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Interim report

Cost allocation and incentive mechanisms for the environment, climate protection and resource conservation along global supply chains

Business approaches and instruments of sustainable supply chain management

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On behalf of the German Environment Agency

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Abstract: Cost allocation and incentive mechanisms for the environment, climate protection and resource conservation along global supply chains – business approaches and instruments of sustainable supply chain management

The research project "Cost allocation and incentive mechanisms for the environment, climate protection and resource conservation along global supply chains" (project number 3722 14 101 0) commissioned by the German Environment Agency, analyses (dis)incentives for and barriers to the implementation of environmental measures as well as the exchange of information between different actors along selected global supply chains. The project focuses on five supply chains from raw material to the end product that represent key sectors of the German industry with a high potential for negative environmental impacts: cotton/readymade garments; tin/tin solder; natural rubber/car tyres; coffee/coffee for consumption; and iron ore/quality steel for the automotive industry. This report summarises the results of the second work package. It aims to present the prevailing and emerging supply chain practices for environmental protection in all five selected raw material-specific supply chains. To provide the background for a supply chain specific analysis, the report provides an inventory of operational approaches to and instruments for sustainable supply chain management at the company level. In addition, the report analyses the contextual factors in which companies operate and which influence their ability to share the costs and benefits of implementing environmental protection measures and exchanging environmental data with other actors in their value chain. The methodology of the report is based on a comprehensive analysis of relevant literature, studies and reports, supplemented by qualitative interviews with company representatives from the relevant supply chains.

Kurzbeschreibung: Kostenverteilungs- und Anreizmechanismen für Umwelt- und Klimaschutz und Ressourcenschonung entlang globaler Lieferketten – Betriebliche Ansätze und Instrumente des nachhaltigen Lieferkettenmanagements

Das vom Umweltbundesamt in Auftrag gegebene Forschungsprojekt „Kostenallokation und Anreizmechanismen für Umwelt-, Klima- und Ressourcenschutz entlang globaler Lieferketten" (Forschungskennzahl 3722 14 101 0) analysiert (Fehl-)Anreize und Barrieren für die Umsetzung von Umweltschutzmaßnahmen sowie den Informationsaustausch zwischen verschiedenen Akteur*innen entlang ausgewählter globaler Lieferketten. Das Projekt konzentriert sich auf fünf Lieferketten, die Schlüsselsektoren der deutschen Industrie mit einem hohen Potenzial für Umwelt- und Menschenrechtsrisiken darstellen und betrachtet diese vom Rohstoff bis zum Endprodukt: Baumwolle / Konfektionsbekleidung, Zinn / Lötzinn, Naturkautschuk / Autoreifen, Kaffee / Konsumkaffee, Eisenerz / Qualitätsstahl für die Automobilindustrie. Dieser Bericht fasst die Ergebnisse des zweiten Arbeitspakets zusammen und zielt darauf ab, die vorherrschenden und neu aufkommenden Lieferkettenpraktiken für den Umweltschutz in allen fünf ausgewählten rohstoffspezifischen Lieferketten darzustellen. Um den Hintergrund für die lieferkettenspezifische Analyse zu liefern, bietet der Bericht eine Bestandsaufnahme von operativen Ansätzen und Instrumenten für das nachhaltige Lieferkettenmanagement auf Unternehmensebene. Darüber hinaus enthält der Bericht eine Analyse der kontextuellen Faktoren, in denen Unternehmen operieren und die ihre Fähigkeit beeinflussen, die Kosten und Vorteile der Umsetzung von Umweltschutzmaßnahmen und des Austauschs von Umweltdaten mit anderen Akteuren in ihrer Wertschöpfungskette zu teilen. Die Methodik des Berichts basiert auf einer umfassenden Analyse relevanter Literatur, Studien und Berichte, ergänzt durch qualitative Interviews mit Unternehmensvertreter*innen aus den relevanten Lieferketten.

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Abbreviation	Explanation
AIAG	Automotive Industry Action Group
ASM	Artisanal and Small-Scale Mining
BF	Blast Furnace (core process of the common production route for primary/ore-based steel)
BMZ	German Federal Ministry for Economic Cooperation and Development (German: Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung)
BSCI	Business Social Compliance Initiative (by amfori)
C.A.F.E.	Coffee and Farmer Equity Practices (by Starbucks)
CCEP	Coca-Cola Europacific Partners
CoC	Chain of Custody
COSCO	Cotton Sourcing Company Limited
EIA	Environmental Impact Assessment
EITI	Extractive Minerals Transparency Initiative
EMC	European Model Clauses
ERP	Enterprise Resource Planning
EUDR	EU Regulation on Deforestation-Free Products
FSC	Forest Stewardship Council
FWF	Fair Wear Foundation
GBP	Green Bond Principles
GCF	Green Climate Fund
GCP	Global Coffee Platform
GHG	Greenhouse Gas
GPSNR	Global Platform for Sustainable Natural Rubber
GRS	Global Recycled Standard
H2GS	H2 Green Steel
HACCP	Hazard Analysis and Critical Control Points
HRC	Hot Rolled Coil
HREDD	Human Rights and Environmental Due Diligence
HYBRIT	Hydrogen Breakthrough Ironmaking Technology
ICMA	International Capital Market Association
ICMM	International Council for Mining and Minerals
IRMA	Initiative for Responsible Mining Assurance

Abbreviation	Explanation
ICO	International Coffee Organisation
IoT	Internet of Things
ITA	International Tin Association
iTSCi	ITRI Tin Supply Chain Initiative
ISO	International Organisation for Standardisation
KPIs	Key Performance Indicators
LME	London Metal Exchange
MCC	Model Contract Clause
MSI	Multi-Stakeholder Initiative
MoU	Memorandum of Understanding
NDC	Nationally Determined Contributions (in Paris-Agreement)
NMVOC	Non-Methane Volatile Organic Compound
NOx	Nitrogen Oxide
OCS	Organic Cotton Standard
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
PEFC	Programme for the Endorsement of Forest Certification
RBA	Responsible Business Alliance
RCP	The Responsible Contracting Project
RCS	Recycled Claim Standard
R&D	Research and Development
RFID	Radio Frequency Identification
RMAP	Responsible Mineral Assurance Process
RMG	Ready-made garment
RMI	Responsible Minerals Initiative
SCF	Supply Chain Finance
SCG	Spent Coffee Grounds
SEDF	Supplier Employee Development Fund
SLBP	ICMA's Sustainability-Linked Bond Principles
SMEs	Small and Medium Enterprises
SOx	Sulphur Oxide
SSCF	Sustainable Supply Chain Finance

Abbreviation	Explanation
SSCM	Sustainable Supply Chain Management
STTI	Sustainable Terms of Trade Initiative
TCLP	The Chancery Lane Project
TIP	Tire Industry Project
TS	Traceability Systems
TSM	Towards Sustainable Mining
TWG	The Tin Working Group
WTO GPA	Agreement on Government Procurement of the World Trade Organisation
WSA	World Steel Association

Summary

The research project "Cost allocation and incentive mechanisms for the environment, climate protection and resource conservation along global supply chains", commissioned by the German Environment Agency investigates (dis)incentives for and barriers to the implementation of environmental measures as well as the exchange of information between different actors along selected global supply chains. It aims to provide guidance to businesses and policy makers to facilitate the practical implementation of environmental measures along global supply chains and to improve the distribution of cost and benefits in the process.

The project focuses on global supply chains in sectors with a high potential for adverse environmental and human rights impacts and that are key for the German industry. We analyse the following five supply chains from raw material to the end product:

- Cotton and the manufacturing of cotton-based, ready-made garments
- Tin and tin solder for the manufacturing of electronics
- Natural rubber and car tyres for the automotive industry
- Coffee for retail and consumer brands
- Iron ore and quality steel for the automotive industry

This report contains the results of the second work package of the project, which aims to explore and catalogue the diverse approaches and instruments employed by companies to foster environmental and climate protection within their supply chains.

Cost allocation and incentivising are core considerations to establish systems for the environment, climate protection and resource conservation along global supply chains. Who pays and who benefits are key criteria for people and organisations to decide whether they engage or resist. In the context of remedy, the question who pays is often considered in the context of responsibility or liability – which is not always easy to identify when dealing with sustainability in global supply chains. This report takes an alternative approach, more entrepreneurial than legal, by linking costs with benefits. In a capitalist system, expected returns not only justify investments, but make them attractive. How are today's activities that aim at improving sustainability in global supply chains set up in terms of economic attractiveness and fairness among the various actors? Why do companies – buyers or suppliers – engage?

Chapter 2 of the report presents a broad selection out of the many approaches and instruments that are available today to companies for driving sustainability in supply chains. The variety of challenges, opportunities, resources, context or motivations triggered different kinds of actors to engage in developing and offering these approaches and instruments – including buyers, suppliers, third parties and government organisations. Some approaches and instruments were developed to realise societal goals, others originated from very concrete needs to resolve a particular crisis. Some approaches and instruments are company-specific, others benefit from collective action of many actors – e.g. of the same industrial sector, the same region or along a specific supply chain. Some are the result of societal pressures, others are driven by entrepreneurial vision, seeking companies for their use (e.g. third-party offers), by the desire for social impact, offering companies help (e.g. civil society activities), by political objectives, offering companies government support and/or regulation. Activities in sustainable supply chains that promise higher benefit than the expected investments (high yields) are pursued by the relevant actors with strong internal motivation. In contrast, others, for which the relevant

actors expect no or low yields, experience realisation only if external pressures coerce the change. In the middle of both extremes, where neither internal motivation nor external pressures exists, no action should be observed.

The actual use of these approaches and instruments, and with that the cost allocation practices and incentive mechanisms, varies in business practices. While one important aspect for the choice of use is the respective company's intentions and objectives, the context in which the buyer and the supplier operate and their business relationship play an important role. **Chapter 3** outlines the key contextual factors, ranging from industry to skills but also to power, dependence, or distance.

Chapter 4 discusses the general structures for cost allocation and incentive mechanisms in sustainable supply chain management (SSCM). How these are perceived by the various players in the supply chain determines their commitment. Some key challenges are fundamental to understand in order to further develop these setups. The heterogeneity in values, objectives or definitions among the various stakeholders in global supply chains is a major barrier to agreeing on a "common formula" to calculate costs and benefits. The difficulty to define the boundaries of companies, and with this their respective responsibility or liability, is another key challenge. The time horizon an organisation considers when calculating costs and benefits is another aspect of limited agreement, as is transparency and comparability of costs or benefits. This ambiguity appears to nourish strong perceptions of potential costs and benefits from SSCM. The chapter further discusses two generic strategies of buyers for supplier management: coercive and collaboration. The coercive strategy is often used when buyers see the opportunity to benefit from supplier independence in large supplier markets. It favours collective approaches that ensure the interchangeability of suppliers. The cooperation strategy is usually found in situations where buyers are dependent on certain suppliers, and enables the parties involved to implement mutually beneficial solutions. Although the use of SSCM is heterogeneous in business practice, the aim to avoid related extra costs appears dominant and more prominent than realizing potential benefits.

Chapter 5 includes an analysis of value-chain specific approaches and instruments for the selected raw materials/commodities, which aims to:

- provide an overview of the main environmental hotspots of each raw material/commodity value chain;
- introduce approaches and instruments applied by supply chain actors for SSCM;
- evaluate the approaches and instruments regarding the distributional fairness of benefits and their potential to trigger change in the respective supply chain.

Methodologically, the report relies on a comprehensive qualitative analysis of relevant studies, reports, and online tools. To supplement the existing data and sources, the team conducted interviews with experts from various segments of the supply chains and with civil society organisations active in the respective commodity-specific supply chains. The key findings of the commodity-specific SSCM approaches and instruments are briefly summarised below:

Cotton

The cotton-garment industry, as part of the fashion industry, is a highly competitive industry with high environmental impacts throughout the supply chain, including water and energy consumption, carbon emissions, waste and the use of hazardous chemicals. Companies in the cotton-garment supply chain predominantly use buyer-individual voluntary approaches, such as audits and certifications, to manage environmental risk in their supply base. The leverage of

SSCM tools to bring about change, such as improved sustainability or environmental performance, is greatest for suppliers that have a close working relationship with their customers, such as strategic or nominated suppliers (it is assumed that not all nominated suppliers are of strategic importance to the buyer). Depending on the business model, buyers (specialty retailers/brands, auction-based fast fashion buyers) send their own team to strategic/nominated suppliers and have occasional and less important suppliers audited by third parties, if at all, to achieve the desired outcome which primarily is passing the audit or achieving the certification, not a reduced environmental impact. Capacity building as a buyer-individual or -collective instrument varies with the level of trust in buyer-supplier relationships and is used to enhance the strategic/nominated suppliers' abilities in terms of sustainability. Buyer commitment to placing more orders if products are manufactured with a certain technology can be an effective incentive mechanism for large strategic/nominated suppliers that have the necessary investment capacity. It is not applicable to SMEs or smallholder farmers.

