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Navigating the Complexity: The Sustainability Challenges in Global Value Chains

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Keywords

global value chains, literature review, governance, supply chain management, sustainability

Abstract

The global value chain (GVC) framework may provide a systematic approach to depict and advance sustainable path options at the global, national, and local scales. However, a coherent picture of the fragmented body of knowledge on the sustainability implications of GVCs is lacking. In an attempt to delineate the most effective perspective for addressing sustainability challenges within GVCs, this review explores the main academic streams that have emerged in response to the pressing need for detailed insights into GVCs. These academic streams include sociological, economic, and management approaches. We examine the intersections and distinctions among them, evaluating whether they converge or diverge in addressing sustainability within GVCs. By discussing the limitations and potential of these approaches, we suggest a possible integrated and appropriate research agenda to achieve an encompassing and still operative perspective to address current sustainability challenges.

1. INTRODUCTION

Inherently complex and multidisciplinary, sustainability demands a holistic view that integrates economic, environmental, and social dimensions. The operational path toward this comprehensive approach is challenging, especially when there is a lack of unity of action, place, and time among those intertwined pillars. In today's world economy, where interconnected production processes distribute tasks and business functions among several companies globally or regionally, the global value chain (GVC) framework may provide a systematic approach to depict and advance sustainable paths at the global, national, and local scales (De Marchi & Gereffi 2023). Over recent decades, research on GVCs has undergone profound transformations. The increasing global fragmentation of production and the rise in cross-border transactions have highlighted the significance of tracing and understanding GVCs (Antràs & Chor 2022, Johnson 2018). Addressing sustainability in GVCs demands a nuanced examination of their intricate components. This encompasses a spectrum of elements, ranging from GVC governance and network mapping through nuances of multinational corporations' (MNCs)¹ strategies, dynamics, and host country selection, and the multifarious impacts of financialization and digitization.

A major obstacle in the field of GVCs is the lack of academic consensus on a theoretical framework (Kano et al. 2020), an issue that becomes even more pronounced when examining GVCs through the lens of sustainability (Negri et al. 2021). However, despite the seemingly disparate perspectives, such as Immanuel Wallerstein's world-systems theory and the study of environmental regulations for Central American coffee producers (Blackman & Naranjo 2012), both offer crucial insights into understanding GVC sustainability. This diversity of viewpoints leads us to ask what perspective best addresses the sustainability challenges within GVCs.

Our review acknowledges the critical need for selecting an appropriate framework but does not aim to provide an exhaustive analysis of GVC frameworks, given the detailed discussions by scholars such as Antràs & Chor (2022), Chor (2019), Johnson (2018), Kano et al. (2020) and Ponte & Sturgeon (2014). In the term global value chain there is the word chain, as chains physically connect industries and countries around the world. Echoing the French poet Nicolas Boileau, "Ce que l'on conçoit bien s'énonce clairement, / Et les mots pour le dire arrivent aisément"² (Boileau-Despréaux 1674), we emphasize that accurately delineating the path of those chains is crucial before assessing their sustainability aspects (Bush et al. 2014, Cabernard et al. 2019, De Marchi et al. 2019). Then, once the physical paths of GVCs are clearly identified, the key issues to address emerge at different economic levels. This especially applies at the microeconomic level, focusing on firm behaviors and strategies and at the mesoeconomic level, concerning foreign direct investment (FDI) and strategies of MNCs, and when mapping relationships and governance structures. Lastly, the governance topic makes the shift to management studies, which underline the scarcity of spontaneous market coordination within GVCs, highlighting the necessity for explicit governance frameworks that manage power dynamics and decision making, predominantly overseen by MNCs.

This review does not catalog every challenge but focuses on the latest sustainability-oriented developments within GVCs, weaving together academic advancements to form a coherent analytical framework. This includes discussions on the environmental footprint (Wiedmann & Lenzen 2018), precise delineation of this footprint (Beaufils et al. 2023), governance issues (Lund-Thomsen 2019), environmental and social upgrading (De Marchi et al. 2019), and many others detailed here. Furthermore, we explore the intersections and distinctions among various academic

¹We define MNCs as firms that conduct direct business activities and own assets in at least two countries (Dietrich & Krafft 2012).

²This can be translated as: Whatever is well conceived is clearly spoken, and the words to say it flow with ease.

fields, assessing whether they converge or diverge in their approaches to sustainability in GVCs. In discussing their limits and potentialities, our contribution aims to suggest an appropriate research agenda.

Given the context of multiple frameworks and the absence of a unified academic consensus on a theoretical framework (Kano et al. 2020), Section 2 outlines the boundaries of our review and introduces the conceptual frameworks we address.

2. TRACING, MAPPING, AND MEASURING THE SUSTAINABILITY OF GLOBAL VALUE CHAINS: A PELL-MELL OF CONCEPTUAL FRAMEWORKS

Given the wide range of theoretical perspectives employed to navigate the multifaceted sustainability challenges of GVCs, it is essential to provide context. Throughout this review, we find ourselves weaving through a tapestry of theoretical frameworks and concepts, a process illustrated in **Figure 1**. This diagram synthesizes key sustainability aspects drawn from the insights of Bush et al. (2014), De Marchi et al. (2019), Kano et al. (2020), Negri et al. (2021), and Tagliani & Winkler (2016). While not exhaustive, owing to the inherent complexity and occasional contradictions among GVC theoretical frameworks, it serves to delineate the potential interrelations among the different analytical perspectives, with a particular focus on sustainability.

Although the boundaries are often blurred, we distinguish three main methodological streams that have emerged in response to the pressing need for GVCs detailed insights³ (Kano et al. 2020, Sturgeon 2019). The first stream is rooted in economic geography, economic sociology, and political economy (see **Figure 1**). From a broader social science angle, this does not adhere strictly to one methodological approach but utilizes an array of tools. It aims to map business relationships end-to-end, focusing on aspects like governance typology, power dynamics, and international regulatory impacts (Gereffi 2001). While this stream has been instrumental in engaging policymakers and been pivotal in incorporating sustainability as an essential and inherent component within globalized networks, its insights are frequently seen as qualitative (Kano et al. 2020) (e.g., operational efficiency, cohesiveness/connectivity, institutional changes) and specific to certain cases rather than broadly applicable (Sturgeon 2019). Lastly, Kano et al. (2020) further identify a critical aspect of this framework: It is primarily descriptive (see Section 3).

A second academic stream has developed mostly from international and development economics, specifically focusing on delineating the GVC network and the flows of FDI and their related environmental and social footprints. Three focal points emerge from this second stream: macro, meso, and micro approaches.

On a macrolevel, the focus is on analyzing country-specific or industry-country-level linkages, assessing the quantitative importance of GVCs in international trade and gauging the environmental and social impacts of the GVCs as well as the repercussions of trade policy shocks along GVC-trade and macroeconomic variables. Empirically, it relies on trade statistics, primarily national input-output tables (IOTs) merged with bilateral trade data. Theoretically, it formulates interpretations for counterfactual analysis, emphasizing GVCs' role. This macrolevel analysis is detailed in Section 4.

³An historical fourth approach is also mentioned in the literature. It has foundations in business administration, economics, and information technology during the 1990s. This perspective, initially delineated by Porter (1985), seeks to assess the strategic significance of geographic locations in the global economy from both a competitive and knowledge-exchange standpoint (Porter 2000, Tallman et al. 2004). This approach is not further elaborated here, given its historical limitations and lack of theoretical and empirical support (Bush et al. 2014, Martin & Sunley 2003, Yu & Jackson 2011).

