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SPES Focus – Work Package #5

Global Sustainability in an Interconnected World:

The Role of the EU in Trade and Value Chains

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Authors

Luca Lodi – Researcher of the SPES Project, University of Florence
Annalisa Caloffi – Associate professor and researcher of the SPES Project, University of Florence
Remy Michael Balarezo Nuñez – Universidad de Piura (UDEP) and PEP – Partnership for Economic Policy
Thong Ho Quoc – Ho Chi Minh City University of Economics and PEP – Partnership for Economic Policy
Mario Biggeri – Scientific coordinator of the SPES Project, University of Florence

Contributors and peer reviewers

Jorge Elias Davalos-Chacon, PEP – Partnership for Economic Policy; Andrea Ferrannini, University of Florence.

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Abstract

This paper explores how sustainability transitions are unfolding within Global Value Chains (GVCs) and Global Production Networks (GPNs), focusing on how environmental and social costs, governance capacity, and value capture are unevenly distributed across sectors and territories. Drawing from case studies in Peru, Vietnam, and Italy, we examine how sustainability is shaped by sector-specific dynamics and the interplay between global standards, local institutions, and innovation systems. We develop an integrated analytical framework combining GVC/GPN theory, global sociotechnical regimes, and the Sustainable Human Development (SHD) approach, structured around the 5Ps (People, Planet, Prosperity, Peace, and Partnership). Our findings reveal three core mechanisms driving sustainability tensions: (1) asymmetrical distribution of costs and risks, (2) institutional misalignment between global norms and local capabilities, and (3) lead-firm control over upgrading opportunities. We show how these mechanisms reinforce inequality and limit inclusive, ecological upgrading, particularly in Global South regions. The paper concludes by outlining actionable policy levers, at EU, national, and multilateral levels, to promote fairer, more sustainable competitiveness in global production systems.

1. Introduction

The global economy has entered a turbulent phase of reshaped globalisation, geopolitical rivalry, and recurring supply-chain shocks; from energy and critical raw materials to food and key industrial inputs (McKinsey & Company, 2024). While the urgency of the sustainability transition keeps rising. For the European Union, this is a defining policy moment: strategic autonomy, decarbonisation, and social cohesion now directly intersect with competitiveness and the governance of interdependence. Choices such as the EU-Mercosur negotiations capture these tensions, promising market access and diversification but also raising political, environmental, and distributional trade-offs. As the Draghi Report on EU competitiveness stresses (European Commission, 2024a; 2024b), Europe's prosperity will depend not only on innovation and productivity, but on embedding them in resilient, fair, and sustainable cross-border production systems.

Considering this landscape, a key question arises:

"How can Global Production Networks (GPNs) and Global Value Chains (GVCs) be reconfigured to promote more equitable and sustainable development across regions in an interconnected global economy?"

We address this question by bringing together four literatures that are often treated in parallel: Global Production Network (GPN) (Coe & Yeung, 2015; 2019) and Global Value Chains (GVCs) (World Bank, 2020; Antràs & De Gortari, 2020), global sociotechnical regimes and global innovation systems (Binz & Truffer, 2017), and the Sustainable Human Development (SHD) (Biggeri et al., 2023; 2026).

GVCs allow us to trace production as a sequence of steps in which value is added across borders, revealing where environmental and social burdens accumulate along different configurations of supply chains ("snake-like", "spider-like" or mixed) (World Bank, 2020).

GPNs widen the lens to the full constellation of actors and power relations (such as firms and suppliers, states and regulators, labour and finance, and the environment), helping overcome the limits of purely trade-centred measurement. Linking these perspectives to the literature on global sociotechnical regimes and innovation systems clarifies how technological pathways, standards, and knowledge flows are governed transnationally, often reinforcing uneven development and lock-ins that shape sustainability transitions.

Importantly, we ground this analytical framework in the concept of Sustainable Human Development, as defined by the 5Ps (People, Planet, Prosperity, Peace and Partnership) and the Quintuple Helix model (Carayannis et al., 2019; Biggeri et al., 2023), which comprises five key stakeholders: academia, businesses, civil society, government and nature. The 5Ps provide a normative framework for evaluating whether global production expands capabilities and well-being within ecological limits, while the Quintuple Helix model identifies the governance structures required to realign networks, with public institutions, industry, academia, civil society and the natural environment collaborating to produce innovation and value (Biggeri et al., 2023).

All these reframes combine to present the idea of 'upgrading' in GVCs/GPNs as not just moving to higher-value tasks, but also as redistributing value creation towards social inclusion, ecological regeneration and democratic agency. This approach can steer global innovation systems towards just transitions and synergies rather than focusing just on efficiency (Biggeri et al., 2026).

To examine how sustainability challenges are addressed across diverse industrial contexts, the study employed a qualitative, inductive approach, conducting 20 in-depth interviews across Peru, Vietnam, and Italy. Sectors included agribusiness and mining in Peru (10 key informants), textiles

and coffee in Vietnam (6 key informants), and the coffee industry in Italy (4 key informants). Participants were selected for their governance relevance within global value chains, with interviews focusing on sustainability practices, innovation, and institutional frameworks. Rather than seeking representativeness, the research prioritized high-leverage insights and treated access asymmetries as reflective of underlying power dynamics.

This cross-sectoral and cross-territorial design allows us to identify recurring sustainability tensions and opportunities, as well as EU-specific leverage points in trade, industrial, procurement, and innovation policy. The aim is twofold: to provide evidence on how contemporary global networks shape sustainability and equity outcomes, and to derive policy implications that can inform the next generation of EU and international policy design for sustainable competitiveness.

First, we discuss the theoretical setting (Section 1), covering the differences and linkages between GPN and GVC. Then, we explore the concept of competitiveness and its relationship with global innovation systems, before discussing how to integrate these with a human development perspective. In Section 2, we discuss three case studies (Italy, Vietnam and Peru) by describing the institutional context, science, technology and innovation (STI) policies, and their sustainable scope. Based on interviews, we describe the supply chain structure, and the sustainability strengths and weaknesses raised by key informants. Finally, we conclude by summarizing the theoretical and empirical findings and outlining the policy implications derived from our analysis.

2. Global Value Chains (GVCs), Global Production Networks (GPNs) and their sustainability challenges

Global value chains (GVCs) and global production networks (GPNs) are the organisational core of the global economy (Coe & Yeung, 2015) and are characterised by fragmented production processes that are coordinated across multiple geographical locations. GVCs emphasise the trade dimension, particularly the global flow of intermediate goods (World Bank, 2020). GPNs adopt a broader perspective, considering the influence of firms, states, labour, finance and the environment on value creation and capture (Coe & Yeung, 2019). Both frameworks reveal how economic power is unevenly distributed, often favouring lead firms in the Global North while relegating many regions in the Global South to roles that are low-value, resource-intensive or environmentally harmful.

Sustainability challenges arise from this asymmetry: circular economy strategies, for instance, are increasingly global but often reproduce inequalities through "dysfunctional circular couplings" where regions become sites of waste processing rather than innovation (Friedrich et al., 2025). Similarly, global sociotechnical regimes (Fuenfschilling & Binz, 2018), defined by multinational actors and embedded in global value chains, can constrain local sustainability transitions by locking in dominant technological pathways. Addressing these challenges requires a shift toward more geographically sensitive and politically informed approaches that recognize the uneven development dynamics and environmental externalities embedded in global economic networks (Binz et al., 2025), together with a normative framework that clarifies what a just and ecologically viable reconfiguration of GVCs and GPNs should entail.

The Sustainable Human Development (SHD) framework (Biggeri et al., 2023) provides such a framework. By emphasizing interdependencies between justice and ecological limits, SHD offers a normative lens to assess and reconfigure global production systems. Integrating SHD into GVC/GPN analysis moves us beyond economic efficiency to question how global production contributes to or undermines wellbeing, planetary boundaries, and equitable development. This hybrid approach reveals the urgent need to rethink value creation and capture in ways that promote just transitions empowering local actors and aligning global production with sustainability and human dignity. It challenges dysfunctional circular economy practices and calls for governance models that embed ecological ceilings and social foundations into global trade and industrial policy.

2.1. GVC and GPN: definitions from Economic Geography and Economics perspectives

To understand the linkages and interconnections of economic and non-economic actors, activities, and outcomes, we need to clarify and distinguish the concepts and phenomena called Global Production Networks (GPN) and Global Value Chains (GVC). Thus, GPNs provide a more actor-centred and spatially nuanced understanding of contemporary global production. In contrast, GVCs aggregate multiple production processes within an industry, focusing primarily on trade flows, particularly the international exchange of intermediate goods, which now surpasses that of final goods (Gereffi, 1994). The focus on these two definitions shows how value creation is fragmented across countries and actors, going beyond traditional trade measures.

GPN thinking goes beyond standard Global Value Chain (GVC) approaches by offering a multidimensional framework for understanding contemporary globalization. It captures how economic, political, social, and ecological forces intersect in complex production networks coordinated by lead firms across multiple locations. In GPN 2.0 (Coe & Yeung, 2015), global production is seen as fragmented and geographically dispersed, involving interconnected economic and non-economic actors, and generating uneven development, governance, inequality, and sustainability outcomes.