Cooperative business models as implemented by the Fair Wear Foundation (FWF) increasingly seek to establish shared responsibility that hold both buyers and suppliers responsible for the conditions under which the product has been produced. Following this approach, current practices are increasingly assessed according to their impact on the supplier and replaced by responsible practices that reduce power imbalances and achieve positive social and environmental impact (e.g. responsible purchasing practices, shared audits to reduce indirect costs for suppliers). The principle of shared responsibility has been promoted by development organisations, such as the German development agency (GIZ), which, together with lawyers from the Responsible Contracting Project (RCP) and The Chancery Lane Project (TCLP), is driving the development of sector-agnostic model contract clauses to improve on human rights and environmental due diligence. Instruments that aim to reduce the perceived distributional unfairness, such as price premia (buyer-individual voluntary instruments), are only applied in very specific, often partnership-based conditions, for instance in integrated supply networks and organic trading models. Sustainable practices per se are not rewarded, but must be factored in by suppliers. Other innovative instruments are emerging, but have not yet taken off (e.g. sustainable financing) or are difficult to realise given the challenges faced by SMEs and smallholders in terms of cost and technological complexity (e.g. traceability through blockchain technology). Circular solutions are also often based on collaboration by sharing knowledge, technology and other resources. However, little is known about the incentive and reward schemes that drive these solutions forward.

Tin

The global tin supply chain is characterised by its fragmented structure, where environmental sustainability poses a significant challenge due to the nature of mining operations. Sustainable practices within the industry are recognised, yet implementing these measures may encounter resistance, particularly by actors that are discouraged by the financial implications of adopting additional approaches and instruments for environmental protection.

Government regulations surrounding mining activities attempt to mitigate the environmental impact. However, the regulatory effectiveness can be low, especially in regions with a high concentration of artisanal and small-scale miner activities that may operate under the radar of formal regulatory mechanisms. In some regions, the regulations have been criticised for not being proactive enough to prevent environmental damage effectively.

Sustainability programmes promoted by industry stakeholders, which include reporting, monitoring, and independent verification initiatives, play an important role in addressing the concerns from human rights to environmental management and corporate governance. The

sector utilises a mix of approaches and instruments, including individual and collective buyer initiatives, alongside supply-chain collective, and third-party profit-focused strategies to encourage responsible practices.

A key component of these efforts involves the adoption of codes of conduct and sustainable procurement policies that guide buyers in engaging with their suppliers. To ensure compliance, buyers conduct audits on their suppliers. The implementation of these in-house systems and the adherence to codes of conduct requires investment from buyers. In certain scenarios, buyers require their suppliers to obtain specific certifications, such as Responsible Minerals Initiative Responsible Minerals Assurance Process (RMI RMAP). These requirements usually create financial burdens for suppliers. Suppliers face financial penalties or risk restrictions on their business dealings with the buyer if they fail to comply with buyer's requirements.

Third-party, for-profit approaches in the tin supply chain play an important role in driving sustainability. These approaches often involve certification schemes, like ISO 14001, or application of third-party transparency tools. The cost of participating in these certification programmes is, again, a significant consideration for supply chain actors. Traceability tools which can also provide a positive impact on transparency are an attempt to resolve the difficulty of tracing the origin tin from the mine to smelter. This challenge has led to the development of traceability tools, either offered by third parties or implemented as in-house systems by smelters, to bridge this gap. Implementing these tools and approaches requires financial commitment from the suppliers.

Additionally, emerging approaches like blockchain technology are being piloted to improve traceability. The emerging concept of the circular economy also advances sustainability within the industry by shortening supply chains and enabling buyers to trace the origin of their tin from the recycler to the buyer.

Natural rubber

Various environmental impacts are generated along the natural rubber-tyre supply chain, especially at cultivation level (e.g. deforestation) and in processing factories (e.g. water use, chemicals). The sector has started just recently to address these issues, partly due to increasing pressure from governmental regulation (especially due to requirements from the EU Deforestation Regulation (EUDR) adopted in May 2023).

While the sector overall is still in its "inception phase" of the sustainability transformation, various frontrunners have started to implement buyer-individual voluntary operational approaches and instruments for SSCM, increasingly also targeting suppliers beyond tier 1. These include the adoption of sustainable purchasing policies and supplier codes of conduct, sometimes making reference to standards jointly developed in supply chain collective settings. Supplier audits are covering more and more environmental criteria, and several buyers have started to use third-party tools such as certifications (e.g. FSC) and programmes to collect environmental risk data from suppliers further up the highly fragmented supply chain (e.g. RubberWay). Due to the increasing demand for transparency and traceability in the natural rubber supply chain, particularly from the EUDR, technical solutions such as blockchain and satellite monitoring are being tested.

While the implementation of these sustainable supply chain activities leads to higher costs, which are particularly burdensome for small farmers at the beginning of the supply chain who are often financially weak, price premiums for sustainably produced products still seem to be the exception rather than the rule. Instead of providing financial incentives, some buyers have started to develop non-financial incentives, such as the provision of training programmes or

recognising environmental best practices amongst suppliers via sustainability awards (both in individual and collective settings).

Some suppliers at farm level aim to improve their bargaining power and lower the cost of the implementation of sustainability measures such as certification via the formation of collaboration, i.e. in supplier cooperatives, also allowing them to develop more long-term and direct business relationships with buying companies.

Coffee

Coffee stands as one of the world's most favoured beverages and ranks among the most commonly traded commodities. The coffee value chain is notably intricate due to its extensive production processes and the geographical separation between downstream and upstream actors. Encompassing various stages of production, the coffee supply chain involves diverse stakeholders, ranging from farmers to end consumers. The sustainability and accountability practices of the coffee supply chain often come under scrutiny. Notably, the industry's close ties to economically disadvantaged regions, where coffee extraction occurs, have faced criticism. The sustainability of this supply chain is shaped by social, economic, and environmental factors, with environmental concerns such as land use, carbon and water footprint, and generated waste playing a pivotal role.

The global coffee supply chain faces critical environmental challenges, including deforestation, intensive farming practices, and substantial water consumption, which contribute to biodiversity loss, soil degradation, and water pollution. Additionally, the industry generates significant solid waste and greenhouse gas emissions throughout its production and processing stages, while the overuse of agrochemicals poses risks to ecosystem and human health. These interconnected issues, spanning from cultivation to consumption, highlight the urgent need for more sustainable practices across the entire coffee industry. Government regulations, acting as compulsory measures, have been implemented to address environmental and human rights issues. These regulations, such as the EUDR and the EU's Corporate Sustainability Due Diligence Directive (CSDDD), collectively advocate for transparency, ethical sourcing, and responsible business conduct across the entire supply chain. Additionally, coffee roasters (and traders), such as Starbucks, Nestlé, Tchibo, have undertaken various initiatives as part of their operational strategies to advance towards a more sustainable coffee supply chain. Many of these initiatives, primarily initiated by buyers, are voluntary and fall under the category of supply chain-collective approaches, requiring collaboration among diverse stakeholders for successful implementation. Stakeholders within the coffee supply chain employ a diverse range of approaches to effectively mitigate negative environmental impacts. These approaches include educational and training programmes for farmers, sustainable farming practices, financial support programmes, responsible contracting, sustainable sourcing practices, direct sourcing practices, and vertical integration, among others. From the farmer's perspective, the formation of Farmer Cooperatives, viewed as a supplier-collective voluntary approach, empower small-scale farmers, enhancing their bargaining power and facilitating knowledge transfer and resource access.

Among these approaches, audits and certifications, including ISO 9001, ISO 14001, Fairtrade, Rainforest Alliance, and Organic certifications, play crucial roles and are widely adopted. These programmes entail collaboration among producers, processors, and distributors to ensure fair compensation, environmentally friendly practices, and sustainable agriculture. Importantly, sustainability certification schemes for farmers in the long-run aim to assist coffee farmers in maintaining high yields while reducing production costs and environmental degradation, and possibly guaranteeing a price premium. Emerging approaches, such as the adoption of information technologies like blockchain and the Internet of Things (IoTs), show potential in SSCM. However, their application is still limited, primarily seen in some case studies. The reasons are that, for instances, they are complex to implement and integrate into existing

systems, expensive to deploy, create environmental impacts from the production, use and end-of-life management of the necessary equipment, and require standardisation in data formats and communication protocols between different IoT devices.

Iron and Steel

While significant environmental impacts occur during the mining of iron ore (e.g. land and water use, dust emissions, risk of tailing dam failure), the environmental topic addressed by most stakeholders in the supply chain is the mitigation of greenhouse gas emissions during the production of steel, with most big steel companies having published voluntary decarbonisation targets in the past years. This focus can partly be traced back to an increase in regulation forcing industries to decarbonise and a parallel lack of environmental regulation in many mining countries.

Several buyers apply individual approaches such as environmental clauses in supplier codes of conduct and some have started to also check for the compliance with environmental criteria (such as carbon footprints) during supplier audits. As the iron ore/steel supply chain is characterised by strong suppliers (big mining companies), buying companies (steel producers, car manufacturers) have less leverage, leading to more collaborative approaches to resolving environmental issues. An important example are efforts of the standards and certification initiative ResponsibleSteel to include responsible sourcing criteria for steel companies by recognising existing standards for mines such as the one developed by the Initiative for Responsible Mining Assurance (IRMA). However, these requirements are not yet mandatory, due to a currently too low participation of suppliers in recognised input material programmes, such as IRMA. In order to enable further uptake of environmental data sharing, traceability and chain of custody approaches, technological approaches such as blockchain are being piloted along the supply chain.

Against the backdrop of the necessary decarbonisation, for which car manufacturers, among others, need “green steel”, various collaborations have been established along the supply chain in recent years between mining, steel and automotive companies that want to jointly stem the necessary investments in technological changes and secure access to input materials that are necessary for the production of new “green” products. Pilot projects in the steel industry have also been supported by state funding. In addition, it is becoming apparent that the production of green steel will also influence business relationships along the supply chain and that offtake agreements, memorandums of understanding and joint ventures (sometimes already in combination with the payment of price premia) will contribute to the implementation of more sustainable practices as a mutual commitment of buyers and suppliers. However, in the future it will be necessary to involve the mining sector more in joint activities and to focus on environmental issues that go beyond greenhouse gas emissions, such as water and land use.

In the further course of the project, the findings presented in this report will feed into the development for incentive mechanisms for effective climate and environmental protection measures and an improvement of transparency and cooperation along global supply chains. The identified solutions will be translated into roadmaps for practical implementation in the respective supply chains. The project will conclude with target group-specific recommendations for the design of operational instruments of supply chain management and recommendations for industry initiatives, governments and intermediaries, among others.

Zusammenfassung

Das vom Umweltbundesamt in Auftrag gegebene Forschungsprojekt "Kostenallokation und Anreizmechanismen für Umwelt-, Klima- und Ressourcenschutz entlang globaler Lieferketten analysiert (Fehl-)Anreize und Barrieren für die Umsetzung von Umweltschutzmaßnahmen sowie den Informationsaustausch zwischen verschiedenen Akteuren entlang ausgewählter globaler Lieferketten. Ziel des Projektes ist es, verschiedenen Akteuren eine Hilfestellung bei der praktischen Umsetzung von Umweltschutzmaßnahmen entlang globaler Lieferketten zu geben und dabei die Verteilung von Kosten und Nutzen zu verbessern.

Das Projekt konzentriert sich auf ausgewählte globale Lieferketten in Sektoren, die ein hohes Potenzial für negative Umwelt- und Menschenrechtsauswirkungen aufweisen und die für die deutsche Wirtschaft von großer Bedeutung sind. Es werden die folgenden fünf Lieferketten vom Rohstoff bis zum Endprodukt analysiert:

- Baumwolle für Konfektionsbekleidung
- Zinn und Lötzinn für Elektronikprodukte
- Naturkautschuk und Reifen für die Automobilindustrie
- Kaffee für den Vertrieb durch Einzelhandels- und Verbrauchermarken
- Eisenerz und Qualitätsstahl für die Automobilindustrie

Dieser Bericht fasst die Ergebnisse des zweiten Arbeitspakets des Projekts zusammen, das darauf abzielt, verschiedenen betriebliche Ansätze und Instrumente zu erforschen und zu katalogisieren, die von Unternehmen zur Förderung des Umwelt- und Klimaschutzes innerhalb ihrer Lieferketten eingesetzt werden.

Kostenverteilung und Anreizsetzung sind zentrale Faktoren bei der Etablierung von Systemen für Umwelt-, Klima- und Ressourcenschutz entlang globaler Lieferketten. Die Frage wer zahlt und wer profitiert, ist für Menschen und Organisationen ein wichtiges Kriterium für die Entscheidung, ob sie sich an Aktivitäten engagieren oder sich diesen widersetzen. Im Zusammenhang mit Abhilfemaßnahmen wird die Frage danach wer die Kosten trägt oft im Kontext von individueller Verantwortung oder Haftung betrachtet – jedoch ist die Zuschreibung von Verantwortlichkeiten zu einzelnen Akteuren im Kontext umweltbezogener Nachhaltigkeit in globalen Lieferketten nicht immer möglich oder sinnvoll. Dieser Bericht verfolgt einen alternativen, eher unternehmerischen als juristischen Ansatz, indem er die für Umweltschutzmaßnahmen anfallenden Kosten mit dem daraus entstehenden Nutzen verknüpft. In einem kapitalistischen System rechtfertigen die erwarteten Erträge Investitionen nicht nur, sondern machen diese auch attraktiv. Vor diesem Hintergrund geht es um die Frage, wie die heutigen Aktivitäten zur Verbesserung der Nachhaltigkeit in globalen Lieferketten im Hinblick auf die wirtschaftliche Attraktivität bestimmter Geschäftspartner*innen und eine faire Kosten-Nutzen-Verteilung zwischen den verschiedenen Akteuren der Lieferkette aufgebaut ist Warum engagieren sich Unternehmen – Käufer oder Lieferanten – vor diesem Hintergrund für den Umweltschutz in der Lieferkette?