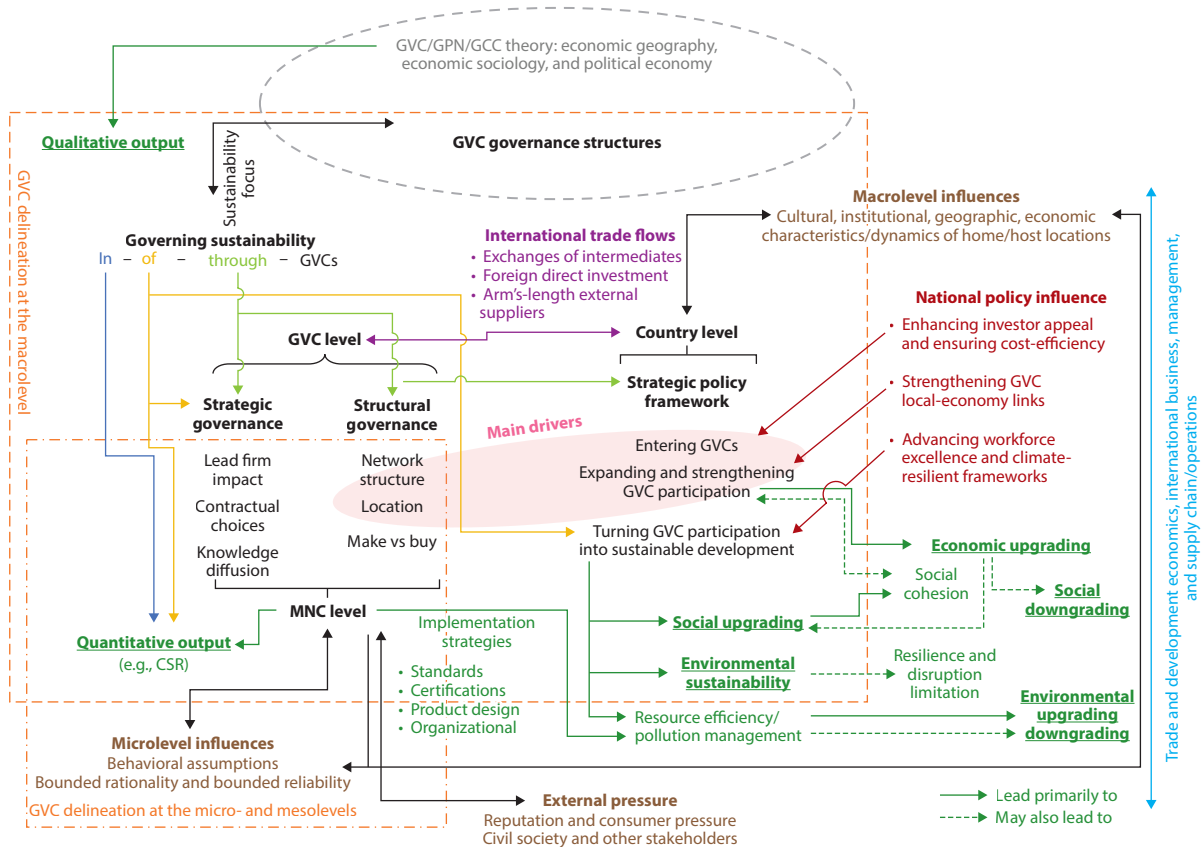


Figure 1

GVC conceptual frameworks and their links with sustainability. Diagram depicts the interconnected nature of GVCs and the multifaceted approach to sustainability within them. It synthesizes key components from various GVC frameworks. Sustainability governance aspects identified by Bush et al. (2014) (blue, yellow, and light green arrows) illustrate their impacts at both firm and country levels. International trade flows (purple), economic pressures/drivers (brown), and key policy options influencing GVC expansion and its evolution toward sustainable developments (red) are from Taglioni & Winkler (2016). Also depicted are primary sustainability outcomes (dark green) with major sustainability categories (bold, underlined dark green). Dashed arrows are shown only between economic upgrading and social up- and downgrading, as the links between these elements are still unclear from a theoretical standpoint. Some aspects are intentionally simplified for clarity; readers are encouraged to consult the original documents for a full appreciation of the complexities involved. Figure based on data from Kano et al. (2020), Taglioni & Winkler (2016), Negri et al. (2021), Bush et al. (2014), and De Marchi et al. (2019). Abbreviations: CSR, corporate social responsibility; GCC, global commodity chain; GPN, global production network; GVC, global value chain; MNC, multinational corporation.

On the micro- and mesolevels, the examination shifts to how individual firms and especially MNCs engage in GVCs, viewing global trade as a collection of individual firm decisions on trading and production. Theoretically, the microlevel approach seeks to develop tools to address firms' intricate challenges when mapping out their global production strategies and their implication for climate change and social sustainability. Details on this firm-centric view are provided in Section 5.

The third academic stream pertains to management and international business and focuses on governance in GVCs, which encompasses a range of principles, structures, and processes, considering societal and environmental impacts. It is composed of a tangle of different theoretical frameworks and theories. As illustrated in **Figure 1**, governance is divided into structural

governance, focusing on the network's organization (e.g., make versus buy decisions, organizational structure, activity allocation, decision-making centralization), and strategic governance, which deals with managing resources and practices for smooth network operation (Kano et al. 2020). Despite those differences, a particular distinction of this third management and international business stream is to use quantitative success metrics, encompassing both financial indicators (e.g., market capitalization, sales growth, and return on assets) and nonfinancial criteria [including capability development, labor coordination, transaction cost reduction, and corporate social responsibility (CSR) outcomes] (see Section 6).

3. ECONOMIC GEOGRAPHY, ECONOMIC SOCIOLOGY, AND POLITICAL ECONOMY: A BROAD APPROACH BUT A LIMITED PREDICTABILITY

In exploring the economic geography and economic sociology literature about international networks governing the organization of global production and consumption, a historical trajectory of three interconnected approaches is evoked (Bush et al. 2014, Ponte & Sturgeon 2014, Kano et al. 2020): global commodity chains, global value chains, and the global production network.

Historically, a first scholarly tradition emerged, drawing from the political economy perspective of the world-systems theory. This led to the development of the commodity chains concept (Hopkins & Wallerstein 1977), shedding light on global economic interdependencies and labor divisions. Yet, despite its insights, this approach's linear narrative—tracing low-value production in peripheral areas to high-value consumption in core regions (Hughes & Reimer 2004)—often missed nuances regarding agency, domestic economic intricacies, and the sustainability of global production. Indeed, while commodity chain studies and world-systems theory highlighted natural resources and global resource equity, they did not significantly connect to the environmental impacts of these chains (Bush et al. 2014). Shifting focus from the world-systems theory to delve deeper into the relational dynamics of production and consumption, the concept of the global commodity chain (GCC) emerged (Gereffi 1994, 1995). Moving beyond merely structural aspects (Bair 2009), this approach incorporates nuanced elements such as culture, quality, and consumer-driven systems. A distinctive aspect of the GCC framework is its emphasis on a segment of firms previously underrepresented in scholarly discussions: global buyers. This group includes both major retailers and well-known branded merchandizers and agrifood processors, as identified by Ponte & Sturgeon (2014). This framework provided a pioneering lens to scrutinize global production, introducing the idea of drivenness and distinguishing chains based on whether they were producer-driven or buyer-driven (Gereffi 1994). However, as critiques appeared around the GCC's limited scope and binary distinction, there was a transition toward the GVC approach by the end of the 1990s.

The nature of this shift leading to the second approach is subject to debate. Some scholars have argued that this shift was primarily terminological (Daviron & Gibbon 2002) or more methodological than theoretical (Peters 2008), whereas others point out a more profound emphasis on industrial structure and transaction cost economics (Sturgeon 2009). Whatever the theoretical degree of separation between GCCs and GVCs, they present some differences (Ponte & Sturgeon 2014). GVCs put forward the concept of value addition, resonating with a broader emphasis on economic development. In this context, human, natural, and material resources are converted into economic profits within an interconnected capitalist framework (Bush et al. 2014). GVCs also deviated from GCCs' narrow drivenness perspective, focusing on a more socially integrated perspective and emphasizing the intricacies of information management, information codification, and the ability of participants within the chain to comprehend and utilize that information

effectively (Gibbon et al. 2008). Yet, critics believe that the GVC oversimplifies coordination (Gibbon & Ponte 2005), underrepresents intranode activities (Derudder & Witlox 2010, Sassen 2010, Vind & Fold 2010), and inadequately incorporates sustainability goals (Bush et al. 2014).

The third framework, known as the global production network (GPN) approach that originated from economic geographers in the 1990s, offers a nuanced perspective on the interconnected nature of global production (Kano et al. 2020). It underscores the global orchestration essential for producing and distributing goods and services, emphasizing the socio-spatial dimensions of production and consumption. Integrating perspectives from actor-network, commodity circuits, and convention theory, the GPN offers an all-encompassing analysis that seamlessly connects global, national, and local scales (Bush et al. 2014, Kano et al. 2020). While the GVC sheds light on the global structure and governance of value creation and distribution, the GPN emphasizes the interconnected nature of production, its firm-specific dynamics, and the importance of nonfirm actors. Yet, critics point out that the GPN, despite its primary network focus, often remains aligned with a linear perspective, from producers to consumers. Moreover, its examination of sustainability largely confines to natural resource exploitation, sidestepping broader environmental concerns (Bush et al. 2014).

The GCC, GVC, and GPN theories are increasingly seen as facets of a cohesive approach (Derudder & Witlox 2010). Ponte & Sturgeon (2014) postulate that the differences are predominantly discursive rather than substantive, with each framework underscoring the pivotal elements of labor dynamics, value generation, and economic determinants. On the sustainability front, this conceptualization presents some strengths and weaknesses. On the one hand, those frameworks share predominant qualitative outputs (see **Figure 1**) that are better suited than quantitative outputs for investigating complex and multifarious subjects, such as the whole sustainability outcomes of the GVC, industrial/economic development, and positive institutional change (Coe et al. 2004, Kano et al. 2020, Yeung 2016).