However, GVCs represent an essential part, especially for quantifying such phenomena. GVCs highlight the systemic role of trade in fragmented global production, GPNs emphasize the organizational and geographic dimensions, especially the strategic role of firms, including emerging market transnational corporations, and the shifting demand patterns toward the Global South.

The main features of GVCs (Antràs & De Gortari, 2020): the later a product is in its production journey, the more sensitive it becomes to trade costs, so small inefficiencies can add up quickly as parts cross multiple borders. Interestingly, even if production is spread out across different countries, the system can still be cost-effective if the right balance is achieved. Moreover, countries do not all lose equally if global trade breaks down. The number of losses depends on how efficiently they trade and how similar their technology and costs are to others. Even in a perfectly equal world, trade barriers still reduce overall gains (economically and not only). Finally, a country's position in the value chain matters a lot: those that are more "central" (meaning they connect to many others) also tend to handle the later, more complex stages of production.

Therefore, unlike traditional trade, which is usually a single transaction between exporter and importer, GVC trade organizes production across borders, with value added at multiple stages in different countries and goods (and services) crossing borders several times. This deepens interdependence and amplifies both the gains and the risks of globalization, and structurally GVCs often take the form of "spiders" or "snakes" (World Bank, 2020):

1. *Spider-like* GVCs feature a structure where various parts and components are produced in multiple locations and then converge at a central assembly point. This resembles a spider with many legs feeding into a single body and is typical of industries like electronics or automotive manufacturing.
2. *Snake-like* GVCs represent a sequential process in which production stages follow one another across countries, with each step adding value before passing the product forward. This linear structure resembles a snake and is common in industries such as textiles or pharmaceuticals.

A broader analytical view of such globally fragmented and connected production is needed. The main elements of the Global Production Network (GPN) literature are relevant here. These are the "constituent outsides" (Coe & Yeung, 2019). These include the state, finance, labour, development

and the environment. The intersection of these elements shapes the global economy. These five domains show that GPNs are not just economic constructs but complex socio-political and ecological systems where:

- The state is recognized as a strategic actor, not just a background force, influencing value creation and capture within GPNs (see Figure 1). States operate across multiple scales, as regulators, producers, buyers, and investors, and play critical roles in shaping the governance and direction of production networks through policy, public procurement (Doner & Schneider, 2016), and international trade agreements and policies (Meckling & Hughes, 2018). This is particularly true for some countries.
- Finance plays a dual role (see Figure 1): it underpins production networks by facilitating investment and infrastructure but also exerts disciplinary power via financialization. Shareholder expectations, offshore wealth chains, and global financial networks impact firm behaviour, corporate strategy, and value distribution, often exacerbating inequalities through tax avoidance and capital mobility (Coe et al., 2014).
- Labour, as both subject and agent. While global networks often generate precarious conditions and informal employment, workers also mobilize agency through organization, negotiation, and social reproduction strategies (De Neve & Carswell, 2013; Baglioni, 2018). Labour regimes, shaped by structural, political, and cultural forces, define working conditions, rights, and bargaining power at multiple scales (Mehrotra & Biggeri, 2007; Barrientos et al., 2011; Bartley, 2018; Taylor & Rioux, 2018). Labour is not only shaped by transnational regimes but also fragmented across formal and informal sectors, with informal labour playing a central yet often invisible role. Particularly in Asia, large portions of GVC production rely on home-based and subcontracted informal workers, especially women and children, who lack basic protections. These informal labour arrangements contribute to the precarity and asymmetry of bargaining power along the chain. Yet, informal workers also engage in collective agency, forming associations and networks to assert rights and negotiate better terms, highlighting the dual nature of labour as both vulnerable and resilient in global production systems (Mehrotra & Biggeri, 2007).
- Development implications of GPN concern how regional economies become strategically coupled, decoupled, or recoupled with global networks. While coupling can drive industrial upgrading, critics stress the need to consider “disarticulations” (regions excluded or marginalized by global processes) and the uneven, sometimes exploitative, outcomes of these integrations (Crescenzi & Harman, 2023).
- Finally, the environment is increasingly seen as co-constitutive of production networks. Natural resource extraction, commodity materiality, and ecological contradictions influence network configuration. Environmental upgrading strategies (like eco-efficiency or green branding) are often constrained by weak regulation and limited coordination across global supply chains with geographical diverse outcomes (Distefano et al., 2024).

2.2. Sustainability

Understanding sustainability transitions requires attention to complex socio-economic and spatial contexts. This involves analysing spatial, economic, and political dynamics through both territorial (place-based) and relational (network-based) lenses, recognising that transitions are multi-scalar and embedded in uneven capitalist structures shaped by power, inequality, and institutional diversity (Binz et al., 2025) and, thus, intersecting with multilevel hierarchical structures.

Within this uneven landscape, a key policy and practice area is the circular economy (CE). Practices such as recycling, remanufacturing, and reuse are increasingly organised through global production networks, in which value creation and capture are shaped by lead-firm governance, standards, and multi-scalar state regulation (Stihl et al., 2025) . Friedrich et al. (2025) describe "circular couplings" to capture how regions are linked into global circular value creation, ranging from functional and beneficial to dysfunctional and exploitative. From a circular GPN perspective, these couplings are structured by power asymmetries and control over design, procurement, certification, and compliance, which can externalise environmental and labour risks while concentrating higher-value functions and rents elsewhere. We use "dysfunctional circular couplings" to denote forms of circular integration that (i) generate limited local value capture, (ii) offload health and environmental burdens onto weaker regulatory contexts, and (iii) constrain upgrading into higher-value circular roles. This helps explain why regions in the Global South are often confined to low-margin and risky activities (e.g., informal e-waste processing or low-grade plastic recycling), while refurbishment, remanufacturing, and advanced recycling remain concentrated in the Global North (Friedrich et al., 2025). State policies and infrastructures are crucial in determining whether regions can upgrade into higher-value circular roles or remain locked in hazardous, marginal positions. Overall, circular economy strategies are not inherently just or sustainable; their outcomes depend on how they are embedded in broader structures of global economic power and regulation (Distefano et al., 2024; Friedrich et al., 2025).

Sustainability transitions must be understood within a global context, challenging the traditionally nation-centric focus of transition theories like the Multi-Level Perspective (MLP) (Geels, 2011). Here, the concept of global sociotechnical regimes is *operationalized* as networks of technologies, rules, and actors (e.g., multinational firms and global value chains) that operate across borders and shape innovation worldwide. These regimes strongly influence where and how sustainable practices emerge and often reinforce geographical and institutional inequalities, especially between the Global North and South. A more global and geographically sensitive framework is therefore needed to capture the uneven and interconnected dynamics of sociotechnical change (Fuenfschilling & Binz, 2018).

In this sense, the importance of global agency and coordination in driving sustainability transitions across sectors traditionally shaped by entrenched national systems is relevant (Biggeri and Canitano, 2010). By challenging the notion that transformative change must always emerge from local innovations scaled upwards. Instead, supranational actors, such as philanthropies, international organizations, and global networks, can initiate and shape systemic change at the global level. By conceptualizing transitions as processes of distributed agency, and how different types of global actors can contribute: by generating new visions, translating these into international norms and standards, and implementing them in practice. A coordinated, multi-actor approach illustrates how global institutions are not merely passive enforcers of existing regimes, but active sites where new paradigms can emerge and diffuse (Lesch et al., 2023).

2.3. Globalization, Deglobalization and Re-Globalization.

With nearly half of global trade now flowing through Global Value Chains (GVCs), national policies that support upgrading from basic commodity exports to higher-value, innovation-driven activities are increasingly essential for sustainable development. As the World Bank (2020) emphasizes, progress along GVCs requires targeted investments in skills, infrastructure, access to finance, and effective governance at every stage of integration.

However, the global momentum behind GVC expansion has slowed since 2008, hindered by weaker economic growth, stalled reforms, and rising trade tensions. Without renewed policy ambition and cooperation, developing countries risk being excluded from higher-value segments of GVCs, jeopardizing poverty reduction and economic resilience. In fact, escalating trade conflict could push over 30 million people into poverty and shrink global income by up to $1.4 trillion (World Bank, 2020).

While new technologies like automation and 3D printing pose challenges, they also offer opportunities to revitalize GVCs by lowering costs and enhancing productivity. But seizing these benefits requires countries to act strategically: developing nations must accelerate trade and investment reforms, while advanced economies must maintain open, predictable policies. Crucially, international cooperation is more vital than ever, as the interconnected nature of GVCs means that domestic policies have far-reaching global impacts. Coordinated action, backed by social and environmental safeguards, can ensure GVCs remain a powerful engine for inclusive and sustainable development (World Bank, 2020).

The relationship between trade and environmental sustainability is complex. Trade drives economic growth, shifts production across countries, and influences the technologies used in that production. While trade contributes to emissions through manufacturing and transportation, it can also help reduce environmental harm by expanding access to green technologies and environmental goods and services. Addressing global challenges like climate change requires coordinated global action. Fragmented climate policies lead to weaker, less efficient outcomes, and economic fragmentation can slow the international spread of clean technologies critical for mitigation. In this context, *re-globalization*, renewed international cooperation, and integration offer significant environmental benefits (Zhou, 2025). It promotes cleaner forms of trade, such as digital services, and supports more cohesive global frameworks for managing both trade and environmental goals (World Trade Organization, 2023).