Kapitel 2 des Berichts stellt eine breite Auswahl der verschiedenen unternehmerischen Ansätze und Instrumente vor, die Unternehmen heute zur Verfügung stehen, um die Nachhaltigkeit in ihren Lieferketten zu fördern. Die Vielfalt an Herausforderungen, Möglichkeiten, Ressourcen, Kontexten oder Motivationen hat verschiedene Arten von Akteuren dazu veranlasst, sich an der Entwicklung und der Bereitstellung dieser unternehmerischen Ansätze und Instrumente zu

beteiligen - darunter Käufer, Lieferanten, Dritte (bspw. Nichtregierungsorganisationen) und Regierungsorganisationen. Einige Ansätze und Instrumente wurden entwickelt, um gesellschaftliche Ziele zu verwirklichen, andere sind aus einem sehr konkreten Bedarf zur Lösung einer spezifischen Herausforderung entstanden. Einige Ansätze und Instrumente sind unternehmensspezifisch, andere profitieren vom kollektiven Handeln vieler Akteure - z. B. aus demselben Industriesektor, derselben Region oder entlang einer bestimmten Lieferkette. Einige sind auf gesellschaftlichem Druck hin entstanden, andere werden durch wirtschaftliche Visionen angetrieben (z.B. Angebote für Unternehmen von gewinnorientierten Dritten). Wieder andere verfolgen das Bestreben nach sozialer Wirkung, die durch Hilfestellungen für Unternehmen erreicht werden soll (z.B. zivilgesellschaftliche Aktivitäten). Einige Ansätze und Instrumente dienen zudem der Erreichung politischer Ziele, für deren Umsetzung Unternehmen staatliche Unterstützung erhalten und/oder durch staatliche Regulierung zur Umsetzung verpflichtet werden. Aktivitäten in nachhaltigen Lieferketten, die einen höheren Nutzen als die erwarteten Investitionen versprechen (hohe Renditen), werden von den entsprechenden Akteuren mit einer starken internen Motivation verfolgt. Andere, bei denen die relevanten Akteure keine oder nur geringe Erträge erwarten, werden dagegen nur realisiert, wenn externer Druck die Veränderung erzwingt. Zwischen diesen beiden Extremen, bei denen weder eine interne Motivation noch ein externer Druck vorhanden ist, ist oftmals keine Handlungsbereitschaft zu beobachten.

Der tatsächliche Einsatz dieser unternehmerischen Ansätze und Instrumente und damit auch die Kostenverteilungspraktiken und Anreizmechanismen variiert in der Unternehmenspraxis. Ein wichtiger Faktor für die Entscheidung über den Einsatz sind die Absichten und Ziele des jeweiligen Unternehmens, aber auch der Kontext, in dem Käufer und Lieferanten agieren, und ihre Geschäftsbeziehung spielen eine wichtige Rolle. In **Kapitel 3**, werden die wichtigsten Kontextfaktoren skizziert, die die jeweilige Branche, die spezifischen Fähigkeiten eines Unternehmens, aber auch Macht, Abhängigkeiten oder Distanz umfassen können.

In **Kapitel 4** werden die allgemeinen Strukturen für die Kostenverteilung und Anreizmechanismen im nachhaltigen Lieferkettenmanagement vorgestellt. Die Wahrnehmung dieser Strukturen durch die verschiedenen Akteure in der Lieferkette bestimmt deren Engagement. Einige zentrale Herausforderungen sind für die Weiterentwicklung dieser Strukturen von grundlegender Bedeutung. Die Heterogenität Werten, Zielen und Definitionen der verschiedenen Akteure in globalen Lieferketten, bereitet diesen große Schwierigkeiten sich auf eine “gemeinsame Formel” zur Berechnung der Verteilung von Kosten und Nutzen zu einigen. Die Schwierigkeit, die rechtlichen Grenzen der Unternehmen und damit auch ihre jeweilige Verantwortung oder Haftung zu definieren, ist eine zusätzliche zentrale Herausforderung. Der Zeithorizont, den eine Organisation bei der Berechnung von Kosten und Nutzen in Betracht zieht, ist ein weiterer Aspekt, über den nur bedingte Einigkeit herrscht. Dies gilt ebenso für die Transparenz und Vergleichbarkeit von Kosten und Nutzen. Diese Unklarheiten scheinen in der Praxis die starken Befürchtungen vor potenziellen Kosten durch ein nachhaltiges Lieferkettenmanagement aufrecht zu erhalten. In diesem Kapitel werden zwei generische Strategien von Einkäufern für das Lieferantenmanagement diskutiert: Zwang und Zusammenarbeit. Die Zwangsstrategie ist häufig anzutreffen, wenn Einkäufer die Möglichkeit sehen, von der Anbieterautonomie in großen Lieferantenmärkten zu profitieren. Sie begünstigt daher kollektive Ansätze, die die Austauschbarkeit von Lieferanten sicherstellen. Die Strategie der Zusammenarbeit wird in der Regel in Situationen angewandt, in denen Käufer von bestimmten Lieferanten abhängig sind, und ermöglicht es den beteiligten Parteien, für beide Seiten vorteilhafte Lösungen zu finden. Obwohl der Einsatz von nachhaltigem Lieferkettenmanagement in der Unternehmenspraxis heterogen ist, erscheint das Ziel, damit verbundene Mehrkosten zu vermeiden, dominierend und stärker ausgeprägt zu sein als die Realisierung potenzieller Vorteile.

Kapitel 5 enthält eine Analyse von wertschöpfungskettenspezifischen Ansätzen und Instrumenten zu den ausgewählten Rohstoffen/Waren, die darauf abzielt:

- einen Überblick über die wichtigsten Umwelt-Hotspots der einzelnen rohstoffspezifischen Lieferketten zu geben;
- Ansätze und Instrumente für nachhaltiges Lieferkettenmanagement vorzustellen, die von den Akteuren entlang der jeweiligen Lieferkette genutzt werden, und;
- die Ansätze und Instrumente dahingehend zu bewerten zur welcher wahrgenommenen „Kosten-Nutzen-Verteilung" sie beitragen und über welchen „Auslöser" sie Veränderungen in der Lieferkette anstoßen.

Methodisch stützt sich der Bericht auf eine umfassende qualitative Analyse einschlägiger Studien, Berichte und Online-Tools. Zur Ergänzung der vorhandenen Daten und Quellen führte das Team Interviews mit Expert*innen aus verschiedenen Segmenten der Lieferketten und mit Organisationen der Zivilgesellschaft durch, die in den jeweiligen rohstoffspezifischen Lieferketten tätig sind. Die wichtigsten Ergebnisse der rohstoffspezifischen Ansätze und Instrumente zum nachhaltigen Lieferkettenmanagement werden im Folgenden kurz zusammengefasst:

Baumwolle

Die Baumwollbekleidungsindustrie ist als Teil der Modeindustrie eine sehr wettbewerbsintensive Branche mit hohen Umweltauswirkungen in der gesamten Lieferkette, einschließlich Wasser- und Energieverbrauch, Kohlendioxidemissionen, Abfällen und dem Einsatz gefährlicher Chemikalien. Die Unternehmen der Baumwollbekleidungs-Lieferkette nutzen überwiegend freiwillige Ansätze auf Käuferseite, wie z. B. Audits und Zertifizierungen, um die umweltbezogenen Risiken in ihrer Lieferbasis zu steuern. Die Hebelwirkung von Instrumenten des nachhaltigen Lieferkettenmanagements zur Herbeiführung von Veränderungen, wie z. B. einer verbesserten Nachhaltigkeits- oder Umweltleistung, ist bei solchen Lieferanten am größten, die eine enge Arbeitsbeziehung zu ihren Kunden haben, wie z. B. strategische oder nominierte Lieferanten (es wird davon ausgegangen, dass nicht alle nominierten Lieferanten für den Käufer von strategischer Bedeutung sind). Je nach Geschäftsmodell schicken Einkäufer (Fachhändler/Marken, auktionsbasierte Fast-Fashion-Einkäufer) ihr eigenes Team zu strategischen/nominierten Lieferanten und lassen gelegentliche und weniger wichtige Lieferanten, wenn überhaupt, von Dritten auditieren, um das gewünschte Ergebnis zu erzielen. Das Ergebnis freiwilliger Audits besteht jedoch oftmals lediglich darin, dass Lieferanten ein Audit bestehen oder eine Zertifizierung erreichen, nicht jedoch in einer tatsächlichen Verminderung der Umweltbelastung. Auch die Ausgestaltung des Kapazitätsaufbaus als Instrument zwischen Einkäufer und einzelnem Unternehmen oder Kollektiv unterscheidet sich je nach Grad des Vertrauens und der Beziehungsqualität zwischen Einkäufer und Lieferant. Es wird eingesetzt, um die Fähigkeiten der strategischen oder nominierten Lieferanten im Hinblick auf Nachhaltigkeit zu verbessern. Auch Verpflichtungen des Käufers, mehr Aufträge zu erteilen, wenn Produkte mit einer bestimmten (nachhaltigen) Technologie hergestellt werden, kann ein wirksamer Anreizmechanismus für große, strategische oder nominierte Lieferanten mit ausreichenden Investitionskapazitäten sein. Für kleine und mittlere Unternehmen (KMU) oder Kleinbauern ist dieser Ansatz jedoch weniger geeignet.

Kooperative Geschäftsmodelle, wie sie von der Fair Wear Foundation (FWF) umgesetzt werden, zielen zunehmend darauf ab, eine gemeinsame Verantwortung zu etablieren, die sowohl Käufer als auch Lieferanten für die Bedingungen, unter denen ein Produkt hergestellt wurde,

verantwortlich macht. Diesem Ansatz folgend werden die derzeitigen Praktiken zunehmend nach ihren Auswirkungen auf den Lieferanten bewertet und durch verantwortungsvolle Praktiken ersetzt, die Machtungleichgewichte verringern und positive soziale und ökologische Auswirkungen erzielen (z. B. verantwortungsvolle Einkaufspraktiken, gemeinsame Audits zur Verringerung der indirekten Kosten für die Lieferanten). Das Prinzip der gemeinsamen Verantwortung wurde von Entwicklungsorganisationen wie der Deutschen Gesellschaft für Internationale Zusammenarbeit (GIZ) gefördert, die zusammen mit Anwälten des Responsible Contracting Project (RCP) und des The Chancery Lane Project (TCLP) die Entwicklung von sektorunabhängigen Mustervertragsklauseln vorantreibt, um die Umsetzung von unternehmerischen Sorgfaltspflichten in Bezug auf Menschenrechte und Umwelt zu verbessern. Instrumente, die darauf abzielen, die empfundene Verteilungsungerechtigkeit zu verringern, wie z. B. Preisprämien (käuferindividuelle freiwillige Instrumente), werden nur unter sehr spezifischen, oft partnerschaftlichen Bedingungen angewandt, z. B. in integrierten Liefernetzen und ökologischen Handelsmodellen. Nachhaltige Praktiken werden nicht per se belohnt, sondern müssen von den Lieferanten aktiv in Rechnung gestellt werden. Andere innovative Instrumente sind im Entstehen begriffen, haben sich aber noch nicht durchgesetzt (z. B. nachhaltige Finanzierung) oder sind angesichts der Herausforderungen, denen sich KMU und Kleinbauern in Bezug auf Kosten und technologische Komplexität gegenübersehen, nur schwer zu realisieren (z.B. Rückverfolgbarkeit durch Blockchain-Technologie). Zirkuläre Lösungen beruhen außerdem häufig auf der Zusammenarbeit durch die gemeinsame Nutzung von Wissen, Technologie und anderen Ressourcen. Es ist jedoch wenig über die Anreiz- und Belohnungssysteme bekannt, die diese Lösungen vorantreiben.

Zinn

Die globale Zinnlieferkette zeichnet sich durch eine fragmentierte Struktur aus, in der die ökologische Nachhaltigkeit aufgrund der Art der Bergbauaktivitäten eine große Herausforderung darstellt. Zwar sind nachhaltige Praktiken innerhalb der Branche anerkannt, doch die Umsetzung solcher Maßnahmen stößt mitunter auf Widerstand, insbesondere bei Akteuren, die durch die finanziellen Belastungen bei der Einführung zusätzlicher Ansätze und Instrumente für den Umweltschutz abgeschreckt werden.

Staatliche Vorschriften im Zusammenhang mit Bergbauaktivitäten versuchen, die Umweltauswirkungen zu mildern. Die Wirksamkeit der Vorschriften kann jedoch gering sein, insbesondere in Regionen mit einer hohen Konzentration von handwerklichen und kleinen Bergbauaktivitäten (ASM), die unterhalb des Radars der formellen Regulierungsmechanismen operieren können. In einigen Regionen wurden die Vorschriften dafür kritisiert, dass sie nicht proaktiv genug sind, um Umweltschäden wirksam zu verhindern.