On the other hand, the core aim of these methodologies is to unpack the structure of the global economy within the economic system. Consequently, their primary lens examines the management and mechanisms of global business operations, and, in this context, sustainability is often relegated to the periphery (Bush et al. 2014). When sustainability aspects are addressed, they typically arise as an exploration of how the dominant economic model shapes social justice and environmental outcomes. Thus, sustainability is often a derivative topic, seen through the repercussions of capitalist endeavors. Nevertheless, a market-oriented economy with a profit-driven production does not merely affect these areas but fundamentally exists within and through them.

This partial incorporation of sustainability into the GVC sociological approach has been historically theorized, at least for its environmental part,⁴ by the commodity frontier (Beckert et al. 2021) perspective by placing a heightened emphasis on the interaction of global production networks with natural resources and ecological contexts (Campling & Havice 2019, Neimark et al. 2016). Drawing from Marx's theories, it highlights firms' continuous pursuit of new domains where the exploitation of nature presents profitable opportunities for capital accumulation. Instead of treating the environment as a mere input or output, this perspective argues for viewing sustainability as an integral and constitutive element of a globalized network

⁴While the theorization of the social aspect is less directly applicable to sustainability, it is important to mention Stuart Hall's idea of articulation (Hall 1980), influenced by Antonio Gramsci, which describes how capitalist expansion is connected to and shaped by social, cultural, and gender differences. This concept highlights that these links are historically constructed and can be changed, emphasizing the role of culture and politics in the economy (Werner & Bair 2019).

integrating production, trade, and consumption. As such, incorporating sustainability into the GVC necessitates a comprehensive approach to fully understand the intricate nexus between economic, environmental, and social dimensions in global trade. By embracing this approach, management of the GVC can become more inclusive, addressing broader geographies, delving into the legacies of colonialism, and recognizing the foundational role of natural resources in capitalist production. This approach leads to a more comprehensive understanding of how economic activities, sustainability, and ecosystems worldwide are interconnected, offering a clearer view of global economic processes (Campling & Havice 2019).

Given how sustainability has been historically integrated into various theoretical frameworks of chains and networks, it appears that they have been insufficiently explored or overlooked within mainstream management studies. This partial integration could be explained by the fact that practical fields such as management aim to reach predictive capacity (Kano et al. 2020) that require further quantitative outputs. In contrast, achieving predictability in social sciences, economic geography, and sociology is particularly challenging due to their reliance on the uncertain assumption that all other conditions remain constant (*ceteris paribus* conditions) (Bhaskar 1998, Kano et al. 2020).

Yet, referencing the work of Bush et al. (2014) offers a bridge. They highlight the profound interplay between governance structures and the dynamics of production, trade, and consumption, particularly in steering sustainability decisions across a spectrum of stakeholders. This nexus suggests that the *modus operandi* of the production, trade, and consumption of goods, which are the main constitutive elements of sustainability in GVCs, is primarily and closely tied to governance mechanisms. Consequently, this allows our analytical lens to zoom from an overarching sustainability framework to a sharper focus on governance dynamics within the value chain to assess the whole sustainability of GVCs.

However, even with a more precise scope, the question of governance in GVCs remains protean and complex. For instance, this concept has been at the intersection of complementary mechanisms in terms of sustainability assessment but is as different as CSR, sustainable trade movements, certification schemes, private governance schemes, and auditing methods, among others. To provide a structured framework facilitating the analysis of those mechanisms, we align our discussions with the tripartite framework delineated by Bush et al. (2014), which identifies three archetypal models for governing chain sustainability: governing sustainability in, of, and through chains (**Figure 1**).

Before diving into governance details (detailed in Section 6), it is important to outline the economic backdrop of these mechanisms in the next two sections.

4. DELINEATION OF THE GLOBAL VALUE CHAIN FOOTPRINT AT THE MACROLEVEL

Macrolevel GVC measurements utilize national IOTs with international trade statistics merged and structured into multiregional input-output tables (MRIOTs). Simply put, a MRIOT encapsulates aggregated information describing “from whom each industry sources inputs from around the world and to whom each industry’s output is sold at home or abroad” (Johnson 2018, p. 208). MRIOTs are usually structured between final end use (the last node of a GVC, where a commodity is absorbed into its final use) and intermediate demands (any anterior node of a GVC before its last node, when semi-transformed commodities are produced as outputs from upstream industries and are used as inputs to downstream industries). MRIOTs are familiar objects for trade economists and are now routinely used to identify the generated value-added along a supply chain between the original production to its final consumers (Miller & Blair 2009). They depict country-sector

GVC participation, either as buyers of foreign inputs to produce exports (e.g., backward participation) or as sellers of intermediates for further processing and export through supply chains (e.g., forward participation).

IOTs have been used to calibrate quantitative models of international trade for decades. Consequently, the macrolevel approach has been the base of the development of different modeling frameworks: computable general equilibrium (CGE) models (Hertel 2013, Hillberry & Hummels 2013), the Ricardian model of international trade (Eaton & Kortum 2002), its subsequent evolution via input-output linkages across industries (Caliendo & Parro 2015), and multistage approaches, wherein production technologies encompass a set sequence of value-adding stages (Antràs & Chor 2022). Although several of these models have been adapted to incorporate sustainability elements, their primary focus is to understand the global economy's response to various shocks, especially trade policies (Antràs & Chor 2022). Consequently, while they can identify environmental and social impacts within the GVCs, their primary uses, rooted in trade, are not mainly geared toward assessing the sustainability aspects of the GVCs. However, it is crucial to underscore the evolving inclination toward integrated assessment modeling. For instance, some derivatives from the Global Trade Analysis Project (GTAP) CGE model, MAGNET (Woltjer & Kuiper 2014), and SIMPLE-G (Baldos et al. 2020) models, among others, offer a deep dive into the economic ramifications of different environmental and social issues, signifying a promising step in bridging this gap.

In the macrolevel examination of GVC sustainability, a groundbreaking advancement has been the introduction of environmentally extended multiregional input-output tables (EE-MRIOTs) (Lenzen et al. 2012, Wiedmann & Lenzen 2018). EE-MRIOTs combine the MRIOT with the environmental impact of production. As such, rather than the value-added, this allows quantifying along the GVCs—physical flows (e.g., CO₂ emissions, NH₃ emissions), natural resource depletions (e.g., ore extraction), and environmental damages (e.g., eutrophication)—and to get the sum of those externalities along the chain from the original production to the final consumption. Semantically, the sum of externalities directly within a nation's territory is called production-based accounting. Conversely, consumption-based accounting, sometimes also referred to as footprint, quantifies the emissions attributable to both the imports and exports of goods, encapsulating the entirety of emissions concomitant with a country's final demand (Beaufils et al. 2023).

Based on the EE-MRIOT development, many studies have investigated the complex global trade pattern of different environmental externalities such as material use, water use, climate change impacts, air pollution, and biodiversity loss (Hertwich & Peters 2009, Kanemoto et al. 2016, Lenzen et al. 2013, Peters & Hertwich 2008, Wiedmann & Lenzen 2018). Today, the EE-MRIOT approach is commonly used to identify externalities generated both directly and indirectly for supplying commodities to final consumers (Wiedmann et al. 2011, Wood et al. 2018).

This evolution has bifurcated academic literature and scholarly works into two main trajectories: one quantifying and measuring externalities embodied in trade and one assessing their associated broader impacts, i.e., the impact of trade (Bai et al. 2023).

The first category focuses on GVCs and assesses the carbon emissions embodied in trade through the different value chain routes. For instance, Meng et al. (2018) introduced a method to track carbon emissions across eight specific value chain paths. However, few studies from this first category integrate a consistent definition of those value chain routes (Bai et al. 2023). Regarding the second category of international impact of trade assessment, numerous studies have pursued the quantification of a nation's direct emissions arising from international trade, gauging them through the balance of embodied emissions (Dai et al. 2021, Hertwich & Peters 2009, Jiang et al. 2016, Kanemoto et al. 2016, Peters et al. 2011).