Trade has delivered welfare and poverty reduction gains over the past 30 years, but its benefits are structurally uneven. Without supportive domestic policies, vulnerable groups, like low-income workers and small businesses, can face lasting harm. Restricting trade often backfires, while targeted investments in education, infrastructure, and digital access are more effective for making trade inclusive amid new global challenges. The World Trade Organization's (WTO) rules-based system plays a key role in supporting global trade, especially for developing countries. However, to ensure all economies benefit fully, trade rules and support measures need to be more effective and inclusive. Particularly in areas like digital trade, Micro, Small and Medium Enterprises (MSMEs) access, and policy coordination. Stronger international cooperation and targeted domestic reforms are essential to make trade a true engine of inclusive development (World Trade Organization, 2024).

2.4. Sustainable Competitiveness in an interconnected world

As discussed in the previous section, production, trade, and innovation are organized through complex and fragmented Global Value Chains (GVCs) and Global Production Networks (GPNs). Therefore, sustainability must be addressed along the entire length of global value chains (GVCs), not just through national innovation systems. Environmental and social costs are often externalized in global production systems, particularly affecting countries in the Global South through unequal power relations and limited bargaining capacity. While integration into global markets can drive economic growth, it often comes with environmental degradation, resource pressure, and social inequality unless accompanied by strong governance and inclusive policy frameworks (as discussed in Case studies from Peru, Vietnam, and Italy in Section 3).

Embedding binding sustainability and equity criteria into GVC and GPN governance, through EU trade, procurement, industrial, and innovation policies, requires shifting from a shareholder-driven to a stakeholder-oriented model. This implies that GVCs and GPNs should be not only efficient and globally competitive, but also fair, transparent, and regenerative throughout their operations (Caloffi et al., 2025). In this sense, sustainability is not a constraint on competitiveness but a core dimension of what we call *sustainable competitiveness*.

Competitiveness refers to a country's or region's ability to sustainably improve the productivity of its economy while delivering rising living standards, social cohesion, and environmental sustainability over the long term (European Commission, 2024a). It involves more than just low costs or export success; it includes the capacity to innovate, invest in skills and infrastructure, attract talent and capital, and support businesses in creating value-added activities across global markets. Competitiveness also reflects how effectively an economy can adapt to change while maintaining economic resilience and social inclusion. For regions like the EU, this means aligning economic dynamism with strategic autonomy, green and digital transitions, and fairness across societies and generations (European Commission, 2024a).

Innovation in sustainability sectors is increasingly organized across borders through networks of firms, institutions, and knowledge flows. Global innovation systems have three core elements: transnational innovation networks, localized nodes of expertise, and global sectoral regimes that steer industry norms and trajectories (Petraite et al., 2022). Therefore, it is shaped by multi-scalar interactions and governance challenges, including power asymmetries and institutional diversity. This lens helps explain how technologies such as renewable energy or electric mobility spread, and how uneven control over innovation affects the outcomes of sustainability transitions (Binz & Truffer, 2017).

While the EU remains strong in scientific research and regulation, it is behind the US and China in commercializing innovation, scaling technology, and fostering high-growth tech firms. This innovation gap threatens long-term competitiveness by limiting the EU's ability to shape future value chains and technological standards. Addressing this requires a bold policy mix: deeper investment in R&D, a more integrated digital single market, and stronger incentives for innovation-driven entrepreneurship (European Commission, 2024b).

The COVID-19 pandemic and geopolitical shifts (e.g., the war in Ukraine, tensions in the Indo-Pacific) have exposed the vulnerabilities of over-reliance on global supply chains for critical goods. Strategic autonomy is now a priority, not as a call for autarky, but as a shift toward resilient interdependence. Policies such as reshoring, nearshoring, and diversifying suppliers are necessary, but they must be approached cooperatively, both within the EU and globally.

In this context, Competitiveness should not be framed just as rivalry, either among EU member states or between the EU and external powers. A more cooperation-oriented approach is essential to align industrial strategies, pool innovation capacities, and avoid fragmentation of the single

market. Pan-European initiatives like the Important Projects of Common European Interest[1] (IPCEIs) and coordinated green/tech transitions exemplify how joint efforts can enhance collective competitiveness.

At the same time, EU industrial and trade policies are closely connected to what happens in the rest of the world. Shifts toward reshoring or "re-globalisation" (i.e., restructuring global supply chains based on values or geopolitics) have direct and indirect impacts on countries in the Global South, many of which are deeply integrated into current value chains. These changes can affect their economic development prospects, employment, and inclusion in the global economy. Therefore, competitiveness strategies must be designed with global justice and inclusive development in mind (Biggeri et al., 2023). This includes fair trade policies, development cooperation, and climate finance that recognize and mitigate the spillover effects of EU decisions.

More broadly, domestic and regional policy decisions often have far-reaching consequences that extend well beyond national borders, impacting third countries in ways that are not always explicitly intended or acknowledged. This phenomenon, known as policy spillover, has become increasingly evident in a globalized economy characterized by deep trade, financial, and regulatory interdependencies. For instance, environmental regulations such as the EU's Carbon Border Adjustment Mechanism (CBAM), while aimed at reducing emissions within the EU, make exporters in developing countries follow new rules, reshaping their production and trade strategies (UNCTAD, 2021). Similarly, monetary and fiscal policies in large economies, such as quantitative easing in the US, can lead to significant capital flow volatility in emerging markets, affecting exchange rates and macroeconomic stability (IMF, 2014; Rey, 2013). Regulatory frameworks like the General Data Protection Regulation (GDPR), although designed for EU citizens' data privacy, have also triggered widespread global compliance among firms seeking access to EU markets, leading to what Bradford (2020) calls the "Brussels Effect." Even social policies, such as labour and supply chain due diligence laws, increasingly influence practices in third-country suppliers and producers (ILO, 2023). Therefore, national or group-level actions can unintentionally shape economic and regulatory landscapes elsewhere. As such, there is an urgent need for greater international coordination and dialogue, especially in areas like trade, climate, and governance, to mitigate negative externalities and promote more equitable global outcomes.

Finally, powerful nodes in global production and innovation networks export their regulatory preferences and risk profiles along value chains. Enhancing international coordination and dialogue is therefore essential to ensure that such spillovers support, rather than undermine, more equitable and sustainable forms of competitiveness worldwide.

[1] See detail at https://competition-policy.ec.europa.eu/state-aid/ipcei_en

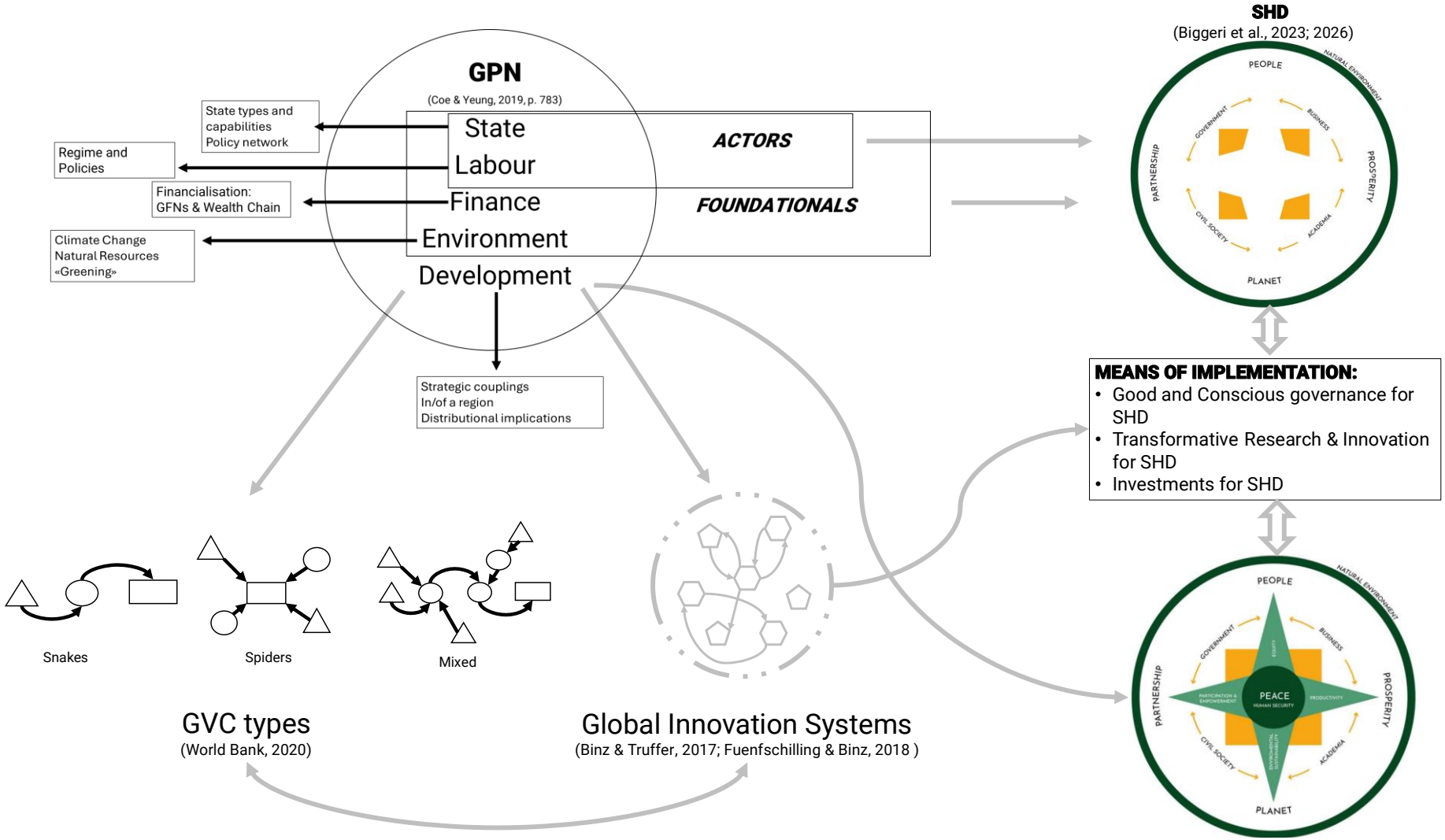
2.5. Global Production Network, Global Innovation System and Integrated Sustainable Human Development