Die von den Interessengruppen der Branche geförderten Nachhaltigkeitsprogramme, zu denen Berichterstattungs-, Überwachungs- und unabhängige Überprüfungsinitiativen gehören, spielen eine wichtige Rolle, wenn es darum geht, den Schutz von Menschenrechten und Umweltmanagement in der Unternehmensführung zu berücksichtigen. Der Sektor nutzt eine Mischung aus Ansätzen und Instrumenten, einschließlich individueller und kollektiver Käuferinitiativen sowie kollektiver Strategien in der Lieferkette und Angebote gewinnorientierter Dritter, um verantwortungsvolle Praktiken zu fördern. Eine wichtige Komponente dieser Bemühungen ist die Vereinbarung von Verhaltenskodizes und einer nachhaltigen Beschaffungspolitik, die den Einkäufern als Richtschnur für den Umgang mit ihren Lieferanten dient. Um die Einhaltung dieser Standards zu gewährleisten, führen die Einkäufer Audits bei ihren Lieferanten durch. Die Einführung dieser internen Systeme und die Einhaltung von Verhaltenskodizes erfordern Investitionen seitens der Einkäufer. In bestimmten Szenarien verlangen die Einkäufer von ihren Lieferanten spezielle Zertifizierungen, wie den Responsible

Minerals Initiative Responsible Minerals Assurance Process (RMI RMAP). Diese Anforderungen sind in der Regel mit finanziellen Belastungen für die Lieferanten verbunden. Die Lieferanten müssen mit finanziellen Strafen rechnen oder riskieren Einschränkungen ihrer Geschäftsbeziehungen mit dem Käufer, wenn sie die Anforderungen des Käufers nicht erfüllen.

In der Zinnlieferkette spielen Angebote profitorientierter Dritter eine wichtige Rolle bei der Förderung der Nachhaltigkeit. Diese Ansätze umfassen beispielsweise Zertifizierungsprogramme wie ISO 14001 oder Transparenzinstrumente. Die Kosten für die Teilnahme an solchen Zertifizierungsprogrammen und digitalen Plattformen stellen wiederum einen entscheidenden Faktor für die Akteure der Lieferkette dar. Rückverfolgbarkeitstools, die sich ebenfalls positiv auf die Transparenz in der Lieferkette auswirken können, versuchen die Herausforderungen bei der Rückverfolgung des Ursprungs von Zinn von der Mine bis zur Schmelze zu adressieren. Vorhandene Rückverfolgungsinstrumenten werden entweder von Dritten angeboten oder von Zinn-Hütten als interne Systeme implementiert. Die Umsetzung solcher Instrumente und Ansätze erfordert ein finanzielles Engagement der Lieferanten. Darüber hinaus werden neue Ansätze wie die Blockchain-Technologie erprobt, um die Rückverfolgbarkeit in der Lieferkette zu optimieren. Das aufkommende Konzept der Kreislaufwirtschaft fördert ebenfalls Nachhaltigkeit in der Branche, indem es die Lieferketten verkürzt und es Käufern ermöglicht, die Herkunft ihres Zinns vom Recycler bis zum Endkunden zurückzuverfolgen.

Naturkautschuk

Entlang der Lieferkette vom Naturkautschuk-Anbau bis zum Autoreifen entstehen verschiedene Umweltauswirkungen, insbesondere beim Anbau (z. B. Abholzung) und in den Naturkautschuk-Verarbeitungsbetrieben (z. B. Wasserverbrauch, Chemikalien). Der Sektor hat erst vor kurzem damit begonnen, sich mit diesen Problemen zu befassen, was zum Teil auf den zunehmenden Druck durch staatliche Vorschriften zurückzuführen ist (insbesondere auf die Anforderungen der im Mai 2023 verabschiedeten EU-Abholzungsverordnung (EUDR)).

Während sich der Sektor insgesamt noch in der “Anfangsphase” der Nachhaltigkeitstransformation befindet, haben verschiedene Vorreiter-Unternehmen damit begonnen, käuferindividuelle freiwillige operative Ansätze und Instrumente für ein nachhaltiges Lieferkettenmanagement einzuführen, die sich zunehmend auch an Lieferanten jenseits der „tier 1” richten. Dazu gehören die Verabschiedung nachhaltiger Einkaufspolitiken und Verhaltenskodizes für Lieferanten, die manchmal auf Standards verweisen, die gemeinsam im kollektiven Umfeld der Lieferkette entwickelt wurden. Lieferantenaudits decken immer mehr Umweltkriterien ab, und mehrere Einkäufer haben begonnen, von Dritten angebotene Instrumente wie Zertifizierungen (z. B. FSC) und Programme zur Erhebung von Umweltrisikodaten von Lieferanten tiefer in der stark fragmentierten Lieferkette (z. B. RubberWay) zu nutzen. Aufgrund der zunehmenden Anforderungen an Transparenz und Rückverfolgbarkeit in der Naturkautschuk-Lieferkette, insbesondere seitens der EUDR, werden technische Lösungen wie Blockchain und Satellitenüberwachung getestet.

Während die Umsetzung dieser nachhaltigen Aktivitäten in der Lieferkette zu höheren Kosten führt, die vor allem für die oft finanzschwachen Kleinbäuer*innen am Anfang der Lieferkette belastend sind, scheinen Preisaufschläge für nachhaltig erzeugte Produkte immer noch eher die Ausnahme als die Regel zu sein. Statt finanzieller Anreize haben einige Einkäufer begonnen, nicht-finanzielle Anreize zu entwickeln, wie z. B. die Durchführung von Schulungen oder die Anerkennung vorbildlicher Umweltpraktiken bei den Lieferanten durch öffentlichkeitswirksame Auszeichnungen (sowohl individuell als auch kollektiv).

Einige Kleinbäuer*innen versuchen, ihre Verhandlungsposition in der Lieferkette zu verbessern und die Kosten für die Umsetzung von Nachhaltigkeitsmaßnahmen und Zertifizierung zu senken, indem sie sich z. B. in Kooperativen zusammenschließen, was ihnen auch die Entwicklung langfristigerer und direkterer Geschäftsbeziehungen zu den einkaufenden Unternehmen ermöglicht.

Kaffee

Kaffee ist eines der beliebtesten Getränke der Welt und zählt zu den global am meisten gehandelten Rohstoffen. Die Wertschöpfungskette des Kaffees ist aufgrund der umfangreichen Produktionsprozesse und der geografischen Trennung zwischen nachgelagerten und vorgelagerten Akteuren besonders kompliziert. Die Kaffee-Lieferkette umfasst verschiedene Produktionsstufen, an denen unterschiedliche Akteure beteiligt sind, von den Landwirt*innen bis zu den Endverbraucher*innen. Die Praktiken der Kaffeeversorgungskette in Bezug auf Nachhaltigkeit und Rechenschaftspflicht werden häufig kritisch hinterfragt. Vor allem die engen Verbindungen der Branche zu wirtschaftlich benachteiligten Regionen, in denen der Kaffee abgebaut wird, sind in die Kritik geraten. Die Nachhaltigkeit dieser Lieferkette wird durch soziale, wirtschaftliche und ökologische Faktoren bestimmt, wobei Umweltaspekte wie Landnutzung, CO2- und Wasser-Fußabdruck sowie das Abfallaufkommen eine zentrale Rolle spielen.

Die globale Kaffeelieferkette ist mit kritischen Eingriffen in die Umwelt verbunden, darunter Abholzung, intensive Anbaumethoden und ein hoher Wasserverbrauch, die zum Verlust der biologischen Vielfalt, zur Bodendegradation und zur Wasserverschmutzung beitragen. Darüber hinaus verursacht die Branche auf allen Produktions- und Verarbeitungsstufen erhebliche Abfallmengen und Treibhausgasemissionen, während der übermäßige Einsatz von Agrochemikalien Risiken für das Ökosystem und die menschliche Gesundheit mit sich bringt. Diese miteinander verknüpften Probleme, die vom Anbau bis zum Konsum reichen, machen deutlich, wie dringend notwendig nachhaltigere Praktiken in der gesamten Kaffeeindustrie sind. Um Umwelt- und Menschenrechtsbelange anzugehen, wurden staatliche Vorschriften in Form verbindlicher Maßnahmen eingeführt. Diese Vorschriften, wie etwa die EUDR und die EU-Richtlinie über die Sorgfaltspflicht von Unternehmen im Bereich der Nachhaltigkeit (Corporate Sustainability Due Diligence Directive, CSDDD), setzen sich für Transparenz, ethische Beschaffung und verantwortungsbewusstes Geschäftsgebaren in der gesamten Lieferkette ein. Darüber hinaus haben multinational tätige Kaffeeröster (und -händler) wie bspw. Starbucks, Nestlé und Tchibo im Rahmen ihrer operativen Strategien verschiedene Initiativen ergriffen, um eine nachhaltigere Kaffeelieferkette zu gestalten. Viele dieser Initiativen, die in erster Linie von den Käufern initiiert wurden, sind freiwillig und fallen unter die Kategorie der kollektiven Ansätze in der Lieferkette, die für eine erfolgreiche Umsetzung die Zusammenarbeit zwischen verschiedenen Interessengruppen erfordern. Die Akteure innerhalb der Kaffeelieferkette wenden eine Vielzahl von Ansätzen an, um negative Umweltauswirkungen wirksam zu mindern. Zu diesen Ansätzen gehören u. a. Bildungs- und Schulungsprogramme für Landwirte*innen, nachhaltige Anbaumethoden, finanzielle Unterstützungsprogramme, verantwortungsvolle Vertragsabschlüsse, nachhaltige Beschaffungspraktiken, direkte Beschaffung und vertikale Integration. Aus der Sicht der Landwirte*innen stärkt die Bildung von Lieferanten-Kooperativen, Kleinbäuer*innen, indem sie ihre Verhandlungsposition stärken und den Wissenstransfer und den Zugang zu Ressourcen erleichtern.

Unter diesen Ansätzen spielen Audits und Zertifizierungen, einschließlich ISO 9001, ISO 14001, Fairtrade, Rainforest Alliance und Bio-Zertifizierungen, eine entscheidende Rolle und sind weit verbreitet. Diese Programme sehen in der Regel eine Zusammenarbeit zwischen Erzeugern, Verarbeitern und Händlern vor, um eine faire Entlohnung, umweltfreundliche Praktiken und

eine nachhaltige Landwirtschaft zu gewährleisten. Wichtig ist, dass Nachhaltigkeitszertifizierungsprogramme für Landwirte*innen langfristig darauf abzielen, die Kaffeebäuer*innen bei der Aufrechterhaltung hoher Erträge zu unterstützen und gleichzeitig die Produktionskosten und die Umweltbelastung zu reduzieren und möglicherweise einen Preisaufschlag zu garantieren. Neue Ansätze wie der Einsatz von Informationstechnologien wie Blockchain und das Internet der Dinge (IoT) haben Potenzial für ein nachhaltiges Lieferkettenmanagement. Ihre Anwendung ist jedoch noch begrenzt, derzeit werden die Technologien in einigen wenigen Fallstudien erprobt. Die Gründe dafür sind beispielsweise, dass sie komplex zu implementieren und in bestehende Systeme zu integrieren sind, dass ihre Einführung teuer ist, dass sie zusätzliche Umweltauswirkungen durch die Produktion, die Nutzung und das End-of-Life-Management der benötigten Geräte verursachen und dass sie eine Standardisierung der Datenformate und Kommunikationsprotokolle zwischen verschiedenen IoT-Geräten erfordern.

Eisen und Stahl

Während beim Abbau von Eisenerz erhebliche Umweltauswirkungen entstehen (z. B. Land- und Wasserverbrauch, Staubemissionen, Risiko des Bruchs von Rückhaltebecken und Dämmen für Abfallstoffe), befassen sich die meisten Interessensgruppen in der Lieferkette vor allem mit der Frage, wie die Treibhausgasemissionen bei der Stahlproduktion reduziert werden können. Der Fokus auf dieses Thema zeigt sich unter anderem darin, dass die meisten großen Stahlunternehmen in den letzten Jahren freiwillige Dekarbonisierungsziele veröffentlicht haben, während solche Verpflichtungen zu anderen Umweltthemen in der Regel nicht vorliegen. Diese Fokussierung kann zum Teil auf die zunehmende Regulierung zurückgeführt werden, die die Industrie zur Dekarbonisierung zwingt, und auf den gleichzeitigen Mangel an Umweltvorschriften in vielen Bergbauländern, in denen die Eisenerzgewinnung stattfindet.

Mehrere Abnehmer wenden individuelle Ansätze an, wie z. B. Umweltklauseln in ihren Verhaltenskodizes für Lieferanten, und einige haben begonnen, auch die Einhaltung von Umweltkriterien (z. B. CO2-Fußabdrücke) bei Lieferantenaudits zu überprüfen. Da die Eisenerz-/Stahl-Lieferkette durch starke Lieferanten (große Bergbauunternehmen) gekennzeichnet ist, haben die einkaufenden Unternehmen (Stahlproduzenten, Automobilhersteller) jedoch weniger Einfluss, was zu mehr kooperativen Ansätzen bei der Lösung von Umweltproblemen führt. Ein wichtiges Beispiel sind die Bemühungen der Normen- und Zertifizierungsinitiative ResponsibleSteel, Kriterien für eine verantwortungsvolle Beschaffung für Stahlunternehmen einzuführen, indem bestehende Normen für Bergwerke wie die der Initiative for Responsible Mining Assurance (IRMA) anerkannt werden. Diese Anforderungen sind jedoch noch nicht verpflichtend, da die Beteiligung von Lieferanten an anerkannten Programmen für Vormaterialien wie IRMA derzeit zu gering ist. Um eine weitere Verbreitung des Austauschs von Umweltdaten, der Rückverfolgbarkeit und der Chain-of-Custody-Ansätze zu ermöglichen, werden technologische Ansätze wie die Blockchain entlang der Lieferkette erprobt.