Regarding the question of delineating the paths of the value chain routes, techniques such as structural path analysis (SPA)⁵ have been foundational to quantifying intermediates' roles (Lenzen 2003), but more recent advancements like betweenness-based accounting (BBA)⁶ (Liang et al. 2016) offer nuanced insights into the externalities certain sectors introduce based on their supply chain position (Beaufils et al. 2023). The burgeoning interest in carbon markets and carbon border adjustment mechanisms and their potential repercussions, such as carbon leakage, has amplified the appeal of accounting methodologies to trace the path of GVCs, the different intermediary suppliers, and their inherent externalities. Yet, even advanced techniques like BBA grapple with obstacles, notably the potential bias that derives from the double counting arising from the back and forth of intermediates.⁷ This challenge is similar to the one faced in value-added taxation. For this value-added challenge, it has been addressed by the trade-in-value-added (TiVA) coined by the Organisation for Economic Co-operation and Development (OECD) and World Trade Organization (WTO).

The TiVA is commonly used in the GVC literature as well as in economic analyses. The TiVA framework allows reallocating the value-added components and depicts how countries integrate into GVCs, both generally and within specific industries (Borin & Mancini 2023, Koopman et al. 2014). As such, the TiVA framework allows identifying the same elements that the accounting frameworks presented above. However, there is a strong difference in terms of scope, as the TiVA is mainly used for value-added. As such, the TiVA's application has been extensive in economic analyses, and, even if Meng et al. (2018) harnessed its use to trace carbon emissions across chains, the widespread adoption of the TiVA to account for environmental or social externalities remains limited (Beaufils et al. 2023).

Recent developments have addressed this double-counting challenge in GVC analysis. Among others, the hypothetical extraction method, tied to the TiVA and closely related to the BBA, effectively measures global interconnectedness at the sector level (Hanaka et al. 2022, Tokito et al. 2022). Its application has allowed quantifying the double counting of the GVCs (Hertwich 2021) and the different GVCs passing through a given territory (Beaufils et al. 2023). Dente et al. (2018) also addressed this challenge based on a different approach. They refined the environmentally weighted material consumption indicator, which integrates material flow analysis⁸ with life cycle analysis,⁹ pinpointing some target sectors in the MRIOT based on the origins and applications of material production. This structure prevents double counting by attributing impacts uniquely to these sectors (Dente et al. 2018, 2019). This approach was further adapted to global MRIOT interactions (Cabernard et al. 2019). These developments have played a significant role in the identification of the GVCs' route, their intermediaries' steps, and the quantification of their

⁵SPA denotes a procedure based on consumer accounts that breaks analysis indicators into the sum of an unlimited number of production chains (or paths) and is used to analyze the contribution rate of different paths.

⁶BBA utilizes SPA in tandem with the concept of betweenness centrality, a measure of a node's role as a bridge along the shortest path between two other nodes. It evaluates a node's ability to relay information in a network; within the context of MRIOs, it quantifies how a sector, acting as an intermediary, influences externalities in supply chains (Beaufils et al. 2023).

⁷We employ this term in the same vein as Liang et al. (2016), Beaufils et al. (2023), and Tokito et al. (2022), i.e., allocating externalities to the same entity repeatedly, which could result in overestimating the social or environmental impacts.

⁸Material flow analysis is a systematic assessment of the flows and stocks of materials within a system, often used to trace substances in environmental or industrial processes.

⁹Life cycle analysis is a methodology for evaluating the environmental impacts of a product or service throughout its entire life cycle, from raw material extraction to end-of-life disposal.

externalities and were thus designed to comprehensively analyze a country's externality impacts in global trade (Beaufils et al. 2023, Cabernard et al. 2019, Hanaka et al. 2022).

The analyses based on extended MRIOTs have predominantly emphasized environmental dimensions of sustainability, leaving the social aspects, particularly those tied to production processes, less explored. Although several studies have assessed the labor or employment embodied in trade (Jiang & Milberg 2013, Treffer & Zhu 2010) and labor/employment footprint (Alsamawi et al. 2014, Wiedmann & Lenzen 2018), the scarcity of literature becomes particularly salient in quantifying the overarching societal impacts that ensue from this employment. A methodological development bloomed more than 15 years ago and was then presented as a valuable tool to assess the social and economic impacts associated with geographic locations and stakeholders: social life cycle assessment. However, despite widespread methodological guidelines (Benoît et al. 2010), this framework was still in its early stage until recently (Mancini & Sala 2018). Nevertheless, it is worth noting a recent renewal in the development of this field with the assessment of social impacts such as fatal and nonfatal occupational injuries (Alsamawi et al. 2017), child labor, forced labor, and human trafficking (García-Alaminos et al. 2021) and the improvement of available databases (Berthet et al. 2024).

Yet, several challenges remain, such as fragmented cross-country data concerning working conditions (Berthet et al. 2024, Delera 2021). Additionally, data on covert activities such as child labor are often inaccessible through official channels, relying instead on localized surveys. These issues are accentuated in low- to middle-income countries due to data scarcity. On a different note, assessing positive social aspects along the GVCs (e.g., social development, increased productivity) appears completely absent from the macrolevel approach via MRIOTs. Sturgeon (2019) states that the lack of granularity at the sector level, when the specialization in GVCs can be quite narrow and missing variables such as ownership and firm sizes, explains this absence.

Although MRIOTs offer valuable insights to trace and assess the sustainability of GVCs, the precision of their findings remains a key issue. This precision is crucial, especially when initiatives like the United Nations' Sustainable Development Goals demand comprehensive metrics that capture the nuances of fragmented international production and intricate national economies. However, this precision remains a point of contention due to the assumptions underlying their construction, which can be considered somewhat excessively stringent. As MRIOTs are primarily built on national IOTs, their effectiveness in thorough GVC analysis largely depends on their accuracy. Additionally, crafting global MRIOTs is a formidable task requiring amalgamating extensive datasets from varied sources and meticulous data harmonization. This process is typically shaped by specific policy or research aims rather than a consistent benchmark (Sturgeon 2019). A main challenge in terms of precision is distinguishing between intermediate and final users among industry-to-industry trade data. The rudimentary approach employs the proportionality assumption, dividing imports of products from a specific country between final and intermediate demands. This method, however, does not account for variances in import types and qualities from diverse regions. A more sophisticated technique employs concordances, primarily utilizing the United Nations' broad classification of economic categories, to differentiate import sourcing across agents (Dietzenbacher et al. 2013, Koopman et al. 2014). The imports from each trading partner are then proportionally distributed across sectors, mirroring domestic input distribution, under the import comparability assumption (Feenstra & Jensen 2012). Yet, this assumption does not allow reflection on the actual input sourcing patterns, where evidence on supply chain linkages based on richer microlevel datasets has shown that input specialization is a characterizing aspect of GVCs (Antràs & Staiger 2012). Additionally, empirical evidence shows that the use of inputs depends on the downstream use of output. For example, using customs microdata for Mexico, De Gortari (2019) shows that the United States accounts for most of the foreign inputs embedded in

Mexican vehicles sold to US consumers but for only a small portion of the inputs of those sold to German consumers. As techniques of production—including the emission intensity and composition of value-added, for example, in terms of required labor skills—are different among different providers, the distortions within the MRIOT accounting for the type of bilateral value-added trade flows may have significant implications in the assessment of externalities from production processes. A last challenge is that imported inputs are assumed to be used with the same intensity by each sector independently from firm characteristics (e.g., size, ownership, or exporter status). Technological differences between firms within industries, traditionally defined in terms of product similarity, may lead to large biases in the measurement of GVC metrics (Johnson 2018, Michel et al. 2018).¹⁰

The ongoing macrolevel efforts to track and evaluate the sustainability of GVCs have arrived at a pivotal juncture where both social and environmental impacts can be delineated at the country level or through the entire chain. However, the current statistical tools exhibit a lack of consistency (United Nations 2018), and the constraints in terms of data coverage, availability, and reliability remain significant barriers to a broader application.

5. CHALLENGES AND DYNAMICS OF USING MICRO- AND MESOLEVEL ANALYSES

To capture complexities and critically examine the GVC, it is essential to expand the focus from the well-established macrolevel to include detailed examinations at a more granular resolution (Kano et al. 2020, Ponte & Sturgeon 2014, Qiang et al. 2021). Although GVC participation is primarily a firm-level phenomenon, its microeconomic study is still at an early stage compared to the country-sector research. Because microbased studies usually rely on different datasets, the resulting research landscape is fragmented and lacks a unified framework and unit of analysis (Antràs & Chor 2022, Nenci et al. 2022).

