local governments, and often a combination of them, contribute to GVC greening. In some cases, suppliers anticipate future environmental requirements to leverage their environmental upgrading initiatives as a competitive factor to access new buyers and markets.

However, the greening opportunities may not be equal among suppliers. Several studies show that lead firms do not always provide enough financial, managerial and knowledge resources for their suppliers to implement green strategies, leaving them out of the chain if they are unable to meet such requirements. This risk is particularly high for small firms in developing economies but also in developed ones.

Uneven distribution of costs, benefits, and rewards for greening value chains poses a challenge for policymakers to address this supplier-squeeze. Actors external to the GVC, such as national or local governments, NGOs, and independent certification bodies, can provide technical and financial support to suppliers in GVCs to implement environmental innovations. National or sub-national public actors can provide the basic infrastructure that contributes to GVC greening.

Finally, there is very limited evidence on the biophysical outcomes of GVC greening. There are important tradeoffs between environmental and socioeconomic outcomes, and the final assessment of whether GVC greening happens or not generally remains a research gap in most of the existing studies. Therefore, accounting, monitoring, and disclosing the environmental outcomes and the possible tradeoffs with socioeconomic outcomes are challenging but essential dimensions to investigate along the entire value chain. However, once again the transboundary nature of GVCs poses a challenge that requires multilateral efforts to orchestrate and harmonize private and national initiatives to monitor environmental outcomes.

Towards Inclusive GVCs

Chapter 7 explores the role of GVCs in driving inclusive development within developing economies. Inclusiveness is a key aspect of resilient and sustainable GVCs. As the backlash against globalization in advanced economies has shown, rising inequality can lower political support for trade and increase barriers to GVC integration. Moreover, since the impacts of shocks tend to be unevenly distributed within economies, it is important that all parts of society are able to recover quickly for the economy as a whole to be resilient. GVCs can also accelerate (green) technology diffusion from technological leaders to the less innovative. Therefore, by prioritizing inclusiveness, GVCs can play a pivotal role in building sustainable and resilient economies for the benefit of all stakeholders.

The topic of this chapter holds more significance than ever for two reasons. First, the negative shocks prompted by the COVID-19 pandemic, geopolitical tensions, and the environmental crisis have been shown to disproportionately hurt certain groups within developing economies, such as low-skilled workers, female employees and MSMEs. Second, consumers are increasingly aware of the spillover effects of their choices on workers in developing economies. This has triggered renewed efforts by policymakers and investors

to address inclusiveness in supply chains. Ensuring that the resulting policy responses are grounded in solid evidence is important for them to achieve lasting improvements.

The chapter has two key messages: First, GVC integration leads, on average, to better outcomes for firms and workers in developing economies. The evidence consistently shows that local suppliers to MNCs and firms exporting intermediates outperform other firms in developing economies. In particular, GVCs provide MSMEs with chances for quality upgrading, knowledge spillovers, technology transfers, and innovation through their affiliations with lead firms. The chapter shows in this regard that firms in developing economies with higher GVC integration tend to have substantially better management practices. Furthermore, becoming part of GVCs can assist in alleviating credit constraints, a substantial challenge encountered by MSMEs.

The performance premium spills over to workers as well. Being employed at MNCs or their suppliers generally results in higher wages and better working conditions, including a higher likelihood of formal employment. For instance, in Cambodia, a surge in garment exports to the EU induced a 16-22 percent increase in employment at formal establishments. Women often benefit from these developments in particular. However, several non-trade related constraints, like access to education, limit their upgrading opportunities. In this regard, the chapter shows that GVC integration lowers gender wage gaps in low-skill occupations but has essentially no effect on inequality at high-skill occupations such as managerial positions.

The second key message is that where GVC integration fails to deliver or underdelivers on benefits, it tends to be caused by underlying market failures and policy barriers rather than GVC integration itself. An important example is market power. Both monopolistic/oligopolistic and monopsonistic/oligopsonistic behaviour of firms on product and labour markets can severely skew the distribution of profits in value chains and put undue pressure on local suppliers to cut costs with negative implications for workers. The chapter highlights a study showing that the income of Ecuadorian farmers in agricultural GVCs would be 77% higher if intermediaries behaved competitively. Other key factors are limited adaptive capacity due to incomplete financial or labour markets in developing economies.

These two findings have important policy implications. Since GVC integration tends to benefit firms and workers, the focus should be on facilitating entry into GVCs and spillovers to the domestic economy to ensure that GVCs are truly inclusive. To maximize the potential of GVCs for inclusive development, it is crucial to address the underlying market failures and barriers that lead to an uneven distribution of the gains from GVCs.

The current policy focus is on non-trade provisions (NTPs) in regional trade agreements, import bans and restrictions, and due diligence requirements (DDRs). However, these policies often aim at improving working conditions exclusively within GVCs even though the evidence suggests that workers and firms within GVCs already enjoy better outcomes. As a result, they might aggravate existing differences between those inside and those outside GVCs. Moreover, many of these policies have been shown to produce adverse effects. The inclusion of NTPs in trade agreements can potentially hinder country-level inclusion in GVCs by raising costs and uncertainty. DDRs appear to assume that firms willingly underpay workers or refuse to improve working conditions, but this is not in line with the evidence. To make sure that these policies work in favour of inclusive development, they should be accompanied by more cooperation and take into account the lessons from the academic literature.

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