Vor dem Hintergrund der notwendigen Dekarbonisierung, für die u.a. die Automobilhersteller "grünen Stahl" benötigen, sind in den letzten Jahren verschiedene Kooperationen entlang der Lieferkette zwischen Bergbau-, Stahl- und Automobilunternehmen entstanden, die gemeinsam die notwendigen Investitionen in technologische Veränderungen stemmen und den Zugang zu Rohstoffen und Vormaterialien sichern wollen, die für die Herstellung neuer "grüner" Produkte notwendig sind. Auch Pilotprojekte in der Stahlindustrie wurden mit staatlichen Mitteln unterstützt. Darüber hinaus zeichnet sich ab, dass die Produktion von „grünem Stahl" auch die Geschäftsbeziehungen entlang der Lieferkette beeinflussen wird und dass Abnahmevereinbarungen, Absichtserklärungen und Joint Ventures (manchmal bereits in Verbindung mit der Zahlung von Preisaufschlägen) zur Umsetzung nachhaltigerer Praktiken als

gegenseitige Verpflichtung von Käufern und Lieferanten beitragen werden. In Zukunft wird es jedoch notwendig sein, den Bergbausektor stärker in gemeinsame Aktivitäten einzubinden und sich auf Umweltfragen zu konzentrieren, die über die Treibhausgasemissionen hinausgehen, wie z. B. Wasser- und Bodennutzung.

Im weiteren Verlauf des Projekts werden die in diesem Bericht vorgestellten Erkenntnisse in die Entwicklung von Anreizmechanismen für die Umsetzung effektiver Klima- und Umweltschutzmaßnahmen und einer Verbesserung der Transparenz und Kooperation entlang globaler Lieferketten einfließen. Die identifizierten Lösungen werden in Roadmaps für die praktische Umsetzung in den jeweiligen Lieferketten umgesetzt. Das Projekt schließt mit zielgruppenspezifischen Empfehlungen für die Ausgestaltung von operativen Instrumenten des Lieferkettenmanagements und Empfehlungen dazu, wie u.a. Brancheninitiativen, Regierungen und Intermediäre eine gerechte Kosten-Nutzen-Verteilung bei der Umsetzung von Umweltschutzmaßnahmen in den ausgewählten Lieferketten unterstützen können.

1 Introduction

Cost allocation and incentivising are core considerations to establish systems for the environment, climate protection and resource conservation along global supply chains. Who pays and who benefits are key criteria for people and organisations to decide whether they engage or resist. The public debate often refers to the enormous extra cost caused (or potentially caused) by measures suggested to improve supply chain sustainability, either harming profitability (or even viability) of companies or causing higher consumer prices. The sustainability issues often occur far away, at sub-suppliers in other parts of the world with different economic development levels, in other cultures or other government systems – with various actors suggesting a limited causality of buyers on these issues, and thus little reason to take on these extra costs. In the context of remedy, the question of who pays is often considered in the context of responsibility or liability – which is not always simple to identify for sustainability issues in global supply chains.

This report takes an alternative, more entrepreneurial than legal perspective by linking costs with benefits. In a capitalist system, expected returns not only justify investments, but make them attractive. But how are today's activities, that aim at improving sustainability in global supply chains, set up in terms of economic attractiveness and fairness among the various actors? Do those who already suffer most from adverse environmental degradation and human rights violations also face the major burden to improve the situation? Do those who benefit most from today's unsustainable practices also benefit most from improvements? Do today's practices of allocations of cost strengthen or weaken imbalances in fairness, equity or hope? And, why do companies – buyers or suppliers – engage in improving environmental performance? Do they believe in a potential benefit that can be realised, giving them motivation to act? Or are they driven by external pressures – the societal conversations, NGO campaigns, media coverage, social media, financial investors, customers and sales markets, political conversations, or government regulation – motivating them to get out of the firing line, but no further?

This report focusses on the approaches and instruments used by companies to improve sustainability in global supply chains, and considers how they are used in practice. Use is highly dependent on the specific context of the buyer and supplier. The variety in business practice demonstrates the importance of considering the broad range of contextual factors. This report can only point to, but cannot cover, this variety in context. It considers dominant practices and situations, first on a more generic level, followed by specific examples, with the aim to provide orientation – without judging on specific cases.

This report starts with Chapter 2, which introduces a broad range of approaches and instruments used in business practice to improve sustainability in supply chains. These approaches and instruments are structured based on the actors that initiated them – since they had a purpose and potentially a benefit in mind – and usually also still maintain them. Chapter 3 describes context factors by taking three positions: the buyer, the supplier and their relationship. Chapter 4 discusses the cost allocation and incentive mechanisms generally used in sustainable supply chain management (SSCM), the current heterogeneity in the scope and means of evaluation, as well as two standard buyer strategies to manage suppliers (coercive and collaborative), and concludes that limited cost transparency in SSCM drives cost avoidance practices. Chapter 5 provides deep insight into the practices of five industries – cotton, tin, natural rubber, coffee and iron – and their respective supply chains, also demonstrating the variation from generic setups like the OECD guidance. The report ends with Chapter 6, a discussion of the insights.

2 Selected business approaches and instruments

In order to discuss cost allocation and incentive mechanisms in sustainable supply chain management (SSCM), it is necessary to briefly introduce the range of business approaches and instruments that are used for the environment, climate protection and resource conservation along global supply chains. This chapter presents a selection of the many approaches and instruments that are currently available to companies for driving sustainability in supply chains. The selection follows the intensity of conversations about the business approaches and instruments in the various fields that address SSCM. The chapter does not aspire to cover all existing approaches and instruments, but to provide readers a guide to explore what is available and by whom. The approaches and instruments are mentioned individually, yet in business practice they are used in combination. Descriptions are short, with further details in Annex A.

The variety of challenges, opportunities, resources, context and motivations have triggered different actors to develop and offer these business approaches and instruments – including buyers, suppliers, third parties and government organisations (fourth parties). Some of the approaches and instruments that started out as highly context-specific (e.g. triggered by a concrete challenge), have become generic over time, while others remain focused on their specific context. They progressed to their status-quo, and continue to be developed further. Some approaches and instruments originated from external pressures on buyer or supplier companies to resolve a specific crisis (e.g. broad media coverage of a business practice that causes significant pollution) or to respond to a more general challenge (e.g. a politically defined goal or limitation). Others originated from buyer or supplier belief in the opportunities or competitive advantages of sustainability practices.

Many of the business approaches and instruments of SSCM aim to change the established practices of business partners that have adverse impacts on the environment or society. There are reasons why companies act the way they do and therefore it is important that they adapt to such external requests for change. Alternatives to current practices may not appear imaginable, feasible or desirable (e.g. economically or culturally). The creation of alternative practices to reach the same ends and the evaluation of their reliability is a common barrier to progress. Feasibility concerns can relate to a lack of technological capabilities, knowledge or funding for required investments. Desirability depends on the perceived business prospect from the changes, such as increases or decreases in profitability or dependence, the longevity of the new business model or embeddedness in their network of business partners, but also on cultural aspects, from legitimacy in the local community (their evaluation of the desirability of this new kind of business) to the alignment with practices and habits of local culture.

To reach the intended objectives, SSCM must adapt to the specificities of and the relationship with the business partners. Coercive approaches are based on power asymmetries, enforcing change on weaker business partners. Collaborative approaches focus on creating win-win situations, so that equal or more powerful business partners engage in the requested changes on their free will. Collaborative approaches require the involved parties to develop an understanding of each other's situation and options, and to find roadmaps to implement the jointly defined changes. Coercive approaches may skip such considerations and simply impose the changes desired by the more powerful actor.

Incentives and penalties are common approaches to influence the desirability of the requested changes. They highlight the consequences of the business partner's compliance with the requested change – for both the buyer and the supplier in the relationship. Incentives aim to make the changes attractive by increasing profitability, directly or indirectly. Common examples that directly increase revenue include price premiums and bonuses, as well as higher business

volumes. Awards or other forms of recognition promote the business partner in the market, potentially enabling it to increase business volume and sales prices. Penalties punish business partners for non-compliance and aim to make resistance to change unattractive by harming the bottom line. Common examples include reducing payments on invoices, recovering fines or reducing/stopping business – all of which aim to have direct effects on profitability. Incentives and penalties are subject to evaluation by the different actors: increases or decreases in revenue need to be evaluated in terms of the company's total revenues, but also with respect to the estimated increase in costs caused by the requested change and the alternatives the business partners have to substitute potential losses. Differences in size or power between the actors, but also dependence on a business partner limit actors' ability to attract with incentives or to threaten with penalties. Most incentives and penalties require efforts on both sides.

To answer the question of who actually bears the cost of sustainability targets, one needs to look at the various kinds of costs along with the benefits that vindicate investments. The costs of a specific approach or instrument consist of two parts: (1) the cost for the development, further progression or adaptation, offering, and maintenance, and (2) the costs from its actual use, including additional, indirect cost implications from this use. Both parts vary considerably with context (see Chapter 3); some costs (in particular investments, premiums or penalties) realise immediately, while others are delayed. Investments, premiums and penalties are rather easy to quantify financially, while indirect effects can be challenging to evaluate and difficult to quantify. The benefits of an approach or instrument relate directly to their purpose of improved supply chain sustainability, and can be structured into (1) improving the company's economic performance (directly or indirectly), (2) ensuring legality of the company's operations, or (3) improving the company's relationship with society and the planet. Benefits can also be challenging to evaluate and difficult to quantify financially.

The question of who should bear how much of the potential additional costs can be discussed from the perspective of the individual supply chain actors or from the perspective of society – with different conclusions. The perspective of individual supply chain actors concerns their specific contribution to (or guilt for) the respective challenge to be addressed and the perceived fairness of the requested measures in terms of competition (e.g. level playing field). Companies that focus on the conventional boundaries of their business and define their purpose as maximising profits (in the sense of Friedman 1970) have a different view on the fairness of cost sharing than companies that consider their supply chains as part of their activities (Donaldson and Walsh 2015). As a result, one could argue that the additional efforts need to be covered by suppliers whose business practices cause social or environmental harm and require improvement. The perspective of society concerns the relation between business, society and the planet, and addresses the collective, adverse impacts of business and expects that companies cover their fair share of the costs of prevention and remedy. For a long time, the negative effects of (profitable) economic activity have been considered inevitable and, as a result, covered by society (e.g., by accepting the situation or by covering the cost of remedy) – a market failure also found among buyers (Gabel and Sinclair-Désgagné 1994). One could argue that buyers who have benefited illegitimately from low purchasing prices – made possible by problematic supplier practices – need to take responsibility and help these suppliers develop until they reach the desired performance level. It appears that the beliefs about how the costs to realise targeted levels of sustainability in supply chains should be shared are heterogenous.

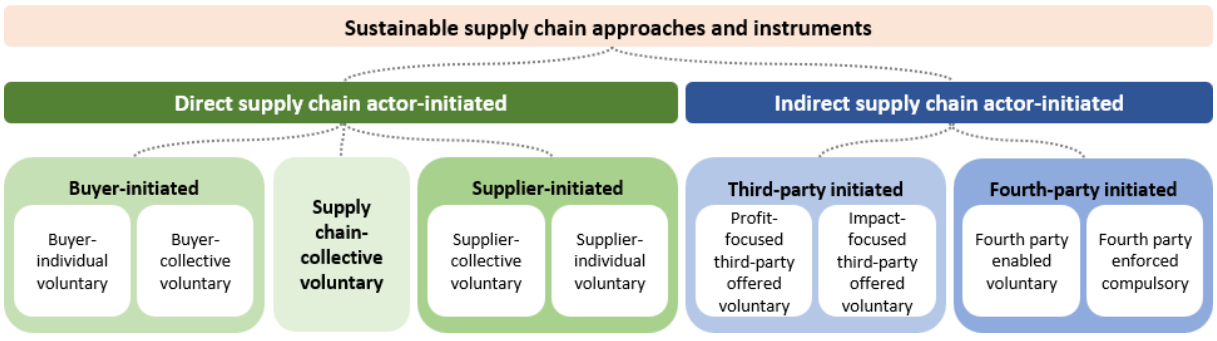
The sharing of costs and benefits in business relationships is of major concern to the involved companies and represents a basis for constant (re)negotiations. The main approaches refer to equality and equity. Equality, i.e. suggesting that each actor shall be treated in exactly the same way, is subject to the critique that substantial differences exist between actors that ultimately

result in different outcomes. Equity has been suggested as an alternative that takes into account each actor's individual circumstances to achieve an equal outcome (Scheer et al. 2003). The buyer-supplier relationship literature uses perceived distributional fairness (or equity) to describe relational performance. It divides the received benefits by the actual investments – what is also referred to as yield – for each actor, and postulates that distributional fairness is perceived by the respective actors when other actors' results are proportional to their own (Scheer et al. 2003; Corsten et al. 2005; Normann et al. 2017). With this definition, assessments need to be cautious of the problems with return-on-investment perspectives (Atz et al. 2019): investments (or costs) are often relatively easy to measure in financial values and occur in a defined period, while benefits often dilute into many performance indicators over a longer, often unclear, period of time. Furthermore, situations when costs are conventionally socialised while profits are privatised require efforts in transparent accounting. Apart from that, however, this perspective only describes how balanced the yield is between two actors; it does not address the magnitude of benefits or investments.