With the use of census data, customs data, and firm surveys, transactions between firms and their foreign partners are observed (instead of being inferred as in the MRIOT framework), and heterogeneity across firms in GVC can be captured; this allows advancements in the measurement of the structure of GVCs. However, the scope of microbased analyses is often confined to a limited number of firms, and they fail to reflect the aggregate GVC participation of a country or industry (Dedrick et al. 2011, Xing & Detert 2010). In principle, macrolevel methodologies can be adapted to microlevel studies (Antràs 2020, Johnson 2018), potentially guiding theoretical and empirical research into firm roles along all steps within a GVC. This can be conceptualized at the intermediate demand level of the MRIOT mentioned above, with a particular focus on the segments of the global input-output matrix capturing the details of the firm-to-firm exchanges, the outcomes of which can be subsequently reaggregated up to the sector level of the MRIOT. However, prominent challenges in this domain pertain to data availability, accessibility, and harmonization. Reliable firm-level data are not collected for all countries and, when available and accessible, they are far from being harmonized among countries. A notably underrepresented facet in any existing datasets is related to interfirm transactions. This deficiency has two main implications. First, the

¹⁰Bems & Kikkawa (2021) find that the aggregation biases in estimating the share of domestic value added in exports vary across countries, ranging from close to zero in Chile to 17 percentage points of gross exports in China. Firm heterogeneity has been found to be a crucial aspect in the evaluation of the carbon emissions embodied in global networks. Zhu et al. (2022) distinguish domestic firms and multinational enterprises and estimate that the carbon emissions originating from GVC activities are underestimated by about 13.8 percentage points under the standard accounting treating heterogeneous firms within the national boundaries as one unit.

lack of a link among customs-level data across countries does not allow following the exported inputs in downstream phases abroad. This weakens the analysis of several aspects, including, for example, the exposure of production to foreign shocks. Second, because intracountry exchanges among firms are generally not recorded, all the domestic activities indirectly associated with GVC activities are not captured by current measures of GVC integration (Bernard et al. 2007). Addressing this gap is particularly challenging regarding lower-tier suppliers, who, while connected to global networks via domestic value chain segments, often operate within the informal sector.¹¹

At the mesolevel,¹² most of the GVC literature focuses on the role of MNCs, key agents in shaping global production networks through their decisions on unbundling, outsourcing, and offshoring production processes (Alfaro et al. 2019, Bernard et al. 2018, Cadestin et al. 2018) and in defining the benefits for domestic firms of joining their supply networks (Alfaro-Ureña et al. 2022, Jordaan et al. 2020) (see strategic governance and structural governance in **Figure 1**). It is well recognized that MNCs are critical players when it comes to sustainability: They have extensive carbon footprints (López et al. 2019) stemming from their global activities and hold crucial positions in GVCs, thus affecting jobs and livelihoods of entrepreneurs, workers, and entire communities (Ocelík et al. 2023).

MNCs and FDI play a complex role in climate change mitigation, affecting it through three primary channels: scale, composition, and technology effects (Steenbergen & Saurav 2023). As such, this can lead to environmental upgrading or environmental downgrading (see Section 6.2 and **Figure 1**).

For the scale effect, MNCs and FDI can expand the economies in which they operate, leading to increased production and, consequently, higher greenhouse gas emissions. Empirical evidence shows that MNCs and their affiliates participate in GVCs more intensively than other firms and magnify the impact of underlying differences in firm characteristics, increasing their share of aggregate trade (Bernard et al. 2018, Wang et al. 2017). One implication is that acknowledging differences in firm ownership is crucial for accurately identifying the environmental impacts of GVCs. However, Zhu et al. (2022) argue that conventional methods underestimate GVC emissions by about 13.8% in 2016, underscoring the need for accurate assessment methods. Regarding the dynamics, the 1990s saw a surge in GVC intensity, fueled by advances in information and communication technologies (Amador & Cabral 2017). Yet, after the 2007–2009 financial crisis, a decline in GVC intensity signaled a shift toward a reduction in global production fragmentation. The decline affected the FDI since 2011 (Timmer et al. 2016). While the proportion of the emissions embodied in trade substantially decreased during the crisis period, the emissions embodied in investment slightly increased, partially offsetting the negative impact of trade decline on the economy (Zhu et al. 2022). Buckley et al. 2019 highlight the evolution of the control of knowledge and intangible assets over physical assets and ownership advantages that can be exploited without fully internalizing operations (Strange & Newton 2006). Supporting this, analysis of OECD data on FDI and cross-border mergers and acquisitions by Hillemann & Gestrin (2016) shows that cross-border financial flows related to intangible assets continue to increase relative to those related to tangible assets. These shifts and their associated impacts can have significant implications for the carbon emissions associated with MNC supply chains. Zhang et al. 2020 further elucidate this by introducing an investment-based accounting framework to assign MNCs' carbon footprints to the investing country, shifting focus from producers and consumers to investors. Their findings also

¹¹A few studies have begun exploring data on firm-to-firm transactions, including those by Alfaro-Ureña et al. (2022) for Costa Rica and Dhyne et al. (2020) for Belgium.

¹²The mesolevel is here defined as an intermediary space between macro and micro, focusing on the linkage characteristics along the value chain (Ponte & Sturgeon 2014).

point to a decrease in global FDI, with a 23% drop in 2017 and 13% in 2018, hinting at a potential deglobalization trend that could reduce MNCs' carbon footprints. Conversely, the authors show that FDI flows to developing low- and middle-income countries are steadily increasing, with a rise in South-South FDI. This evolving trade-investment nexus adds complexity to global carbon transfer, underlining the urgency for targeted policies to mitigate carbon leakage. MNCs, through their production and export strategies, are central to this nexus and should be at the forefront of addressing these environmental challenges. Future research is anticipated to delve deeper into the connections between trade, investment, and carbon transfer dynamics (Zhang et al. 2020).

Regarding the composition effect, the nature of MNCs' investments can either worsen or improve the carbon footprints of host countries, depending on whether these investments move toward more- or less-carbon-intensive activities (see resource efficiency and pollution management in **Figure 1**). Steenbergen & Saurav (2023) assess the shifting effect of MNCs' overseas investment on industrial structures around the world, considering FDI project announcements. These are grouped into a set of green sectors (that accelerate a net-zero emissions future, such as electricity generation from renewable energy, afforestation, and manufacture of products that help the transition to a low-carbon economy) and polluting sectors (that are inconsistent with a net-zero emissions future, such as processing of fossil fuels, metals, and minerals, and the conventional manufacture of chemical, metal, and plastic products). They find a robust trend of FDI shifting out of polluting sectors and into green sectors. This trend can be explained by declining costs and substantial growth opportunities in renewable energy generation and low-carbon manufacturing methods (IRENA 2020) and by the increasing costs linked to polluting activities (Steenbergen & Saurav 2023).

Finally, with the technology effect, MNCs are pivotal in transferring low-carbon technologies to domestic firms, thereby reducing emissions (Adeel-Farooq et al. 2021, Steenbergen & Saurav 2023). Although this channel has attracted significant scholarly attention and political interest for its essential contribution to mitigating climate change (Iyer et al. 2015, Rempel & Gupta 2021), the extensive literature on low-carbon technology transfer is a broad and fragmented area of research (Blanco et al. 2022, Kirchherr & Urban 2018). Zarsky (2008) highlights potential positive environmental spillovers arising from the clean technology transfer (i.e., transfer to MNC affiliates of production technologies that are less polluting and more input efficient than those used by domestic firms) and from the transfers of state-of-the-art production and pollution control technologies by MNCs, which allow low- and middle-income countries to leap to the global technology frontier (technology leapfrogging). Noailly & Ryfisch (2015), Konara et al. (2021), and Castellani et al. (2022) focus specifically on the role of FDI undertaken by MNCs as a focal channel of low-carbon technology knowledge transfers and innovation capability building in the host economies. Amendolagine et al. (2023) concentrate on green technologies and assert that the extent of green knowledge transfer and development of innovative capabilities in subsidiaries hinge on three aspects: host country characteristics, the specific technology in question, and the mode of entry. The empirical analysis combines data on FDI with patent analysis and indicates that being a subsidiary of a green MNC positively influences both the quantity and quality of locally produced green patents. This advantage in green innovation, compared to domestic companies, is more pronounced in low-income countries and in those with lower reliance on oil rents, especially when they already possess higher levels of relevant domestic innovative capacity. Additionally, firm and sectoral characteristics play a significant role. This suggests that green FDI is more impactful when technologies are characterized by low tradability and tacit knowledge.

In the current sustainability landscape, MNCs are increasingly pressured by consumers, regulators, and internal governance to adopt sustainable practices (see external pressure in **Figure 1**). These practices, encompassing carbon footprint reduction, ethical labor standards, and investment

in sustainable technologies, are crucial not just for addressing environmental and social concerns, but also for enhancing the long-term viability and reputation of MNCs. Therefore, at the parent company level, integrating sustainability into core business strategies and fostering partnerships with suppliers committed to sustainable practices are becoming essential and should logically be core elements in the production decision of MNCs.