In this section, we bring together the elements discussed above: Global Production Networks (GPN), Global Value Chains (GVC), global innovation systems, and the Quintuple Helix / ~~Integrated~~ Sustainable Human Development (SHD) framework (Biggeri et al., 2023). By combining these perspectives, we aim to build an integrated framework to assess environmental and social sustainability along value chains in an interconnected world and to identify policy levers for both local and global actors.

Figure 1 integrates the elements and illustrates how production is fragmented and interconnected across countries. In GPN 2.0 (Coe & Yeung, 2015), these chains are typically governed by lead firms and embedded in broader structures of labour, state, finance, environment and development. These dimensions mirror the five actors of the Quintuple Helix (business, government, civil society, academia, and nature), as in Biggeri et al. (2023), and interact through global innovation systems (Binz & Truffer, 2017; Fuenfschilling & Binz, 2018).

On the right, the SHD framework (Biggeri et al., 2023) specifies the "means of implementation": conscious and fair governance, transformative research and innovation (Biggeri & Ferrannini, 2020; Ferrannini et al., 2023), and mission-oriented investment. Together, these elements link value-chain configurations, innovation dynamics and governance arrangements to the 2030 Agenda's 5 Ps (People, Planet, Prosperity, Partnership and Peace) to assess environmental and social sustainability along value chains and to identify policy levers for local and global actors.

Figure 1. *A framework for Sustainable Human Centred GPN and GVC*



To make the framework operational and comparative across cases, we propose a mechanism-based lens that explains how sustainability tensions in GVCs/GPNs emerge and persist. Building on GPN 2.0's emphasis on lead-firm governance and multi-scalar embeddedness (Coe & Yeung, 2015), and linking this to global innovation systems (Binz & Truffer, 2017; Fuenfschilling & Binz, 2018) and SHD "means of implementation" (Biggeri et al., 2023), we focus on three mechanisms to be traced empirically in each case:

1. Asymmetric distribution of environmental and social costs across nodes.

Sustainability tensions arise when risks and burdens (pollution, unsafe work, land/health impacts) are displaced onto specific territories and actors, while benefits accrue elsewhere. This approach highlights who is responsible for what across the network and shows how this connects to the 5Ps, especially People and Planet.

2. Institutional thinness or misalignment between global standards and local capacities.

Tensions intensify when transnational standards, certification schemes, and compliance requirements are not matched by local regulatory capacity, infrastructure, skills, or enforcement, creating gaps between formal sustainability expectations and real-life implementation.

3. Lead-firm governed value capture structures that limit upgrading opportunities.

Even when "green" practices diffuse, upgrading can be constrained if lead firms control design, procurement, and market access in ways that lock peripheral nodes into low-value functions. This links sustainability outcomes to distributional dynamics (Prosperity/Partnership) and to innovation pathways shaped by global innovation systems.

Together, these mechanisms connect network structure and innovation dynamics to SHD outcomes, while also clarifying where policy levers can intervene, through conscious and fair governance, transformative research and innovation, and mission-oriented investment (Biggeri et al., 2023; Biggeri & Ferrannini, 2020; Ferrannini et al., 2023).

3 Case studies: EU and Global South

To explore how sustainability challenges are addressed across diverse industrial contexts, a qualitative, inductive research design was employed (Edmondson & McManus, 2007), focusing on the agribusiness and mining sectors in Peru, the textile/garment and coffee sectors in Vietnam, and the coffee industry in Italy. We involved twenty participants in total; each interview lasted approximately 1.2 hours on average, in different ways, either in person or online.

We aimed to cover upstream, midstream, and downstream nodes and to include both private and public governance actors, prioritising informants with direct operational or regulatory responsibility. The distribution of interviews across countries and actor types is intentionally unbalanced. Our objective is a mechanism-based explanation rather than representativeness: we prioritise informants occupying governance-relevant positions (lead firms, regulators, certifiers, producer organisations) and follow the chain links that structure the three mechanisms. In line with theoretical sampling and the information power principle, fewer interviews are required where actors observe (and/or manage) multiple chain segments and provide high leverage evidence, while access constraints and gatekeeping in some upstream settings limit feasible coverage. Importantly, these access asymmetries mirror the power structures we analyse. Therefore, these are treated as part of the empirical context rather than a purely logistical limitation.

In Peru, a total of ten in-depth, semi-structured interviews were conducted with elite informants, including 4 agribusiness experts (CEOs, a specialized agricultural banker, and a former Minister of Agriculture) and six mining sector stakeholders (former Ministers of Mining, industry association leaders, and Vice Presidents of Sustainability from two of the country's top copper mining firms). Interviewees were selected for their direct and exclusive knowledge of sustainability practices and governance within global value chains. Access was gained through personal networks and snowball sampling techniques, with interviews conducted both online and face-to-face.

In Vietnam, six interviews were conducted with stakeholders selected for their substantial experience and sectoral relevance. These included a textile firm manager, a representative of the Binh Duong Industrial Zone Authority, two academic researchers (one on industrial zones, one on coffee production), and two coffee farmers from Dak Lak Province.

In Italy, four key informants were interviewed: two researchers specialized in coffee industry products, one coffee factory owner, and the president of a national coffee makers' association. Across all three countries, the interviews aimed to elicit insights into the implementation of sustainability norms, innovation dynamics, and institutional frameworks within and across global production networks, offering a rich, multi-scalar perspective on responsible and inclusive development practices.

We discuss the context and political landscape of Peru and Vietnam, and the main findings from Peru, Vietnam, and Italy, and then we compare the results

3.1. Peru Political Landscape

Context

In the last years, Peru's political and institutional landscape is marked by instability, elite fragmentation, and weak state capacity, which undermines policy continuity and public trust. Although the country has experienced periods of macroeconomic growth and market openness, the state has struggled to align economic dynamism with social and environmental objectives, as regulations are often present but poorly implemented, creating "institutional voids" (Khanna & Palepu, 1997). Governance tends to be reactive and fragmented, with limited territorial presence and frequent co-optation of public policy by private interests or international donors, so sustainability is treated more as a technical issue than a political and redistributive one. A highly centralized system further weakens subnational governments, leaving them ill-equipped to manage the local sustainability impacts of development and participation in global value chains. Overall, Peru is an insightful case study because it reflects a common dilemma for resource-rich Global South economies: how to attract competitiveness and foreign investment while lacking the institutional coherence and political commitment needed to turn that growth into equitable, environmentally sustainable development.

STI and Sustainability

Peru's journey toward environmental sustainability is ambitious and multifaceted. The country has laid a strong legal and strategic foundation, but the path forward requires a nuanced, inclusive, and context-sensitive approach. In particular, when translating high-level policies into actionable practices within key economic sectors.

Peru is highly vulnerable to climate change, and in recent years has developed an increasingly articulated framework for environmental governance. The Ministry of the Environment (*Ministerio del Ambiente*, MINAM) stands at the centre of this effort, not only as a regulator but as the main actor tasked with mainstreaming environmental goals across all sectors and levels of government. Under its leadership, Peru has adopted key instruments such as the National Environmental Policy, also called the National Strategy for Climate Change 2021–2050[2], and the Circular Economy Blueprint for 2030 (launched in 2025), which are aligned with the National Competitiveness and Productivity Plan 2024–2030.

Together, these policies aim to anchor economic development in environmental sustainability by improving waste management, cutting pollution, boosting energy efficiency, and meeting Peru's Nationally Determined Contribution (NDC) target of a 20% reduction in emissions, rising to 30% with international support, with the energy sector so far playing a leading role.