Activities in sustainable supply chains that promise higher benefit than the expected investments (high yields) are pursued by the relevant actors with strong internal motivation (Porteous et al. 2015). In contrast, others, for which the relevant actors expect no or low yields, experience realisation only if external pressures coerce the change. In the middle of both extremes, where neither internal motivation nor external pressures exists, no action should be observed.

The approaches and instruments presented in this chapter are structured by the actors (Lambin et al. 2020) who develop, maintain, and offer them (see Figure 1). This structure underlines the attention to costs and benefits of this report. Primarily, we distinguish between two kinds of actors: direct and indirect supply chain actors. We define direct supply chain actors as all companies that are part of a supply chain as producers, buyers or traders, and all other related organisations as indirect supply chain actors (Carter et al. 2015). Although this report puts its focus on business approaches and instruments, we also briefly mention "non-business" approaches and instruments from civil society and government, as these also play an important role in SSCM. Most approaches and instruments are offered and run by private organisations, and supply chain actors can use them on a voluntary basis (contractual obligations between private organisations are entered into voluntarily, even if one party may have dominated the terms set out in the contract). In contrast, government-enforced approaches and instruments are compulsory measures that supply chain actors must comply with (Sharma 2000).

Figure 1: Structure of approaches and instruments to initiate sustainability in supply chains



Source: own illustration (adelphi)

Among the approaches and instruments that are initiated by direct supply chain actors, we distinguish among buyer-initiated and supplier-initiated, since it is direct buyer-supplier

relationships that need to address sustainability targets in supply chains with concrete action (in contrast to company-internal targets and activities). Among the buyer-initiated (second party) and supplier-initiated (first party) approaches and instruments, we further differentiate between individual and collective. Individual approaches and instruments are company-specific and internally developed. The latter category takes into account that many activities are carried out jointly by several companies (either in their role as buyer or as supplier), which also leads to common approaches and instruments. We emphasise the special case of supply chain collectives that comprise of producers and traders of multiple tier steps of the respective supply chain.

Among the third parties, we distinguish between the options from profit-oriented actors (in the sense of commercial activities) and those of impact-oriented actors (in the sense of civil society activities). Finally, for fourth-party (government) approaches and instruments, we distinguish between enabling and enforcing – acknowledging that legislation increasingly combines both. The rest of this chapter provides a brief introduction of the various approaches and instruments.

2.1 Buyer-individual voluntary approaches and instruments

Buyer-individual voluntary approaches and instruments serve the buyer's interests (internal use), are voluntary, and exist because buyers decided individually to develop, advance and maintain them, without obligation from public policy.

Sustainability-related structures and responsibilities: more of a prerequisite than an approach or instrument, these are specific organisational entities, business processes, capabilities, and cultures that buyers require to address sustainability issues in their supply chains and to use the various approaches and instruments outlined below. The deep integration of sustainability into a company plays a key factor for success (Sroufe 2017).

Supply chain mapping identifies and documents a buyer's suppliers and upstream sub-suppliers at different levels of abstraction. Buyers have little access to information beyond direct suppliers, limiting their options to create transparency either to desk research (consulting publicly available information e.g. on specific materials, business practices or world regions) or asking their suppliers about their upstream supply chains and the companies, regions or sectors therein (Farris 2010). High dynamic and complexity in buyer-supplier relationships on all tier levels limit the accuracy of supply chain maps.

Supplier performance monitoring and sustainability risk identification in supply chains conducted by buyers refers to first- and second-party auditing. With supplier self-assessments (first-party audit), buyers request suppliers to evaluate their own practices or performance based on a provided questionnaire and to share the results with them (Tan et al. 2023). Second party approaches are supplier site visits with audits conducted by the buyer with internal staff, or attending supplier events (Chen et al. 2020a).

Supplier code of conduct is an official documented statement by the buyer that specifies their expectations for minimum requirements and target performance levels for environmental, social and legal aspects as well as the buyer's approach to monitoring and improving supplier performance (Vandenbroucke 2024). Companies base a major part of their supplier codes of conduct on international or sector standards and customise them by adding relevant aspects for the company (Altura et al. 2021).

Nomination of sub-suppliers is an attempt by buyers to lower supply chain risks or to benefit from opportunities, by specifying specific companies to their suppliers for the procurement of goods or services (Grimm et al. 2023). As such nominations can impose technological, commercial, and operational limitations on suppliers, they are often perceived as threat.

Sustainable sourcing practices refer to a buyer's consideration of sustainability in all sourcing activities. For sustainability requirements to be considered during sourcing, they must: form part of the specifications of goods and services; include processes and evaluation schemes to assess supplier offers or to consult supplier audit results; and be considered in the objectives and incentive systems.

Supplier contracts are legal documents, usually resulting from a negotiation between a buyer and a supplier, and define in particular the transactions, the expectations of both parties (including codes of conduct), enforcement, incentives or penalties, as well as terms and conditions – and go beyond verbal agreements or the reliance on general laws (Suchman 2003). They can be verbal agreements or written documents, and vary in the level of detail.

Risk sharing with suppliers addresses power abuse in relationships by making the risks imposed on suppliers by buyer practices explicit and defining arrangements that limit such practices or balance the adverse effects among buyer and supplier. For the buyer, this implies coordination among different business functions and balancing between short- and long-term goals.

Supplier performance response follows up on supplier performance monitoring, providing suppliers the buyer's evaluation of the results and expectations, advice or support for further improvement and a platform for dialogue. It also offers suppliers attractive incentives for achievements or relevant penalties for failure. The timely link between monitoring and the buyer's response is of key importance (Hajmohammad et al. 2021).

Supplier or sub-supplier development for sustainability addresses identified, lacking capabilities required to operate at or above a minimum performance level, helping suppliers in closing these gaps with specific improvements (Tran et al. 2021; Jia et al. 2023). Supplier development means that buyers, possessing internally the capabilities required by the supplier, identify the exact capability needs, educate the required knowledge and assist in applying these new resources (Marttinen et al. 2023).

Crafting of sustainable supply chains aims to create new supply chains by contracting only suppliers and sub-suppliers that align with the buyer's sustainability (and other) values and requirements and defining new modes of interaction (e.g. contractual elements), instead of altering the business practices of suppliers and sub-suppliers in the existing supply chains. This approach reduces supply chain risks as well as supplier monitoring and development efforts to a minimum, allowing the investment of these savings into their sustainability practices (Allal-Chérif et al. 2023).

Design for sustainability enables buyers to limit adverse impacts from materials and business practices by substituting critical designs with alternatives that meet the sustainability expectations. It has become a key approach to ensure that sustainability considerations and limitations are taken into account in these early stages, potentially eliminating problematic processes or materials (Rocha et al. 2019).

Business modelling is an instrument from strategic management that helps to identify and position specific practices and activities by including social or environmental criteria during the development and comparison of potential alternatives. This helps buyers to select their best option.

Non-financial reporting allows buyers targeting and controlling supplier activities or performance criteria that are not financial (although they may have a financial impact). The "balanced scorecard" is a widely adopted tool that gives sustainability goals and performance indicators the important role needed to enable comprehensive management decisions (Hansen and Schaltegger 2016). Reporting on senior management conversations is a way for suppliers to

show developments on a more strategic level than supplier monitoring (Wohlgezogen et al. 2021).

Political lobbying both in the political (legislative) and in the governmental/administrative (executive) spheres can shift the duties to government and limit a buyer's involvement or liability and aim to increase regulatory pressures on the companies in the countries where the sustainability issues actually occur.

2.2 Buyer-collective voluntary approaches and instruments

Buyer-collective voluntary approaches and instruments serve both the buyer (internal use) and other members of the relevant industrial sector (often organised in an association). They are voluntary and exist because a collective of buyers decided to develop, improve and maintain them collectively and in partial dependence on one another (Peters et al. 2011).

Sustainability-related exchange and interest representation in voluntary sector initiatives comprise activities that allow buyers that are active in similar markets to address specific issues jointly among several buyers to achieve a more comprehensive understanding of issues and explore a wider range of potential responses or solutions, making it more attractive to third parties to engage and develop out-of-the-box solutions.

Voluntary sustainability sector standards are agreements by the collective upon their shared expectations in terms of minimum requirements and target performance levels for environmental, social and legal aspects to be fulfilled by their supplier as well as the collective's approach to monitoring and developing supplier performance.

Collective supplier sustainability performance monitoring with shared audit systems align buyers in using the same method to identically measure supplier sustainability performance (shared audit system). The use of the same questionnaire (based on the voluntary sustainability sector standards, see above) and the same assessment approach (often conducted by third parties) ensure comparability, ultimately allowing the sharing and the shared filing of audit results, which reduces the number of audits per supplier.

Collective supplier or sub-supplier development for sustainability bundles efforts for supplier development in a collective to reduce individual costs, involve more stakeholders and counter potential freeriding – but also to make the request to suppliers for development more powerful, since it comes from a larger number of their customers representing a more significant share of their sales (Liu et al. 2018).

Collective grievance and remedy structures provide individuals or organisations (including employees of suppliers and sub-suppliers but also communities or others who are negatively affected) safe means to address their concerns about the adverse environmental or social impacts of a supplier's or sub-supplier's business practices to neutral parties, which enables buyers (individually and collectively) to initiate adequate, formalised responses to ensure corrective action is taken (Harrison and Wielga 2023). Collective approaches can also be used to deal with reparation claims or remedy for past events (e.g. accidents or prior abuse of workers) when the respective sustainability issue concerns a number of buyers (Donaghey and Reinecke 2018).

2.3 Supplier-individual voluntary approaches and instruments

Supplier-individual voluntary approaches and instruments serve the supplier (internal use), are voluntary, and exist because suppliers decided on their own to develop, further progress and maintain them, without obligation from public policy.

Sustainability-related structures and responsibilities – as is the case for buyers (see 2.1), more of a prerequisite than an approach or instrument, as such – refer to specific organisational entities, business processes, capabilities, and cultures that suppliers require to address sustainability issues in their supply chains with their customers (i.e. buyers) and to use the various approaches and instruments outlined below. The deep integration of sustainability into a company plays a key factor for success (Sroufe 2017).

Business modelling (as defined in 2.1) is an instrument from strategic management that helps to identify and position specific practices and activities by including social or environmental criteria during the development and comparison of potential alternatives. This helps also suppliers to select their best option.

Active feedback structures to buyers allow suppliers to feed their customers (i.e. buyers) with the latest developments and updates on challenges, enabling buyers to quickly learn about pros and cons of their activities and to adapt their respective strategies and tactics.

2.4 Supplier-collective voluntary approaches and instruments

Supplier-collective voluntary approaches and instruments (similar to 2.1) serve both the supplier (internal use) and other members of the relevant industrial sector (often organised in an association). They are voluntary and exist because this collective of suppliers decided to develop, further progress and maintain them collectively and in partial dependence on one another.

Certifications guarantee compliance with specified requirements. In this case (as opposed to third party certifications, see 2.6), supplier collectives define the rules and own the right to grant or withdraw the certification of a member of the collective.

Supplier cooperatives enable smaller suppliers (often in developing or industrialising countries) face similar challenges or demands to address their needs that often relate to sustainability issues (Verhofstadt and Maertens 2014; Candemir et al. 2021). Cooperatives allow parties to share fixed costs or investments, achieve critical mass, or increase supplier power in negotiations with buyers to address and defend their interests.

2.5 Supply chain-collective voluntary approaches and instruments

Supply chain-collective voluntary approaches and instruments (similar to 2.1 and 2.3) serve both the company (internal use) and other actors (buyers, suppliers and sub-suppliers) in this supply chain (often organised in an association). They are voluntary and exist because these actors in the supply chain decided to develop, further progress and maintain them collectively and in partial dependence on one another.

Sustainability-related exchange in supply chain collectives apply an integrative, collaborative approach to coordination that considers the interests and context of the various actors in multi-tier supply chains. They seem to have gained momentum when supply chain actors experienced strong contextual limitations to establishing sustainability practices – often when behaviour of a specific tier level undermines the activities of the rest of the supply chain (Alexander 2022).

Supply chain tracing is enabled by transaction partners along a supply chain revealing their identity and sharing information (Wowak et al. 2016). It contributes to supply chain transparency, allows all supply chain actors to have better understanding, and helps to develop systemic solutions.

Identity preservation or physical segregation along supply chains (chain of custody models without mixing) allows supply chain actors that comply with specific sustainability requirements to link their goods to specific customers who are willing to reimburse them for their elevated efforts. This requires strict segregation of physical flows.

Controlled blending or mass balance within supply chains (chain of custody models with mixing) allows supply chain actors to mix according to defined criteria materials with and without specified characteristics.

2.6 Profit-focused third-party voluntary approaches and instruments

Profit-focused third-party voluntary approaches and instruments are profit-oriented commercial services offered to supply chain actors that are voluntary and motivated by delivering to the needs of actors that aim at increasing sustainability in supply chains. The providers of these approaches and instruments are invested in the development, offering and promotion of their services and usually hold the intellectual property, which allows them to charge for their services.