However, when delving into the micro-meso economic GVC foundations, Kano et al. (2020) reveal more complexities such as bounded rationality, bounded reliability, cognitive biases, and entrepreneurial orientation. For instance, bounded rationality can result in functional silos within supply chains (Akkermans et al. 1999). Eriksson et al. (2014) emphasize the role of individual cognitive and managerial capabilities in managing cross-border GVC transactions. Furthermore, Seppälä et al. (2014) focus on limited rationality in accounting decisions in lead firms, usually MNCs (Stephenson & Pfister 2017), arguing that their accounting systems may misrepresent their accurate GVC value creation affecting their location decisions.

Nevertheless, to our knowledge, an exhaustive review analyzing the actual weight of sustainability in MNCs' decision process on production and location remains missing. Current research, such as that of Qiang et al. (2021), suggests that MNC production decisions are primarily driven by cost reduction, risk mitigation, and market power increase. When deciding on global sourcing, firms consider the costs of accessing foreign suppliers, which include establishing networks and navigating foreign regulations, balanced against the financial benefits of outsourcing. Given the fixed costs associated with importing and exporting, only sufficiently large and productive firms tend to find foreign sourcing profitable (Antràs & Chor 2022, Helpman et al. 2004). Furthermore, there is a potential complementarity between these activities: Outsourcing can lead to reduced production costs, whereas exporting augments revenue. This synergy further emphasizes the benefits for firms to engage in both activities (Aristei et al. 2013, Kasahara & Lapham 2013, Pane & Patunru 2023).¹³

This concerns strategic governance as well as structural governance, notably MNCs' decisions on whether to make or buy, where and how to produce, and how to integrate suppliers into their global production networks, which define their organizational boundaries and geographical distribution (**Figure 1**). Two main theories explain these boundary decisions (Qiang et al. 2021): transaction cost economics (Klein et al. 1978; Williamson 1973, 1975) and property rights theory (Grossman & Hart 1986, Hart & Moore 1990). While these theories emphasize macrolevel economic factors, Kano et al. (2020) highlight that MNCs often prioritize economic and social factors such as economic development, labor costs, technological environments, and institutional quality over a comprehensive sustainability approach (**Figure 1**). Factors such as favorable business regulations, intellectual property protection, and significant education spending are key in attracting sophisticated technological activities (Amendolagine et al. 2023, Ascani et al. 2016, Pipkin & Fuentes 2017). Empirical studies indicate labor costs are a critical determinant for locating production activities for both advanced- and emerging-economy MNCs (Azmeh & Nadvi 2014, Chen et al. 2016). However, this efficiency-driven offshoring can result in strategic challenges, particularly if local institutions are inadequate in preventing knowledge loss. Lipparini et al. (2014) distinguish the decision process, noting that common identity and language in GVC networks may be prioritized to reduce knowledge spillover risks.

Additionally, MNCs face demand-side issues such as sustainability and ethical concerns in their value chains, leading to public outcry over poor labor conditions in South and Southeast Asia (Malesky & Mosley 2018). These issues can also significantly affect the host country. Specifically,

¹³For a comprehensive theoretical framework capturing GVC linkages, see Antràs et al. (2017) and Antràs & Chor (2022).

offshoring might depress real wages for those handling offshored tasks, influenced by shifts in relative prices and labor supply (Grossman & Rossi-Hansberg 2008). The connection between GVCs and wages is nuanced and varies based on worker skill levels (Acemoglu et al. 2015) and positions in the production hierarchy (Costinot et al. 2013). Although some studies highlight wage disparities between GVC participants and domestic entities in lower-income nations, results are not universally consistent (Lewandowski et al. 2023). As for MNCs' activities, consistent evidence supports the view of a positive effect of foreign ownership on workers' wages in MNCs (Hale & Long 2011, Harrison & Scorse 2009, Hijzen et al. 2013, Lee & Wie 2015, Lipsey & Sjöholm 2004). This is mostly because MNC affiliates hire more productive workers and thus must remunerate at rates higher than their domestic counterparts (Saurav & Liu Yan Sinha 2020), which increases wage inequality (World Bank 2020). In host economies, the increased demand for skilled labor may induce upward pressure on wages (Hale & Xu 2016), potentially forcing domestic firms to substitute skilled with lower-skilled workers to preserve the average costs of production (Barry et al. 2005). The overall impact hinges on the extent of the skills competition and ability of the competitor to substitute skilled workers (Saurav et al. 2020). FDIs may also affect the wages of domestic firms that supply inputs to MNC affiliates. The limited research on this topic suggests a minor positive influence (Fatima & Khan 2018), which can be explained by productivity and technological spillovers from foreign firms accruing to domestic private firms that push wages upward (vertical wage spillovers) (Hoi & Pomfret 2010). These varied facts illustrate a complex scenario that, depending on the situation, can result in social cohesion and social upgrading (Taglioni & Winkler 2016) as well as social downgrading (Figure 1).

6. NAVIGATING THE DIFFERENT SUSTAINABILITY GOVERNANCE FRAMEWORKS

According to Ponte et al. (2019), within the GVC landscape, spontaneous coordination via market exchanges tends to be the exception rather than the norm (Gereffi 1994, Gereffi et al. 2005, Gibbon et al. 2008). This observation underscores the imperative need for a well-defined governance framework. This often involves a few leading companies making key decisions and controlling access to markets, highlighting the importance of power dynamics and coordination among firms (Havice & Campling 2017). Consequently, this led us to analyze the sustainability issue in GVCs under the third and last strand detailed in this article: management and international business.

In their review, Dimitropoulos et al. (2023) highlight four prominent studies establishing conceptual frameworks for sustainability governance within GVCs: those by Knoll & Jastram (2019), Bair & Palpacuer (2015), Eller (2017), and Schrage & Gilbert (2021).

Knoll & Jastram (2019) discuss a case study in Ghana, advocating for a bottom-up collaborative and pragmatic method for sustainable GVC governance, as governance models frequently overlook issues because they do not account for institutional and cultural differences. While their insights are relevant, incorporating them directly into a broad, top-down management and international business governance framework presents difficulties. Bair & Palpacuer (2015) and Eller (2017) provide foundational insights that can be used to methodologically frame our approach more precisely. Their work elucidates the relationship between CSR (Bair & Palpacuer 2015) and third-party certifications (Eller 2017), with sustainability governance within GVCs and their related impacts in terms of social and environmental upgrading. Lastly, Schrage & Gilbert (2021) detail a comprehensive typology of governance gaps in GVCs (private, social, and public actors), offering a valuable perspective to streamline those frameworks.

However, Havice & Campling (2017) point out that the different frameworks for sustainability governance within GVCs, as currently conceptualized by the management field, fall short of

fully addressing sustainability. Their analysis suggests that these frameworks often lead to narrow interpretations, missing critical elements of sustainability (Havice & Campling 2017). This does not invalidate the findings from Dimitropoulos et al. (2023) but calls for further disambiguation to better evaluate sustainability. Bush et al. (2014) provide a compelling additional insight with their tripartite framework, which offers a structured way to look at sustainability governance in GVCs: sustainability governance in, of, and through chains, as illustrated in **Figure 1**. Governance in the supply chain focuses on individual companies that enhance social and environmental impacts using established standards, such as the CSR framework, including all stakeholders. Governance of chains involves lead firms, usually from high-income countries, influencing production in low- and middle-income countries through standards and knowledge transfer, targeting reputational risk management and environmental and social upgrading tactics. Meanwhile, governance through chains provides a comprehensive approach to sustainability, blending firm actions, interfirm coordination, and external entity involvement, supported by both public and private policies (Bush et al. 2014).

6.1. Corporate Social Responsibility

The CSR concept has been marked by notable fluidity and evolution, particularly within OECD nations. This evolution has been shaped by a confluence of strategic considerations, historical contexts, and academic discourses. The literature underscores increasing expectations for corporations to elevate their social and environmental performance (Bartley 2003, Carroll & Shabana 2010, Windsor 2006), expectations that align seamlessly with the shifting societal expectations of how corporations should operate (Latapí Agudelo et al. 2019). The perception of CSR by private companies has also gradually shifted over time. Historically, CSR was viewed as a mere adjunct to profit generation (Latapí Agudelo et al. 2019) and an opportunity not only to secure the long-term sustainability of their enterprises but also to potentially preempt stringent government regulations by proactively addressing social and environmental dimensions (Bush et al. 2014). The modern discourse is increasingly oriented toward determining the tangible business benefits of CSR (Porter & Kramer 2006, 2011). Carroll & Shabana (2010) crystallized this transition, outlining a compelling business case for CSR that encompasses cost and risk reductions, enhanced legitimacy and reputation, competitive advantage building, and the cultivation of synergistic values.