Their effectiveness, however, becomes clearer when seen through sectoral lenses. In copper mining, environmental governance revolves around water conflicts, social tensions, and the need to move from firm-centred Corporate Social Responsibility (CSR) to collaborative models with communities and the state. Cases such as the Cerro Verde project in Arequipa show that shared water management and local supplier development are possible, but still limited, and must be

[2] See https://stip.oecd.org/stip/interactive-dashboards/policy-initiatives/2025%2Fdata%2FpolicyInitiatives%2F200002183

complemented by stronger action on illegal and artisanal mining, circular practices, emissions tracking, and community development.

In agribusiness, especially for fresh fruits and vegetables, sustainability is largely governed through international certifications (GlobalGAP[3], Rainforest Alliance[4], Fairtrade) demanded by foreign buyers and adapted to local conditions by Peruvian associations. These schemes have helped integrate small farmers into global value chains and upgrade their practices, yet again, water scarcity and competition in arid regions remain critical. Across both sectors, a common challenge emerges. Therefore, international sustainability frameworks often sit uneasily with Peru's institutional and socio-economic realities, reinforcing the need for closer coordination among firms, government, academia, and civil society to co-design strategies that are both globally credible and locally grounded.

3.2. Agri-food and Mining in Peru

3.2.1. Agri-Food and Mining GPNs and GVCs in Peru

Peru is deeply integrated into two emblematic global value chains that structure its export profile and development path: copper mining and high-value agribusiness (fresh fruits and vegetables). Both chains have expanded rapidly over the last decades, but they do so through very different techno-economic logics and governance structures. Copper mining ties Peru to a capital-intensive, long-lived extractive system dominated by a handful of transnational lead firms, while agribusiness connects Peru to fast-cycle, standards-driven food networks led by global retailers and exporter-packers. Reading them side-by-side helps clarify how Peru is positioned in global production and where upgrading constraints and opportunities lie.

Peru's copper-mining GVC can be defined as an upstream-specialized segment of the global copper system in which exploration, extraction, and concentration are performed domestically by junior explorers and major international miners, whereas a significant share of processing and refining is coordinated abroad through long-term contracts and treatment/refining arrangements. In GVC terms, Peru occupies the early nodes of a snake-like sequential path:

exploration → extraction → concentration → processing → refining;

with rents and standards largely governed by lead miners. Yet the operational backbone is also spider-like, because a dense ecology of global suppliers and services converges on mine sites (equipment, engineering, chemicals, logistics, finance, environmental and social services). Under a GPN lens, this mixed snake-and-spider configuration is shaped by power asymmetries among lead firms and key suppliers and by Peru's state, finance, labor regimes, and socio-environmental politics that condition project viability and local participation.

Peru's fresh-produce agribusiness GVC can be defined as a high-value, export-oriented agricultural system where domestic production, packing, and cold-chain logistics are tightly coordinated to meet

[3] See https://www.globalgap.org/

[4] https://www.rainforest-alliance.org/for-business/certification/sustainable-agriculture-certification/?gbraid=0AAAADJ4Zli-CVJAWXt_3b97Qsh8NX-5d&gad_source=1&gad_campaignid=23034361355

the quality, safety, and timing requirements of global supermarkets, while upstream R&D/seed licensing and downstream marketing/retail are often governed abroad. The core chain is snake-like:

R&D → inputs → production → processing/packing → cold storage → distribution → retail;

but organization is simultaneously spider-like, since many growers and input providers channel into hub exporter-packers and cold-chain operators that interface directly with international retailers. In GPN terms, governance hinges on buyer power and on compliance with layered public/private standards, while Peru's reforms in land, irrigation, and trade policy enabled rapid scaling and exporter coordination.

These two GVCs also concentrate Peru's sustainability stakes. Copper mining raises acute environmental pressures (water withdrawal and contamination, tailings and air emissions, land disturbance) and social tensions around territorial rights, community consent, labour safety, and unequal value capture; long project horizons intensify conflict when governance is weak. Agribusiness brings different trade-offs: intensive irrigation in arid coastal areas, pesticide and fertilizer loads, seasonal and gendered labour precarity, land concentration, and vulnerability to climate shocks, all under the disciplining force of global standards. Studying both chains together foregrounds a shared challenge for Peru: reconciling global competitiveness with socially inclusive, environmentally resilient upgrading pathways.

3.2.2. Findings

Mining

Rising global copper demand is creating major economic opportunities for Peru, but it is also intensifying social and environmental harms that directly affect water resources, land, and local community livelihoods. Our elite informants repeatedly pointed out that water scarcity and pollution are the most serious concerns, along with tailings-dam risks[5], unresolved mining legacies, and air pollution from extraction and processing. A recurring issue is the still-limited adoption of circular-economy practices. Especially the reuse of water and tailings suggests that production gains do not match equivalent advances in environmental mitigation and long-term territorial sustainability.

Against this backdrop, water emerges as the central fault line in mine–community relations. The origin of the social conflicts between the mines and the local communities is largely rooted in water issues. Using the words of a senior sustainability manager in Peru's copper sector:

"The water problem is generated because it is seen as a competition between its usage for the mining process or agriculture, and also for the life (access to safe drinking water) of the community. Nowadays, despite the technology used by mining operations, there remains a fear that everything that comes out of the mines is polluted."

These perceptions of scarcity and environmental risk (related to pollution) shape local trust and often trigger broader disputes over territorial priorities. These tensions are compounded by the fact

[5] https://www.icmm.com/en-gb/our-work/tailings/about-tailings

that much of the direct water pollution affecting nearby communities is attributed to informal and artisanal mining. While this activity is far more widespread in gold, informants note that it is beginning to spill over into copper, through small but growing operations such as Apu Chunta[6]. This blurs accountability on the ground and makes it harder for communities to distinguish between impacts generated by formal versus informal actors.

In the social dimension, our key informants converge on the view that formal mining should act as an ally for local development rather than a substitute for the state, by helping to bring public services and institutions into remote territories. They emphasize that the most pressing social challenges are place-based development bottlenecks—persistent competition over water between mining and agriculture, the spread of illegal and artisanal mining, weak upgrading and knowledge transfer to local suppliers, and the need to move beyond one-off "social philanthropy" toward sustained territorial development strategies. While also recognizing that indigenous rights may become more salient. Then, a major remark was raised by one of the key informants:

"… the mining firms should not replace the Government; instead, they should bring it to these geographical areas to help close the social gaps of the local communities."

Institutionally, these issues are negotiated within a governance framework involving three actor groups: the private sector (industry confederations and major copper firms), civil society (communities, NGOs, academia, media, international organizations), and the public sector (relevant ministries, congress, and local/regional governments), who must balance competitiveness, rights, and effective governance. According to a key informant from the private sector. The role of private investors is crucial:

"The mining industry is the one that pushes the changes on environmental and social practices to more advanced ones in the environmental and social standards of the Peru laws."

Our interviews indicate that international NGOs and, especially, international investors are key external drivers of new sustainability norms, often pushing firms toward higher environmental and social standards. Consistent with this, informants report ongoing practices such as multi-actor territorial initiatives, "Works for Taxes[7]" infrastructure investments, clean technologies, water-cycle projects, reforestation, air-pollution controls, renewable energy uptake, and early circular-economy

[6] https://www.bloomberg.com/features/2025-cobre-conflicto-peru-mineria-indigena-las-bambas/

[7] Peru's Works for Taxes scheme (created in 2008) lets private firms pay part of their corporate income tax in advance by financing and delivering public infrastructure projects (e.g., transport, schools, sanitation, health, security). Instead of the state paying upfront, the firm covers project costs and execution/management; once the work is completed and quality-validated, the firm receives government-issued certificates that can be used to offset up to 50% of its annual income tax (and can also be traded), creating incentives for faster, higher-quality delivery of local public works (Del Carpio, 2018).

pilots, while Scope-3[8] decarbonization remains nascent. Looking ahead, priorities are clear: deepen integrated water management, scale circular-economy solutions across the chain, accelerate Scope-3 emissions reduction, and invest in local supplier upgrading within a territorial development approach that strengthens, rather than replaces, the state.

Agrifood

Over the past two decades, agribusiness has been a major engine of growth in Peru; its expansion is widely seen as generating net-positive social and environmental spillovers (in contrast with extractive activities). Socially, informants emphasize that the sector is a key source of formal employment, particularly in rural areas, with jobs shaped by international labour and sustainability requirements. Because export markets demand compliance with social and environmental standards, Peruvian firms have progressively adopted certifications and modern production protocols, which in turn have driven technological upgrading and more sustainable crop management. This modernization has also created spillover benefits through worker training and on-the-job knowledge transfer, diffusing advanced farming practices into rural labour forces (Montiel et al., 2021)[9]. Using the word of one key-informant (high-level politician):

"Modern agriculture has brought the formalization of firms, certifications, and international standards. The international demand for fresh products has generated positive incentives for firms to adapt to sustainability standards."

At the territorial level, agribusiness firms have also implemented sustainability and development projects (ranging from "Works for Taxes" and irrigation investments to schools, health facilities, and community programs) organized around blended social-environmental models. However, a consistent theme emerging from interviews is that these initiatives do not always translate into deep, structured relationships with local communities. CEOs and financial actors tend to stress worker-centred benefits and philanthropy. Whereas former ministers and association leaders argue that firms have underestimated the importance of building a broader "social license" beyond their employees.