Supply chain mapping by third parties provides customers with results from either new collected data or the results from analytics of existing data, such as trade data, natural sciences databases, or internal data of the respective customer.

Supply chain tracing and blockchain solutions aim to generate and store transactional data that cannot be manipulated. Data collection and storage can be automated, and data security can be enhanced by the use of distributed ledger technologies, often referred to as blockchain solutions for supply chains (Saberi et al. 2019; Bager et al. 2022; Khan et al. 2022).

Digital product passports store individual product information about material contents, suppliers and sub-suppliers, production technologies or processes. Such "digital twins" of a product require procurement and operations data as well as information from supply chain mapping and tracing.

Third-party supplier auditing and reporting conducts audits on behalf of companies, for reimbursement, and according to their sustainability requirements. This approach allows buyers to limit their efforts for monitoring sustainability performance in their supply chain and suggests relatively high objectivity from an independent third party.

Supply chain risk identification are solutions primarily supplied to investors and insurance companies. They identify and quantify the supply chain risks of companies – usually either investment objects or clients for financial services ranging from loans to insurances (Berkan et al. 2021).

Supplier development addresses performance gaps identified in third party supplier audits by offering training or consulting projects. They can target a specific buyer's suppliers or cover an regional sector (Blome et al. 2014; Jia et al. 2022).

Certificate trading in book and claim systems are solutions for traceability that ensures financial flows between producers and buyers while allowing transactions to take the shortest paths. The third party running such systems needs to maintain accurate bookkeeping to keep physical and certified volumes aligned.

Identity preservation, physical segregation, controlled blending and mass balance are chain of custody solutions for supply chains offered by third-parties to ensure traceability.

Certifications of goods can also be provided by profit-focused third-parties (as opposed to supplier collectives, see 2.4) who take care of the entire processes from standards definition to authorisation. Such certification is often costly with unclear benefits.

Exchanges and trading platforms for sustainable commodities have only recently received interest (Bernards 2021). The separation of conventional and sustainable material allows buyers and suppliers to match demand with supply while respecting the different requirements and accounting for different price developments.

Green financial products promote a company's sustainability performance and target investors and lenders. Companies with higher sustainability performance in their supply chain are considered lower risk – which also lowers their cost of capital and increases the total capital (Gonçalves et al. 2022). New business models for financial service providers emerged in developing countries, such as microfinance (Sim and Prabhu 2017), which provide loans to the most disadvantaged at reasonable conditions (Girabi and Mwakaje 2013) as well as FinTech solutions that facilitate access to capital in remote locations.

2.7 Impact-focused third-party voluntary approaches and instruments

Impact-focused third-party voluntary approaches and instruments are impact-oriented, often non-commercial collaboration offers to supply chain actors. They are voluntary and motivated by improving environmental or social performance. These third-party organisations often target activities that should be adopted on a broader basis without their active involvement.

Issue identification and public scrutiny is a central contribution by watchdog organisations to direct public attention and pressure on sustainability issues in supply chains – often in distant parts of the world (Moosmayer and Davis 2016). Usually, the supply chains outlined in campaigns are well researched, providing a lot of relevant information to buyers and suppliers.

Collaborative multi-stakeholder approaches engage in the development of solutions, often with a focus on specific end-products, commodities, social (including human rights or labour rights) or environmental issues, or world regions (Peng et al. 2022a).

Humanitarian aid and its organisations contribute to the activities on sustainability in supply chains with their long-time presence and relationships with local social structures. The organisation can help in reaching out to and engaging with local citizens, in particular to find solutions for social issues (Wang et al. 2021).

Funding of sustainability development by private foundations intends to help develop the local economy in developing or industrialising countries. While the main purpose is to make the local economy more productive and robust, the increasing sustainability requirements of buyers of some world regions make these considerations important parts of their portfolio of activities.

2.8 Fourth-party enabled voluntary approaches and instruments

Fourth-party enabled voluntary approaches and instruments relate to government action that drives and supports change towards sustainability, triggering or supporting business activities with funding and incentives.

Policy development and advocacy provide frameworks, context and support to business approaches.

Regulatory frameworks and standards refer to standards and guidelines that require global harmonisation or integration into the larger regulatory context.

Financial incentives and support mechanisms are a key tool to steer business and academic action and can lead to public-private partnerships.

Capacity building and technical assistance feature different forms of the creation and the dissemination of new knowledge. Some nations have large economic development organisations that are specialised in knowledge transfer.

Public procurement policies could allow government-owned organisations to direct government orders to suppliers with sustainable supply chains, substantially increasing the market and demand for sustainable products and services.

2.9 Fourth-party enforced compulsory approaches and instruments

Fourth-party enforced compulsory approaches and instruments relate to government action that coerces and enforces change towards sustainability, triggering or supporting business approaches and instruments with power, incentives and penalties.

Incentives and penalties cover a wide range of mechanisms such as preferential business agreements or tariff or tax reductions or penalties such as taxes, fees or penalties.

Legislation, regulatory enforcement and compliance comprises of legal frameworks and laws, their enforcement, and consequences in case of non-compliance.

3 Context factors for cost and benefit sharing

An evaluation of the sharing practices for costs and benefits among the participants in a supply chain from the actual use of the approaches or instruments introduced in Chapter 2, in particular the implementation of actions to protect the environment and the gathering and sharing of data on environmental performance, requires the consideration of context factors that cause their variation observed in practice. Sharing describes the outcome of negotiations between several parties, usually aiming at minimising their respective costs or at maximising their respective benefits – while considering that the definition or perception of costs or benefits is highly subjective, depending on the values and goals of an actor. Context factors can influence the sharing of costs or benefits among the participants in a supply chain, but also their actual magnitude. They consider the specific context of the buyer, the supplier, and the specific relationship of these two parties. Some of these factors relate to the parties themselves, others are external. This chapter briefly introduces some of the major context factors for the implementation and use of the approaches or instruments discussed in Chapter 2.

3.1 Buyer business context

In this report, buyers are organisations in their role of purchasing goods or services. Any commercial organisation is also considered a buyer. This report puts its focus on buyers that are based in industrialised countries. To account for the heterogeneity among these buyers, several context factors help to capture some of the major differences.

3.1.1 Institutional context

Societies set expectations for their members' behaviour in institutions (values, norms and practices) and determine enforcement mechanisms, incentives and penalties. Institutions are deeply rooted in the past, but also under constant development to align with economic, societal or environmental changes (DiMaggio and Powell 1983). They set the limits and rules, and companies need to find a way to work with them. Some of these institutions go into political debates while others find other homes, with implications on their importance or enforcement.

In the OECD countries, recent years have seen a drastic increase in laws and regulation but also common agreements on objectives and strategies to address sustainability issues by increasing the responsibility and liability of economic actors. This government action follows two decades of self-regulation by companies, intensifying societal expectations and political negotiations on different levels (Sarkis et al. 2021). Buyers experience changes in their legal and economic environment, and must adapt accordingly. The rollout and enforcement of laws have a strong influence on the agenda of buyers. International agreements and national laws increasingly connect buyers to suppliers in case of adverse impacts of their action. Societal expectations that are not covered by government laws and regulations may be taken up by other regulating systems – e.g. religious organisations – or remain in the societal conversations.

Public interest in the upstream and downstream stages of supply chains is growing steadily, leading to increasing pressure on buyers to take corrective action (Hartmann and Moeller 2014). This scrutiny is the result of public conversations whose topics, perspectives and scope are gradually evolving. Existing understandings are being challenged and evolving as a result. Civil society organisations, political decisions, academic research, accidents and business scandals highlight the importance of considering upstream and downstream steps in supply chains and how the conventional understanding of the boundaries of business ignores these parts (Marano et al. 2024). This evolution in perspective is reflected accordingly in public policy. However, the traditional understanding also has its proponents who use their agenda to exert influence –

often addressing the role of the consumer, who is also affected by an extension of responsibility and is confronted with unpleasant demands for change. Despite these conflicts, wherever the attention of the general public extends beyond the boundaries of the company, people ask questions, point out risks and are interested in current developments. Public attention can start with a single case, gain momentum and expand to cover entire industries, regions or topics. Buyers can hardly escape public scrutiny, the perceived risks, and the legal implications of these risks being known. The public pressures can limit the individual power of buyers, but can also be deployed by them to strengthen specific supplier requirements.

3.1.2 Industry context

Industry specifics influence both the power of buyers and their attractiveness for suppliers. They consist of similarities among buyers operating in the same regional industry sector (Chen et al. 2017). Some similarities are caused by external factors such as the general public policy environment (e.g. laws, regulations, funding) or public scrutiny, which may vary in intensity or impact depending on the industry. Many industry specificities are rooted in their own business heritage or competition rules and are related to the concept of dominant design: common industry practices, common production technologies, common materials, common sources, common market needs and demands, industry trends, similar strategies or technological developments, skills and capabilities, etc. (Deephouse 1999). Some industries are characterised by an oligopoly situation in which a few large (often powerful) buyers sharing the majority of the market among themselves (concentration), which - alone or together - can influence the rules in the industry. In the opposite case, some industries are characterised by a larger number of smaller buyers, or a combination of both. Power can also result from consolidated action of many buyers, e.g. in the form of buying cooperatives, industry associations or common rules, which often comes at the expense of a lower degree of freedom. The relevance of industry specifics is reflected in the fact that companies are heavily involved in or belong to industry-specific organisations. Buyers tend to increase their power by joining collective approaches.

3.1.3 Sustainability awareness

Buyers differ by their approaches to identifying, interpreting and responding to challenges from actual or potential adverse environmental or social impacts, the respective political conversations, and public scrutiny. Their awareness about sustainability issues is part and result of the various conversations they participate in, which depends on one side on their engagement but also on the conversations taking place – or being available to join - in their realm, and the topics that societies avoid (Bansal et al. 2018).

Buyers' decisions to consider sustainability challenges as risks or as opportunities determines their options (Zeidan and Spitzeck 2015). Many buyers, being related to adverse impacts or requested to extend responsibility, interpret such situations as risks to their established business - which they want to continue - as well as an external imposition of additional costs that customers are unwilling to cover. This perspective leads buyers to optimise on the reduction of risks and the limitation of costs. Collective buyer approaches and requirements for suppliers to cover their expenses for monitoring or development are examples for strategies to reduce risks and costs. In contrast, buyers may interpret sustainability challenges in their supply chain as an area of problems whose resolution can increase their competitive advantage. Their focus is on identifying opportunities to add value. While the definition of cost is specific, the understanding of value requires further definitions – from higher financial profits to business resilience or higher customer loyalty, from short- to long-term perspectives. This perspective leads buyers to optimise the creation of competitive advantage and seek for suppliers that align

with their goals. While collective approaches can be helpful in various areas, individual action and investments - including in business partners and the relationship with them - play the central role for value leadership.

3.1.4 Ownership and financing

Buyers are impacted by the rules, goals and interests of their owners as well as of financial services providers as well as from the heterogeneity among them. A broad range of types and strategies exists for owners and investors, with their respective impact on this company's strategy and behaviour. The degree to which owners emphasise on financial risks and financial returns defines a company's degrees of freedom in taking action and reporting on sustainability in its supply chain. For publicly traded companies, expectations on rents, business development perspectives as well as business risks are conventional aspects in company analysis (Zeidan and Spitzeck 2015). Family-owned businesses tend to be less focused on short-term rents but on long-term value, often structured to level out profit and loss over extended periods (Sharma and Sharma 2021). Some owners value ethical conduct, pay high attention to sustainability, elevated it to a central element of corporate strategy and assigned capital for the required changes – with the willingness to wait for returns (salient capital). Other owners continue to ignore sustainability and insist on short-term profits. With capital markets being subject to increasing regulation and a rise in active investors, more owners require their senior management to implement more sustainable business models and strategies for their companies (Velte 2023).. Various business needs require buyers to engage with banks and insurances, who are particularly interested in the risks of the potential business. Increasingly, financial service providers also consider sustainability aspects as they have come under public scrutiny regarding the companies or business project they fund, and the conditions they provide (Galletta and Mazzù 2023). Capital and financial markets differ by world region, enabling large buyers more simple access.

3.1.5 Corporate strategy and structure

Buyers' fundamental strategic positioning defines in which areas they have degrees of freedom, and where they lack alternatives (Argyres and McGahan 2002). Strategic positioning is fairly constant since companies and their partners need to remain clear about who they are, what purpose they intend to serve, or how they want to make and provide their goods and services. Generic strategic choices are cost leadership versus differentiation. To safeguard their competitive advantage, buyers taking a cost leadership position strive for lowest costs and highest efficiency, while differentiators compete with their ability to provide unique solutions to their customers at extra efforts. Buyers who position themselves as cost leaders target large markets to satisfy standard demand and drive customers to frequent substitutes with low selling prices. The low cost from high productivity, scale effects, or standardisation are essential and need to be reflected in each of the sub-strategies of functional departments such as sales, production, R&D, or procurement. Sustainability issues need to be addressed in a way that safeguards the level playing field. Differentiators require the ability to realise individual solutions for customer which depends on collaboration, innovativeness, and customer specific designs – which also need to be broken down into corporate and department strategies. When customers value solutions to sustainability issues, buyers are motivated to leave the level playing field and realise unique solutions (Cavaleri and Shabana 2018).