Bair & Palpacuer (2015) have highlighted the intricate relationship between CSR and sustainability governance within GVCs. This pivotal intersection can be traced back to a foundational work from Cruz & Boehe (2008), who introduced the sustainable GVC paradigm, highlighting the importance of bargaining power and collaboration among chain members. Since then, these topics have received burgeoning academic interest, as evidenced by investigation into human rights in low- and middle-income countries and exploration of the roles or corporate codes of conduct by nongovernmental organizations (NGOs) (Bartley & Egels-Zandén 2015).

Despite some notable exceptions underscoring the critical nature of collaborative governance in GVCs, especially for effective CSR policy implementation, the literature often remains elusive and scattered (Lund-Thomsen 2019). Building on this, Lund-Thomsen's (2019) governance typology delineation offers a structured framework for analysis. Given this foundation, we aim here to comprehensively examine the prevailing governance gaps affecting CSR in GVCs through this typology.

From a private governance perspective, the literature on CSR in GVCs has evolved in two different directions: buyer driven and supplier driven. The buyer-driven approach is mainly a compliance approach developed around a system where international purchasers design and propagate a corporate code of conduct, which they expect their associated suppliers to adhere to. Prominent examples of such systems are ISO 14001, which targets environmental management, and SA8000,

which emphasizes social accountability (Bush et al. 2014). To ensure its implementation, these suppliers undergo audits—conducted either internally, by the buyer, or by an independent third party—to ascertain their adherence to the code (Locke et al. 2009). The supplier-driven CSR in GVCs often connects to industrial clusters in low- and middle-income countries, where small- and medium-sized enterprises (SMEs) benefit from shared resources. These SMEs, due to their individual limitations, engage in collective CSR efforts within clusters, leveraging joint initiatives, financing, and training for compliance (Lund-Thomsen & Nadvi 2010). Sinkovics et al. (2021) further accentuate the instrumental role SMEs hold in steering sustainability outcomes in the context of GVCs.

Public governance can be broadly classified into two domains: actions undertaken by the national states and initiatives by international organizations. National states can function as facilitators (assisting local firms to engage in GVCs), regulators, producers (via state-owned enterprises), and buyers (through public procurement) (Horner 2017). Furthermore, states can control production in strategic sectors or can drive production in areas overlooked by the private sector. Public procurement processes can also serve as a mechanism through which states operate within GVCs. Posthuma & Rossi (2017) further address the role of international organizations in promoting coordinated governance, underscoring the collaborative efforts of various public and private entities at the supranational level.

Civil governance has largely emerged as a response to global outsourcing, trade liberalization, and the deregulation of economies in the Global South. The relocation of industrial jobs from Europe and the United States during the late 1980s and early 1990s brought media attention to poor working conditions and suppressed worker rights in producer locations, catering to the Global North markets (Utting 2005). As Bair & Palpacuer (2012) note, an important part of the academic literature in this area focuses on the transnational character and impacts of the solidarity campaigns between consumers from high-income countries and workers from low- and middle-income countries.

The coordination between those different perspectives of governance is crucial for an efficient implementation of CSR within the GVCs. However, while Gereffi & Lee (2016) suggest that synergistic governance, which combines private, public, and civil governance, can offer sustainable forms of upgrading, Lund-Thomsen (2019) poses strong reservations about its effectiveness. His main critique is the neglect of public governance's role in enhancing workers' conditions in GVCs. Private governance tends to pay little attention to the influence of public governance on worker conditions in GVCs. The buyer-driven compliance approach rarely involves national governments and basically excludes civil society contributions. Although NGOs or trade unions could occasionally conduct third-party audits, it is usually expected that private professional services networks such as PricewaterhouseCoopers (PwC), EY, KPMG, or Deloitte Touche Tohmatsu Limited perform these audits (O'Rourke 2003). Public governance can sometimes suppress worker rights. This might promote CSR in specific clusters, but it often leans to bolstering private governance, encouraging exports, and using public procurement. Lastly, civil governance faces limitations in GVCs' CSR, especially in the Global South, where free trade unions are often restricted, and it struggles to challenge dominant private governance. Ultimately, the potential for harmonious governance of CSR in GVCs, aiming to enhance workers' rights in the Global South's export industries, seems limited.

Methodologically, two tracks of development emerge from those observations. First, it is crucial to build analytical approaches to quantify the beneficiaries and those disadvantaged by CSR strategies in GVCs. There is a pressing need to apply those frameworks at each node level in chains but also at the interfirm coordination level of the chains, encompassing the different types of governance involved. Second, a broader and more comprehensive application of those frameworks

through the entire chain is necessary. If not, a transparency fallacy can arise, when stakeholders operate under the misconception that firms are transparently conveying the sustainability of their supply chains. However, a myriad of challenges, from supply chain intricacies to geographical and cultural disparities and even resistance from suppliers, drastically limit companies' grasp on their own supply chain complexities (Gold & Heikkurinen 2018).

6.2. Global Value Chains and Upgrading

The CSR framework offers an incomplete lens on governance and sustainability in GVCs (Dimitropoulos et al. 2023). Eller (2017) contends that third-party certifications deserve consideration. More broadly, these certifications can fit into the upgrading GVC framework, a central concept from the management literature that aims to address sustainability within the entire chains of production. Indeed, the increasing fragmentation of production across dispersed firms presents a challenge: ensuring sustainability throughout supply chains. This is where the notions of environmental upgrading and social upgrading come into play. These ideas lay the groundwork for evaluating sustainability facets such as livelihood improvement (Riisgaard et al. 2010), gender dynamics, and human rights responsibilities.

The term environmental upgrading is generally understood as any shift reducing a firm's environmental footprint. However, its interpretation is multifaceted. Whereas De Marchi et al. (2013) stress proactive reduction measures, Krishnan et al. (2023) assert that genuine environmental upgrading should result in improved environmental outcomes. In contrast, the term social upgrading has its roots in two distinct works. One examines employment quality in GVCs, and the other highlights exploitative conditions. Hence, social upgrading crystallized as a process encapsulating the "improvement in the rights and the entitlements of workers as social actors, which enhances the quality of their employment" (Barrientos et al. 2011, p. 324). This delineation underscores the dynamism inherent in the progression toward comprehensive worker rights recognition, pivoting the narrative from a mere quantification of GVC-associated employment to an in-depth analysis of labor conditions (Rossi 2019).

These concepts can be implemented in GVCs through various strategies (see implementation strategies in **Figure 1**). For environmental upgrading, firms can revamp processes for eco-efficiency via production system overhauls and abatement technology; introduce environmentally friendly product lines (De Marchi et al. 2019); or adopt holistic management strategies, often linked with obtaining third-party certifications. In contrast, literature on social upgrading in GVCs primarily focuses on worker rights, wages, and employment quality where, in the case of GVCs, the social and economic conditions of the host country play a key role (see **Figure 1**).

De Marchi et al. (2013) categorize upgrading approaches into two key governance models: compliance-based governance and relational governance. Both categories resonate with our perspective of upgrading primarily as a governance challenge. Although we could retain the framework from De Marchi et al. (2013), we have chosen to categorize upgrading issues using the tripartite framework of Bush et al. (2014, p. 9) that "establish a typology of governing sustainability *in* chains, *of* chains and *through* chains to understand how firm and non-firm actors influence decisions over sustainability in globalised commodity production and consumption." The upgrading "in" chains emphasizes the utility-driven nature of sustainability efforts: Lead firms are motivated to improve social and environmental performance of their suppliers via standard and CSR activities primarily because it serves specific functions such as enhancing their reputation, ensuring long-term viability of resources, or meeting consumer demand for ethically produced goods. The upgrading "of" chains emphasizes the role of standards and knowledge transfer, enabling suppliers to undertake environmental upgrades (De Marchi et al. 2019). Upgrading "through" chains stresses the utilization of value chains as a conduit to influence

socioenvironmental production and consumption parameters. It promotes vertical collaboration within value chain entities and horizontal collaboration with external stakeholders, encompassing both private and public/civil governance. In conclusion, although the first two perspectives align with compliance-based governance, the third resonates more with relational governance.