As noted by a politician interviewed, firms often assume that community engagement is primarily a mining issue, which leaves a gap in joint territorial action (such as co-managing irrigation channels or strengthening farmer associations). In short, the sector's social footprint is strong inside the farm-firm boundary (wages, benefits, formalization) but thinner in community-level co-development.

This gap matters even more because sustainability governance in fresh-produce GVCs is increasingly buyer-driven. Interviewees repeatedly underline that retailers and international markets

[8] According to Corporate Social Responsibility, Scope 3 refers to all indirect emissions (not in Scope 1, fuel, company vehicles, and fugitive emissions, and in Scope 2, electricity, steam and heat) happening in the company's value chain: such as, purchase of goods and service, travels and commuting, waste, transports and distribution, investments and other leases assets and franchises (https://www.carbontrust.com/en-eu/our-work-and-impact/guides-reports-and-tools/what-are-scope-3-emissions-and-why-do-they-matter).

[9] See also *Asociación de Gremios Productores Agrarios del Perú*, and for more details on the ongoing projects visit: https://agapperu.org/guia-de-proyectos-de-sostenibilidad/

are now the main enforcement mechanisms for sustainability upgrading in Peru, pushing firms to go beyond national requirements through traceability, audits, and continuously evolving certifications. A key informant from the private sector (grapes and avocados) captured this shift clearly:

"The sale you make is not only because you have grapes or avocados. It is because your customer increasingly wants to know what else is behind that grape or avocado… Today, the story behind your crops and fields is more important for retailers and the market... they buy history, therefore, traceability."

Several informants add that certifications often move faster and further than Peruvian regulation, requiring firms to audit suppliers, measure footprints, and demonstrate responsible water and chemical management. Yet this retailer-led model can create inclusion obstacles for small farmers who lack capital to meet upfront certification and infrastructure costs—though industry representatives stress that smallholders are increasingly entering export chains through upgrading and integration with larger firms.

In terms of concrete practices, informants describe a relatively advanced sustainability toolkit already in place: certified wells and aquifer monitoring; safer handling and disposal of agrochemicals; pest control through biological agents and bacteria labs; precision and drip irrigation that reduces water and fertilizer use; early circular-economy applications (composting crop waste, reusing materials, energy recovery, water recycling); and rising attention to carbon footprints and renewables. Still, they agree on clear next steps: scale electric and low-emission machinery, expand regenerative agriculture, and deepen circularity. Especially around water and strengthen community development efforts in partnership with the government rather than through isolated philanthropy. Therefore, one of substantial sustainability progress driven by export governance, paired with a remaining challenge to translate firm-level modernization into more embedded, cooperative territorial development.

3.3. Vietnam Policy Landscape

Context

In recent years, the state has shown growing awareness of these issues, aligning national strategies with global frameworks such as the SDGs and the EU–Vietnam Free Trade Agreement, and promoting green growth, circular economy principles, and technological upgrading. However, institutional fragmentation across ministries and levels of government, combined with a strict vertical hierarchy, hampers integrated sustainability governance and effective coordination between central and local authorities. As export-led growth generates social inequalities and environmental degradation, especially in rural and resource-intensive sectors, Vietnam's governance model faces mounting pressure to improve regulatory enforcement, broaden stakeholder inclusion, and better manage the unintended consequences of integration into global production networks.

STI and Sustainability

Vietnam's turn toward science, technology, and innovation (STI) must be read against this political backdrop. A centralized one-party system allows the state to set long-term priorities and orchestrate policy across sectors, even as it struggles with participation, enforcement, and uneven local implementation. Within these constraints, STI has been framed as the key pathway to reconcile continued export-led growth with competitiveness, digitalization and sustainability.

Over the past two decades, Vietnam has increasingly built STI into the core of its development strategy, seeking to move from a low-cost, factor-driven model to a knowledge- and technology-based economy. High-level frameworks such as Resolution 57-NQ/TW (2024), the STI Development Strategy to 2030 (Decision 569/QĐ-TTg) and the National Digital Transformation Programme, alongside Resolution 52-NQ/TW (2019), set ambitious targets: a digital economy contributing 30% of GDP and R&D reaching 2% of GDP by 2030, with even higher innovation and digitalization goals by 2045. To support this, the state has introduced generous incentives for business-led R&D (e.g. allowing firms to allocate up to 10% of pre-tax profits to R&D funds, preferential tax treatment for high-tech firms) and created innovation funds such as NATIF and NAFOSTED. These instruments are particularly relevant in strategic export sectors like textiles, clothing and footwear (TCF) and food and beverages (F&B), where digital transformation (automation, ERP, smart logistics) and sustainability policies (the 2024 MOIT circular economy MoU in TCF; the National Action Plan on Food Systems Transformation in F&B) are reshaping production models. Complementary investments in human capital—via upgraded vocational training, firm-level upskilling, and international programmes such as Aus4Innovation and GIZ initiatives—aim to ensure that firms can absorb new technologies. Taken together, this policy mix seeks to align R&D, digitalization, green practices and skills development, positioning Vietnam's key GVC-linked sectors as "smart" and low-carbon, while raising the perennial challenge of implementation and inclusion for smaller firms and less connected regions.

3.4. Agri-food and Manufacturing

3.4.1. Agri-Food (Coffee) and Manufacturing (Textile – Clothing-Footwear) in Vietnam

Vietnam's post–Đổi Mới[10], sustained high growth and poverty reduction, and a more pragmatic, multi-vector foreign policy that deepened Vietnam's integration into institutions (such as ASEAN, APEC, the WTO, and the UN) growth and export-led integration have made two GVCs especially emblematic of its development model: the Textile–Clothing–Footwear (TCF) manufacturing chain and the coffee chain. Both are deeply inserted into global markets: the former (TCF) as a leading manufacturing exporter with large imported input needs, and the latter (coffee) as a top robusta

[10] Đổi Mới ("renovation/restoration") refers to Vietnam's reform package launched in 1986 to overcome the failures of Soviet-style central planning and post-1975 economic isolation. The reforms progressively liberalized domestic markets, recognized and encouraged private enterprise, opened the economy to foreign direct investment, and reduced subsidies and privileges for state-owned firms. These shifts catalyzed a transition toward a "socialist-oriented market economy," triggering export expansion (including a rapid move from food shortages to major rice exports (Tuan, 2009).

supplier dominated by smallholders and export flows. These two together capture Vietnam's dual insertion into global production through industrial assembly and high-value agrifood commodities.

Vietnam's TCF GVC can be defined as a buyer-driven, export-oriented manufacturing chain where Vietnam specializes in midstream and downstream stages (cut-make-trim, assembly, finishing, and increasingly fabric production), while upstream raw materials and intermediate textiles remain heavily imported. In classic GVC terms, the core value-adding sequence is snake-like:

inputs (often foreign) → spinning/weaving/dyeing → garment/footwear assembly → export to major markets;

reflecting stepwise transformation and tight compliance with rules of origin and retailer standards. Yet the chain is also spider-like in organization: many global input suppliers, logistics firms, and brand/retail buyers converge on a network of Vietnamese factories (including FDI plants and emerging domestic integrators), making governance highly dependent on lead firms' purchasing power and standards. Under a GPN lens, Vietnam's TCF insertion is thus a mixed snake-and-spider configuration, where transnational buyers and input suppliers shape upgrading paths, and the state's industrial policy and FDI regime influence domestic value capture and vertical integration (ILO, 2025).

Vietnam's coffee GVC can be defined as an upstream-anchored agrifood chain in which millions of smallholders in the Central Highlands produce robusta beans, local collectors and traders aggregate and pre-process them, and export-oriented processors channel green beans (and a smaller share of roasted/soluble products) to foreign roasters and retailers. The physical chain is predominantly snake-like—farm:

inputs → cultivation → harvesting/drying → aggregation → hulling/processing → export → roasting/branding abroad;

So Vietnam occupies early nodes where volume and productivity are high, but downstream value (branding, specialty roasting, retail) is mostly captured overseas.

At the same time, governance is spider-like domestically: a dense web of middlemen, traders, processors, credit/input advances, and certification/quality actors converge on small farms, coordinating flows at scale. From the GPN perspective, this makes Vietnam's coffee system a mixed snake-and-spider network whose performance depends on interactions between smallholder capabilities, trader/processor coordination, global price signals, and export-market standards.

Despite their dynamism, both chains face sustainability stress points that reflect their mixed governance structures. In TCF, rapid export growth coexists with persistent labour risks (low wages, weak protections, gendered precarity) and heavy environmental burdens concentrated in wet-processing and dyeing (water use and pollution), with uneven access to green/digital upgrading among SMEs.

In coffee, high productivity and smallholder dominance are increasingly threatened by irrigation-driven water pressure, agrochemical overuse, soil degradation, and biodiversity loss in key growing regions. Ensuring resilient upgrading therefore requires stronger environmental enforcement, buyer-aligned cleaner production, targeted green finance and technology diffusion, and labour upskilling that reaches smaller firms and farms rather than only lead exporters (ILO, 2025).

3.4.2. Findings

Textile-Clothing-Footwear

The expert informants we interviewed see Vietnam's TCF performance as a textbook success of GVC-led industrialization: exports have surged to the $61–71B range in 2023–24, the sector now counts roughly 7,000 firms, and it employs several million workers, making it a pillar of Vietnam's trade balance and industrial livelihoods. Yet interviews consistently stress that this success rests on a narrow base (low-cost cut-make-trim manufacturing), so the same integration that powered growth is now exposing structural limits. In particular, informants underline a persistent "missing middle" upstream: despite solid progress in spinning, Vietnam still relies on imported export-quality fabrics (often cited at around 70%), because domestic weaving, dyeing, and finishing capacity remains technologically uneven (TFC_001, TFC_002). This dependence may weaken backward linkages, reduces firms' ability to meet rules-of-origin under new FTAs, and leaves SMEs especially vulnerable to buyer shocks and shifting market requirements.

On sustainability, the interview narrative is equally clear and layered. Environmental concerns, in experts' view, concentrate where Vietnam is least upgraded: wet processing. Dyeing and finishing are repeatedly flagged as the sector's pressure point. Thus, water-intensive, chemical-heavy, and clustered in zones, where treatment systems and monitoring fall behind production growth. As for the social dimension, informants describe a workforce large in number but stuck in the least remunerative segment of the chain, with low wages, intense overtime cycles, and limited training trajectories under constant cost pressure from global buyers (TFC_003). They also draw attention to the sector's demographic asymmetry: young women form the backbone of production, while older workers, particularly women past their late 40s, face a quiet but growing cliff of job insecurity, few reskilling routes, and age-linked discrimination. In simple words, experts see Vietnam's TCF GVC at a crossroads: impressive export dynamism but upgrading and sustainability are constrained by weak upstream capacity, heavy environmental loads in processing, and labor practices that risk long-term inclusiveness unless policy and firm strategies shift toward higher-value, cleaner, and more skill-intensive production (TFC_001).

Coffee

From the interviews, Vietnam's coffee sector is under growing pressure from intertwined environmental and social challenges, especially in the Central Highlands. Informants repeatedly pointed to water as the sector's primary ecological stressor: irrigation has become the default risk-management tool for farmers, but in practice it is often excessive relative to agronomic needs, accelerating groundwater depletion and leaving production highly vulnerable to drought shocks. They linked this to a broader pattern of "intensification by inputs," where heavy reliance on fertilizers and pesticides sustains yields in the short run but progressively degrades soils and contaminates water, raising costs and undermining long-term farm viability. In their view, the combination of over-irrigation, falling water tables, and chemically intensive farming is not a marginal issue but the central sustainability bottleneck of Vietnam's robusta-led model (COF_001, COF_002).

On the social side, interviewees converged on the idea that the coffee GVC's dynamism masks deepening inequality risks among the smallholders who produce most of the crop. They emphasized that the typical 1–2 hectare farmer (especially among ethnic minority communities with limited education) often lacks the capital and information needed to adopt water-saving or low-chemical practices, making them more exposed to climate-driven yield declines and input price volatility. This creates a vicious circle for vulnerable farmers: lower yields push farmers toward even more chemical use, which further degrades land and incomes, raising the likelihood of land sales and livelihood loss (COF_001, COF_002). Several experts also warned that the recent period of high coffee prices may

amplify land consolidation, as better-off farmers can expand holdings while poorer farmers may be forced out, widening gaps in wealth and resilience within coffee regions (COF_001).

Finally, the interview narrative frames sustainability in coffee as a dual challenge: ecological limits driven by water and agrochemicals, and a distributional problem where upgrading and adaptation are least accessible to the most vulnerable producers.

3.5. Agri-food in Italy: a focus on the coffee industry

Italy sits downstream in the coffee global value chain and global production network as a major importer of green coffee, transformer (roasting/blending), and exporter of branded espresso products. Imports are concentrated in a few key origins: Brazil and Vietnam first, then Uganda and India, with smaller quantities but quality. And also, relevant shares from Ethiopia, Colombia, Peru, and Honduras (all partners lie close to the Equator line). Brazil provides the backbone of many espresso recipes, while Vietnam is strategically central for high-quality Robusta: interviewees stress its scale (top global producer), reliable "washed/cleaned" processing, strong technological traceability, and a state/sector governance that makes origin and characteristics predictable. Moreover, Vietnam offers an advantage compared with several African suppliers, where process control and standardization are harder to guarantee.

The network is governed through multilayered actors: farmers and cooperatives in origin countries; local exporters and international traders/commodity exchanges that can amplify price volatility; certification bodies and auditing firms; Italian producers (torrefattori). often organized via industry associations that also mediate diplomatic/technical relations with origins (e.g. Vietnam).

"In the meantime, a very important chain of responsibility has been created. Large roasters, the ones with high consumption volumes, usually buy directly at origin. Medium and small roasters, on the other hand, because of the smaller quantities they include in their blends, often buy some main origins (for example Vietnam and Brazil) directly from the producing country, because they purchase those in large amounts. But the other four or five varieties they use to enrich the blend, to make it more "tailor-made", they obtain through other channels. At this point, every link in the chain has administrative and operational responsibility. A control procedure is introduced along the chain, but a sort of "shield" is also created: I buy a certified coffee and, if I were to receive a sanction, I can seek recourse from whoever certified or guaranteed that lot. In short, a real chain of responsibility is being built along the entire supply chain."

Italy exports mainly to Germany, France, Poland, the US and the UK. These linkages are not purely linear: they form a production network where standards, prices, and knowledge circulate across nodes (origins, traders, roasters, NGOs, regulators, consumers) and where Vietnam has become a tightly connected hub for Robusta supply into Italian blends.

Across this chain, sustainability challenges are concentrated upstream in partner countries and mid-/downstream in Italy. In origins, the interviews highlight structural pressures: coffee expansion is tied to deforestation, water stress, and monoculture, which depletes soils, increases erosion, and locks farmers into high pesticide/fertilizer dependence, especially in fragile tropical systems. Scholars interviewed stress environmental issues related to coffee farming:

"Monoculture is highly damaging for the environment, for water, and for the soil. In general, it is associated with practices typical of intensive, industrial agriculture, which lead to soil erosion. […] Having a diverse ecosystem, with multiple plant and animal species integrated with one another, also makes it more resilient to today's main challenges: climate change, extreme events, and soil erosion."

Socially, low bargaining power, intermediation and liquidity needs can expose producers and workers to precarious conditions; and policy implementation gaps allow speculative or fraudulent behaviour (e.g., manipulation of "deforestation-free" documentation along shipping/trading nodes). Vietnam reflects a double edge: strong traceability and processing governance reduce some risks, yet its large-scale monoculture terraces and current land competition with more profitable crops (like durian) illustrate how market incentives can still undermine long-term sustainability:

"In many production areas, workers face precarious conditions. We choose suppliers who respect workers' rights, promoting fair contracts, equal opportunities, and access to education and healthcare in rural communities. Our commitment is geared toward supporting cooperatives that reinvest in their own communities, for example in school infrastructure or local development projects. [Our Company], we believe that sustainability is not an option but a responsibility. For this reason, every choice along the supply chain is guided by an ethical, environmental, and transparent approach."

In Italy, main sustainability constraints appear more in processing, consumption, and cost structures: rising energy and transport prices squeeze margins and consumer willingness to pay for certified coffee; waste streams from capsules, multilayer packaging and post-consumer grounds are growing; and firms face the challenge of communicating sustainability credibly beyond marketing, while younger cohorts inside companies push for deeper environmental and social strategies.

Policies and initiatives shape the governance of this GVC/GPN in three ways. First, voluntary certifications (Rainforest Alliance, Fairtrade, Organic, Bird-Friendly) act as private regulation and market signals, requiring traceability audits back to the farm level and covering biodiversity, water, and labour standards; their effectiveness depends on both enforcement capacity in origins and recognition by consumers.

Second, public regulation is tightening, especially through the EU Deforestation Regulation (EUDR): it will require geolocated plot-level proof (GPS + satellite cross-checks) that coffee entering the EU is not linked to post-2020 deforestation and will likely be complemented by due diligence expectations on labour rights and community impacts. Thus, it creates a "chain of responsibility" that shifts liability and sourcing choices all along the network.

Third, science-technology-innovation (STI) and circular-economy initiatives are presented as key levers to make compliance and sustainability feasible: precision-agriculture sensors and agroforestry R&D to reduce water/chemical use and raise resilience; digital traceability platforms, remote sensing, and field monitoring to stabilize markets and verify standards; and circular solutions that re-use waste (biogas from pulp and wastewater, reuse of spent grounds, recovery of roasting by-products like silverskin for fertilizers/energy or bioactive extracts, and aluminum capsule take-back schemes with composting). Together, these STI and circular-economy pathways support a shift from short-term yield/price logics toward a more resilient, deforestation-free and socially

responsible coffee network linking Vietnam, Latin America, Africa and Italy. On circular economy and sustainability practice:

"We're talking about normal economic and business dynamics. Obviously, excluding extraordinary or catastrophic events within the company. We have concrete data showing growth and improved performance. Also because sustainability means paying attention to processes: you become sustainable when you stop to look at everything you do and reorganize it within a coherent sustainability framework. That's the point."