The “in” and “of” perspectives fall short in offering a comprehensive framework for gauging the sustainability of the entire GVCs. First, as mentioned by Hochachka (2023), those compliance models, although potentially capable of driving sustainability, can witness only superficial commitments from suppliers. Furthermore, as illustrated by Krishnan et al. (2023) in their in-depth examination of the Kenya–UK horticulture value chains, a misaligned analytical framework can lead to paradoxical outcomes. Even with the transfer and adoption of environmental upgrading practices—mandated by UK supermarkets, disseminated by Kenyan export enterprises, and facilitated by governmental bodies—Kenyan agriculturalists predominantly encountered environmental downgrading. This degradation not only impacted the farmers within the value chain but also had ripple effects, detrimentally influencing other farmers and resource stakeholders external to the chain. Expanding on this, Ponte (2020) elucidates that lead firms in GVCs are now benefiting from sustainability management in terms of profitability without a major negative counterpart regarding their market valuation. This phenomenon, termed green capital accumulation, empowers these dominant firms. They can intensify the monitoring of their suppliers for sustainability objectives and strategically shift sustainability-associated costs onto these suppliers. While this trajectory might be economically advantageous for the lead firms, it imposes heightened requisites on suppliers, resulting in a sustainability-driven supplier squeeze, augmenting the already prevalent dynamics of the cost squeeze.

The “through” perspective, the relational governance, appears the most promising. Marked by close interactions and tacit, complex information sharing, it is considered particularly effective for addressing sustainability in high-uncertainty contexts. Such chains hold the potential for transformative changes addressing sustainability challenges. Yet, the need for well-defined metrics and methodologies remains (De Marchi et al. 2019, Hochachka 2023).

Lastly, a compelling observation arises: Although the management field consistently highlights the lack of governance through the GVCs due to the challenge of developing a conceptual framework, macrolevel economics has actively tackled this very issue over the past decade. Therefore, given this juxtaposition, the next section explores the extent of separation between the three themes covered in this review.

7. ECONOMICS AND MANAGEMENT: MOVING TOWARD SHARED QUANTITATIVE FRAMEWORKS?

The three broad fields ascribable to sociology, economics, and management are significant contributors to GVC research. As of September 2023, of the 4,701 GVC-related documents in the Scopus¹⁴ database from 1997 to 2024, 24.5% are from economics, econometrics, and finance; 24.0% from social sciences; and 20.6% from business, management, and accounting. However, despite the substantial research volume, and based on the findings discussed above, it appears that the conceptual frameworks of those fields to quantify the sustainability of GVCs have evolved in distinct, minimally interconnected silos.

¹⁴Overseen by Elsevier, Scopus is a leading database of peer-reviewed interdisciplinary literature. Encompassing >20,000 journals from major publishers, it offers broader coverage than the Web of Science. Given our emphasis on peer-reviewed publications, Scopus emerged as an ideal choice, encompassing esteemed international journals, including nascent yet impactful ones. Previous research has lauded Scopus as an effective source for peer-reviewed articles in supply chain studies (Chicksand et al. 2012). However, Scopus has limited representation of articles prior to 1996.

The GVC sociological approach provides qualitative encompassing insights into viewing sustainability as an integral and constitutive element of a globalized network integrating production, trade, and consumption. This comprehensive understanding of the interconnectedness of economic operations, sustainability, and global ecosystems, however, comes at the expense of limited predictability. From its side, the economic approach, both at the macro- and microlevels, has developed some robust quantitative frameworks to trace GVCs more precisely through their entire paths, though it still falls short of achieving a holistic view of sustainability. Finally, despite promising developments, such as CSR and upgraded perspectives, the management field continues to face challenges in formulating a coherent theoretical framework and comprehensive metrics, verified by both the model and data, for globally assessing the economic, social, and environmental impacts throughout entire GVCs.

This trend in management was already identified a decade ago (Bush et al. 2014, Coe 2012, Ponte & Sturgeon 2014). Bibliometric analysis by Fahimnia et al. (2015) revealed five research clusters: conceptual development, empirical studies, sustainability assessment measures, practical application barriers, and prescriptive mathematical modeling. Although conceptual and empirical studies form the foundational core, the authors noted a marked gap in prescriptive and quantitative modeling research. They also pointed out that with the increasing availability of data, this gap potentially holds considerable promise for advancing the field (Fahimnia et al. 2015).

Those calls to close this research gap appear to have had a limited effect. An initial proliferation of systematic literature reviews in the field has reached a saturation point (Carter & Washispack 2018). Furthermore, those reviews have been criticized for being considerably less stringently presented than other empirical research (Seuring & Gold 2012) and for the noticeable absence of reliability among most of them (Martins & Pato 2019). Seminal literature reviews, including those by Ansari & Kant (2017) and Negri et al. (2021), consistently highlight the need for greater emphasis in management studies on quantitative methodology and its application. Rajeew et al. (2017) further stress the importance of industry-specific studies using actual data and a synergy between empirical studies and mathematical modeling to address sustainability concerns effectively. A recent literature review by Dimitropoulos et al. (2023) confirms these findings. When examining the 77 most significant studies selected prior to 2022 on sustainability in GVCs, a dominant methodological trend persists. Most key contributions (~60%) are inclined toward conceptual or theoretical analyses, contrasting starkly with case studies, which constitute approximately 20%. Quantitative techniques and interview-based methods remain notably underutilized, representing roughly 18% and 7% of the methodologies, respectively.

Nevertheless, recent trends suggest a growing link between management and economics silos, especially at the macroeconomic level. For a deeper exploration, we replicated research in the Scopus database of Dimitropoulos et al. (2023) exactly but supplemented it with the following keywords: “MRIOT,” “footprint,” “environmental footprint,” and “social footprint” (cf. Section 4). We found 18 peer-reviewed articles, with most (15) published after 2019, which indicates a notable increase in research on this topic between 2020 and 2023. The results of this brief bibliographic analysis need to be confirmed by more systemic and structured research. However, the uptick in the 2019 results clearly suggests a shift in research dynamics and a convergence, at least a semantic one, between the two research areas.

8. CONCLUSIONS

This review outlines the latest theoretical and empirical advancements related to assessing sustainability within GVCs. The GVC sociological approach provides a comprehensive understanding of the interconnectedness of economic operations, sustainability, and global ecosystems. However, its link to the GVC management approach is limited due to the limited compatibility in their

outputs and insufficient examination of individual-level assumptions and their specific connections to various aspects of GVC governance.

One recurring challenge, beyond sustainability itself, is the detailed mapping of these chains. On a macrolevel, economic research has progressed significantly, especially with tools such as the MRIOT. Yet, on a microlevel, despite theoretical leaps, significant data gaps hinder practical implementation and broader applications. The management field, vital for embedding sustainability practices in chains, significantly lags in theoretical depth compared to its economic counterpart regarding the question of governance through the entire chain. Notably, both fields seem to have evolved in isolation despite calls for interdisciplinary collaboration on this topic.

Considering this, a paradigmatic transition becomes necessary. A substantive adoption of quantitative analytical methodologies by the management field from the economic field not only offers an opportunity for a more rigorous statistical or econometric validation of prevailing theoretical constructs but also may serve to recalibrate or contest some of the entrenched theories within the domain. The imperative for this integration is evident when we consider that GVC sustainability assessments are crucial for areas ranging from resource management to trade policy. A robust foundation for assessing sustainability is indispensable for significant progress. Any ambitious development is difficult to reach without a solid base to assess sustainability. For instance, the work of Taglioni & Winkler (2016) from the World Bank, *Making Global Value Chains Work for Development*, highlights key aspects to make GVCs more sustainable: skill development, social progress, environmental consideration, and fair opportunity distribution. However, the related policy questions they formulate are challenging to address globally without confronting the research gaps we have discussed: “What is the relationship between economic and social upgrading, and is downgrading a possibility?, What are the links between social upgrading and cohesion?, and What benefits to sustainable GVC participation can originate from environmental regulation?” (Taglioni & Winkler 2016, p. 6).

Besides the convergence between academic fields, a particular salient challenge remains: the lack of granular company-level data. The meticulous creation of the MRIOT, referred to as yeoman’s work by Antràs & Chor (2022), has spurred many research innovations. However, the next phase demands overcoming this data challenge. Without such comprehensive data, much of the research remains theoretical and lacks practical application. Given that global firms consistently report financial metrics in line with standards (e.g., International Financial Reporting Standards or US Generally Accepted Accounting Principles) and with some confidentiality while giving enough information to financial analysts, the acquisition, anonymization, and publication of relevant data regarding their supply chains do not appear as immeasurable challenges for lead firms. However, considering the limited focus of the academic community and the tepid efficiency of present-day extrafinancial reporting practices, bridging this data void may remain more of an ideal than an imminent reality.

On an optimistic note, recent directives from international entities provide some hope. As stated by the United Nations in 2021, there is a push as “. . . statistical offices need to find solutions for sharing granular data, as long as confidentiality and the trust of respondents can be guaranteed. . .” (United Nations 2021, p. 92). In contrast, it is disconcerting to observe that amid recent advancements of the European Corporate Sustainability Reporting Directive, where one could not have dreamt of a more suitable moment for developing this topic, the near total absence of these issues within the final legislative document suggests a more pessimistic future.

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