3.6. Comparative Analysis

The cases analysed suggest that sustainability transitions within GVCs and GPNs have two main implications: first, sustainability is sector-specific, as some sectors are naturally more sustainable than others; second, global standards and market power shape how territorial institutions function and influence opportunities for local upgrading as well as labour conditions. Peru's mining and agribusiness illustrate how sustainability tensions become territorial and political, where water and community legitimacy are central, especially under weak implementation capacity. Vietnam's TCF and coffee show how export dynamism can coexist with environmental hotspots and unequal upgrading access under buyer-driven governance and uneven enforcement. Italy's downstream coffee node highlights how value capture and regulatory responsibility concentrate in consumption markets, creating new obligations (traceability, deforestation-free compliance, circular packaging) that reverberate upstream. A mechanism-based comparison, therefore, clarifies where interventions must be targeted: reducing cost asymmetries, closing institutional capacity gaps, and reshaping value capture to enable inclusive upgrading.

First, sustainability tensions emerge through an uneven geography of costs and risks. In Peru's copper mining, impacts are intensely territorial and politically charged, such as water scarcity, pollution fears, tailings risk, feeding conflict, and distrust. Peru's agribusiness shows a different version of the same mechanism: export growth and formal jobs coexist with water stress in arid regions and labour/chemical pressures. Vietnam displays comparable hotspots in other nodes. In textiles, the environmental burden is concentrated in dyeing and finishing, while social risks are associated with a large, cost-pressed workforce. In coffee, groundwater depletion and input-intensive farming collide with unequal capacity among smallholders, making the most vulnerable the least able to adapt. Italy, positioned downstream in coffee, illustrates the flip side: many of the ecological and labour burdens sit upstream, while tensions at the consumption/processing end appear as compliance responsibility, energy-cost pressure, and growing packaging waste.

Second, these tensions deepen when global standards outpace local capacity. In Peru, ambitious frameworks often meet weak enforcement and fragmented governance, so private certifications and investor expectations can become the de facto drivers; effective for some upgrading, but uneven and sometimes disconnected from local realities. Vietnam's centralized strategy-making enables strong national direction on STI and "green growth," yet uneven local implementation and regulatory coordination gaps limit what firms and farmers can actually do, especially outside leading zones and large exporters. Italy/EU rule tightening (e.g., deforestation-free requirements) further amplifies this dynamic: it can push responsibility up the chain, but it also risks excluding smaller producers when traceability, monitoring, and compliance infrastructure are missing.

Third, sustainability outcomes depend on who captures value and controls upgrading. Peru's mining and fresh-produce chains remain anchored in earlier nodes, while key rents and strategic functions (advanced processing, branding, standard-setting, market access) are often coordinated elsewhere,

constraining local supplier development and higher-value transitions. Vietnam's textiles are shaped by buyer power and input dependence that keep many firms in lower-value segments; in coffee, smallholders produce most value physically but capture little of the downstream premium. Italy's roasters and brands sit closer to the high-value end, with more leverage and resources to invest in traceability and circular solutions. Yet margin pressure can weaken incentives to transmit sustainability premiums upstream.

Finally, the three mechanisms reinforce one another: burdens concentrate where capacity is weakest, and limited value capture reduces the ability to invest in cleaner technologies and inclusive upgrading. That is why the SHD "means of implementation" can be framed as targeted levers: fair governance to rebalance risk and conflict (especially around water and pollution hotspots), transformative innovation to make compliance and decarbonisation feasible (clean processing, water-saving agronomy, circularity), and mission-oriented investment to build shared infrastructures and upgrading pathways that reach SMEs and smallholders rather than only lead firms.

4. Conclusions and Policy Recommendations

In this paper, we demonstrate how Global Value Chains (GVCs) and Global Production Networks (GPNs) have reshaped the world economy by fragmenting production into multiple stages across various countries. Our main contribution is to look beyond trade flows and efficiency, highlighting the social, environmental, and institutional dimensions of these systems, especially the persistent power asymmetries between the Global North and the Global South. We demonstrate how environmental harm and social risks are frequently shifted onto producers and territories in the Global South, while lead firms and downstream actors in the Global North capture a disproportionate share of value. We also argue that "circular economy" strategies and global sociotechnical regimes can reproduce these inequalities when they are designed without attention to local contexts, bargaining power, and uneven capabilities.

This implies that global production should no longer be assessed purely through economic performance, but against sustainability and human development benchmarks. The Sustainable Human Development (SHD) and Quintuple Helix approaches capture this shift by emphasising co-governance among states, business, civil society, academia, and nature, treating value chains as systems that shape wellbeing and ecosystems, not just channels of trade.

Our cases illustrate how these dynamics play out across different positions in GVCs. Vietnam exemplifies export-led industrialisation in textiles and coffee, but with significant environmental pressures (notably water pollution in textiles and intensive irrigation in coffee) and labour precarity. While state planning can support long-term STI goals, implementation gaps persist, and smallholders are unevenly included. Peru's integration into mining and agribusiness GVCs shows both opportunities and tensions: certification and export demand can spur sustainability improvements in agriculture, yet mining continues to generate acute socio-ecological conflicts, especially around water use and governance. Across both sectors, firm-level sustainability initiatives often fail to align with broader territorial development needs. Downstream, Italy's role in the coffee chain highlights how European demand and regulation (e.g., deforestation-related rules) can shape upstream practices, while challenges remain around waste management, traceability, and credible sustainability communication to consumers.

Building on this analysis, we organise policy implications at three levels:

i) EU external governance;
ii) EU internal industrial policy and member-state policy;
iii) Global and multilateral coordination, linking them directly to the key problems identified (value capture and cost shifting; and institutional misalignment across chain stages and territories).

The EU's external governance should regard trade, due diligence, and development cooperation as directly addressing the value-capture and cost-shifting dynamics embedded in GVCs/GPNs.

Then, reward sustainable producers rather than penalising them. Aiming at reorienting trade incentives so that compliance with robust social and environmental standards generates tangible benefits (e.g., preferential tariffs, green public procurement, longer-term contracting, targeted technical assistance). For the EU, this means embedding *enforceable* sustainability clauses in trade

agreements and preference schemes and avoiding designs that effectively push compliance costs onto weaker actors (e.g., smallholders and SMEs in the Global South).

Moreover, make due diligence and deforestation rules operational, enforceable, and supportive. EU market access should be contingent on credible human-rights and environmental safeguards, including traceability and remediation duties. But compliance pathways must include dedicated support (finance, data infrastructure, extension services, verification capacity) so that small producers are not excluded or forced into informal channels.

Finally, the use of development cooperation to build territorial capabilities, not just firm compliance**.** Align aid and partnerships with local governance, water management, labour inspection capacity, producer organisation, and innovation systems, so that sustainability becomes a territorial development outcome rather than a narrow reporting exercise.

Policies within the EU, such as EU internal industrial policy and member-state policy. Industrial and regulatory strategies inside the EU should reduce institutional misalignment between “downstream” sustainability ambitions and “upstream” realities, and improve the sustainability of value chains within Europe as well.

Therefore, aligning internal rules with value-chain realities (avoid shifting burdens upstream). Ensure EU sustainability requirements are matched by internal changes in sourcing practices (pricing, purchasing lead times, contract terms) so that standards do not become unfunded mandates for suppliers. Furthermore, strengthen traceability, waste policy, and circularity with fairness safeguards. Improve infrastructure and rules for waste management, eco-design, and materials recovery, while ensuring circularity strategies do not simply relocate environmental pressures to exporting countries (e.g., through problematic waste exports or uncompensated resource extraction).

It is crucial to support responsible competitiveness. Redefine European competitiveness to include resilience, regeneration, and global justice, backed by innovation funding, procurement, and reporting rules that reward business models sharing value and risk more equitably across the chain. And also, improve credibility in sustainability communication. Tackle greenwashing risks by standardising claims, strengthening verification, and supporting transparent consumer information, especially in downstream sectors like food and textiles.

The global and multilateral coordination, as GVCs/GPNs operate across jurisdictions, requires systemic change through multilateral reforms that correct structural inequities and establish shared rules of the game.

The reform of multilateral institutions for fairer representation and accountability. Strengthen the Global South’s voice in the IMF, World Bank, and WTO; increase transparency in debt and contracts; and integrate human-rights, gender, and environmental assessments into global economic decision-making.

Protect policy space for green industrialisation. Enable developing countries to use industrial, innovation, and regulatory tools to pursue sustainability and development goals (e.g., strategic sector support, local value addition, public-interest regulation) without being penalised by overly narrow interpretations of trade liberalisation.

Treat GVCs/GPNs as governance systems that shape wellbeing. Promote international coordination around living wages, labour rights, biodiversity and water protection, and corporate accountability, moving from voluntary initiatives to binding, interoperable standards that reduce regulatory arbitrage and cost shifting.

Taken together, these three policy levels clarify how the EU can use its external leverage (trade, due diligence, cooperation) to counter value capture and cost shifting, while also fixing internal

institutional misalignments through industrial policy and demand-side reforms, and simultaneously advancing multilateral coordination so that sustainability and human development goals are not subordinated to a narrow, efficiency-only model of globalisation.

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