Companies' make-or-buy decisions determine the activities that are run within the company, and consequently what goods and services are sourced from and run by externals – and under which conditions. They further define how much and what control the buyer has over specific

activities, and acknowledge that for all other parts the buyer has little to no influence. Some companies actively engage in determining their supply chain and the levers they have, while others outsource problematic activities from opaque paths in their supply chains (Surroca et al. 2013; Berry et al. 2021).

3.1.6 Procurement strategy and structure

Procurement is the business function that is responsible for the establishment and the maintenance of a company's relationships with suppliers and sourcing markets. Procurement matches the needs and requirements from internal users – for the case of materials this could be the production department – with supplier offers, and optimises internal commercial interests. A procurement strategy is derived from the buyer's corporate strategy, to ensure contribution to the corporate objectives. However, the last decades have been determined by extraordinary focus on purchasing price reductions, also for many companies that were strategically positioned as differentiators. This created a profession – across companies – that defined itself primarily by its ability to reduce purchasing prices (Murfield et al. 2021). Many companies appreciated or were forced to realise these cost reductions, and nourished this development with incentive systems that ignore or devalue other objectives (e.g. quality, availability, sustainability). To take care of these other responsibilities, separate organisational entities (e.g. sustainable procurement) were established – separating the buyer's negotiations with suppliers on price from those on sustainability. Such structures and objectives limit a buyer's ability to influence or collaborate with suppliers beyond the negotiation of the price. Some companies now reorganise their procurement strategy and structure (Schulze and Bals 2020). They incorporate conflicting targets into one mandate, for the respective manager to find solutions that are balanced among their different targets and responsibilities, and provide internal expertise to procurement managers on those targets and responsibilities they are less familiar with. In particular buyers positioned as differentiators present procurement's new way of contribution to the company as value creation, identifying, developing and deploying suppliers' capabilities to the benefit of the buyer – focusing on yield instead of costs. The recent increase in supply chain issues – from supply interruptions to price volatility – nourished broad conversations about the necessity or importance of supply chain resilience. The key elements to resilience – e.g. long-term horizon, benevolence, or trust – require buyers to give up some of their conventional opportunistic practices and lower their expectations on short-term profits (Pettit et al. 2019).This triggers further structural changes, such as more comprehensive approaches to accounting and financial controlling – replacing isolated optimisations within departments with models that capture the entire company over a longer period of time. Such organisational developments change the nature of the negotiations with suppliers, enabling negotiations that consider the many aspects that determine solutions of sustainability issues with suppliers.

3.1.7 Skills and resources

The rise in sustainability issues and demands requires buyers to respond with the establishment of new mandates and organisational entities. In the past, sustainability roles were often added on top of the existing structure to limit organisational changes – or sourced from consultants. Their focus was set on identifying the major challenges, managing stakeholder expectations, and on reporting (Kolk and Pinkse 2007). With increasing need to change business practices, buyers need to change structures and practices in their conventional business functions (Sroufe 2017). However, the respective professionals are often insufficiently skilled to address sustainability concerns and cannot be expected to fulfil their new mandate. When consultant mandates are focused on specific issues, they tend to emphasise short-term solutions that downplay the need

for profound development of skills and resources. For companies running on high efficiency levels, limited organisational slack slows down training and organisational adaptations. Skills development may be limited to companies with sufficient wealth or margin. Limited skills and resources weaken buyers to realise their objectives (Reuter et al. 2010; Schulze and Bals 2020).

3.1.8 Company specificities

Typical company specificities that impact negotiation power of buyers (Meehan and Wright 2012; Touboulic et al. 2014; Um and Oh 2020)) – and thus directly impact both a buyer's ability to influence sustainability practices in their upstream supply chains as well as the sharing of costs or benefits from sustainable supply chain management (SSCM) approaches and instruments – are for example company size or wealth, market share, transaction volume, intellectual property protection, or business partner-specific investments.

3.2 Supplier business context

In this report, suppliers are organisations in their role of selling goods or services. Any commercial organisation is in the role of a supplier, selling to its customers. This report puts its focus on suppliers with which buyers have a contractual relationship, but also considers sub-suppliers and sub-contractors which are understood as the suppliers of goods or services to a buyer's suppliers – extending the consideration upstream in supply chains. Since many buyers in industrialised countries source from a large number of different suppliers, several context factors help to capture some of the major differences. Since most of the factors explained above for buyers that are headquartered in industrialised countries applies to suppliers that are headquartered in industrialised countries, too, in a comparable way, this sub-chapter focuses on context factors that may apply for suppliers (and sub-suppliers) located in developing and industrialising countries (Ruamsook et al. 2007).

3.2.1 Institutional context

Many developing and industrialising countries are criticised for their institutional system when sustainability issues occur or persist in their jurisdiction (Doh et al. 2017). Typical concerns relate to government laws and regulations but also to rules, values or norms of ethnicities, religious groups or tribes (Ndulu 2006). Further concerns address varying enforcement of institutions, favouring some groups or punishing others, corruption, or lack of transparency that may disadvantage parts of the society. Government services may not cover the needs of citizens or companies, from logistics infrastructure or social security to banking or education. In consequence, in these locations suppliers as well as their employees need to invest a part of their capacity into managing their risks. This reduces productivity and limits dedication to professional development. In consequence, the institutional context can weaken suppliers in their negotiations with buyers.

3.2.2 Industry context / GVC context

Buyers' price pressures on suppliers, their requests for innovation, their strategies to limit the number of direct suppliers, or their attempts to transfer business risks to upstream suppliers urge suppliers to find ways that allow them to defend their interest. To gain power or stay in business, suppliers consolidate into larger companies (Hu et al. 2023) or organise in cooperatives, export agencies or industry organisations. Regional industries who missed to do so experience dominant foreign traders to position themselves as the channelling link between the local suppliers and the buyer – at a loss of their original margin. Production capacities in upstream supply chains consolidated for specific goods. Further upstream, concentration

continues to be a strong trend in some sectors (Sexton and Xia 2018), fuelling the establishment of cooperatives to channel supply from traditional smallholder structures. In some sectors and tier levels, some suppliers or sub-suppliers have become so powerful because of their hard-to-substitute market share, that they can dictate conditions or ignore customer requests (Staritz et al. 2023). However, a large number of sub-suppliers missed to upgrade and find themselves in further increased distance to the buyers. This distance shields their potentially unsustainable business practices from the buyer. It is in upstream supply chain steps of sub-suppliers where sustainability issues continue to occur, well shielded from buyers (Villena and Gioia 2018).

3.2.3 Sustainability awareness

Societies in many developing and industrialising countries need to address concerns of poverty or survival, giving economic considerations more weight than sustainability considerations. At the same time, these societies tend to be closely related to nature and struggle under the current adverse impacts. People experience the problems first hand, but many lack concrete support in establishing solutions. When people don't see a potential for resolution, the problematic situation can get accepted as normal (Barbier and Hochard 2018), accepting such conditions also in other trade relationships (Meng et al. 2018). Buyers can bring up environmental or social concerns to suppliers, contributing to a growing sustainability awareness in these societies. However, when buyer requests focus on suppliers' sustainability certifications, conversations often revolve around the seriousness of buyers, the compatibility and costs of these certificates, and what business they may exclude - distracting from the actual purpose of improving social and environmental impact. Experiences with buyers, who force suppliers into performance assessments but do not engage in improving the identified situation, contribute to cynicism, lethargy or indifference (Gonzalez-Padron 2016).

3.2.4 Ownership and capital

A main concern of suppliers in developing and industrialising countries is access to capital and financing and the conditions for interest and amortisation (UN Inter-agency Task Force on Financing for Development 2022). Intransparency and limited budgets are key concerns for lenders. Lack of registration of companies or information about customer relationships, make it difficult for banks to assess the credit worthiness and derive the right interest rate. If suppliers get a loan, they are often under high pressure to generate the extra financial returns needed to cover interests and amortisation – potentially compromising on sustainability concerns.

3.2.5 Corporate strategy and structure

Following the dominant paradigm in procurement of buyers to focus on a continuing reduction of purchasing prices, suppliers in developing and industrialising countries tend to use price leadership as the most promising strategy to continue and benefit from the business relationship. This strategy requires the supplier to decide on the activities worthy enough to continue inhouse, and what activities to source (make-or-buy) from upstream sub-suppliers or what to share with sub-contractor for additional capacity (Labowitz and Baumann-Pauly 2015). Suppliers with high heterogeneity among their customers usually face pressures to comply with different sustainability requirements or certifications (Montiel et al. 2019). Cost considerations but also lack of alignment of requirements make it impossible for suppliers to adhere to all requests, and instead give priority to the requests of a portfolio of customer with similar requirements (Prado and Woodside 2015). In consequence, such decisions can cut important business for the supplier for which alternatives need to be established with customer with similar or no sustainability requirements. Request for specific sustainability requirements or

certifications partially weaken suppliers' power, since such decisions exclude suppliers in markets with other requirements and increase dependence on a smaller number of customers.

3.2.6 Sales strategy and structure

Suppliers' sales strategy concern in particular how directly they interact with the users of their products or services. Direct transactions avoid fees or margins by middlemen, give suppliers access to information about buyers' needs and wants and thus enables them to adapt their offer for higher customer value, or allows to address adverse impacts. However, limited supplier capacity may limit the buyer's interest in a direct relationship. When suppliers are certified, they offer added value but need to adapt their practices to fulfil the certification standards, cover the cost for certification or membership, and face higher logistics cost for the chain of custody of the certifying organisation (Prado and Woodside 2015).

3.2.7 Skills and resources

The buyer attention on suppliers' sustainability issues requires suppliers to develop deeper understanding of buyer requirements, their own structures and practices that may lead to such problems and their options for corrective action (UNIDO 2024). Suppliers require skills and experiences in understanding buyers' sustainability requirements, often specified in codes of conduct, the terms and condition of contracts or by auditors, but also buyer's motivations and goals to better align their strategies. Handling buyers' auditing requirements as well as accompanying the audits require specific skills – not only to ensure better audit quality, but also for the supplier to protect against unintended consequences. Monitoring and corrective actions cause costs that suppliers need to be able to fund, requiring skills to develop realistic business models that ensure future competitiveness, correct monitoring and business practices that meet the sustainability requirements. This is particularly important for suppliers with low profitability or wealth. Suppliers, who cannot imagine how to meet mandatory buyer requirements, – in particular if they depend on this business – are in a very weak position in the negotiations with buyers.

3.2.8 Company specificities

Similar to the buyer, typical company specificities that impact negotiation power are company size, wealth, market share, transaction volume, intellectual property protection, or business partner-specific investments.

3.3 Relationship-defining factors

The nature of their relationship sets the stage for negotiations between buyers and supplier. The following discusses the major factors in the context of sustainable supply chains.

3.3.1 Power and dependence in buyer-supplier relationships

Power describes one party's ability to affect and control another party's intention, decisions, behaviour and actions. Such influence can be taken in a coercive or confrontative way against the other party's will and deploy threats such as penalty costs or loss of business (Cox 2001). However, a party can also influence the other party in other ways: indirectly by impacting third parties that relate with the other party or by positively engaging with the other party. Dependence of one party on the other refers to this party's degrees of freedom determined by consequences it experiences from the other party's reaction or the potential losses of previous investments (sunk cost). In case of dependence, misuse of power can harm the outcome for the powerful party, limiting the benefit of coercion. Relevant for the outcome in one-to-one

relationships is the difference in power between the two parties: symmetric power when the gradient is zero and asymmetric power for actual differences. Buyer or supplier dominance are situations that enable the more powerful party to increase or even maximise its benefits and tolerate or even accept harming (i.e. power abuse) the other party. In situations of symmetric power, dependence determines parties' interest in engaging in developing mutual agreements. Strong interdependence makes the case to invest into a balanced relationship while independence suggests arms' length relationship. Public conversations revolve much around the use of coercive power in asymmetric power situations. On the one hand, powerful parties are accused of power abuse against weak suppliers, and on the other hand, they are requested to use their power to enforce suppliers to change some of their business practices or elements of their business model. Although coercion appears as an efficient, straight forward solution, it creates resistance by the affected party. The distribution of power in supply chains requires nuanced analysis: powerful players are found at many steps in supply chains – e.g. in mining, commodity trading, production, logistics, retailing - and their sources of power differ (from market dominance to national interests); dependencies are influenced by factors such as required volumes, protected intellectual property, joint investments, buyer-specific products, technological or administrative capabilities, centralised production capacity, location etc. which apply independent of the position in the supply chain. Companies headquartered in industrialised countries tend to be more powerful and benefit from higher buyer dependence than companies in developing or industrialising countries, yet in some sectors this situation may change. Companies that are unrecognised by the public are more involved in power abuse – both as unobserved abuser or as unseen victim – also in industrialised countries (Schleper, M.C., Blome, C. & Wuttke, D.A. 2017).

3.3.2 Governance in buyer-supplier relationships

Governance in supply chains is based on contractual and relational mechanisms (Cao and Lumineau 2015). Contractual mechanisms include formal contracts, processes, monitoring, unilateral investments in assets, or short-term gains. Relational mechanisms are trust, mutual commitment, transparency or shared knowledge. The procurement strategies and practices of buyers have caused an increase in arm's length relationships – when two parties are unrelated and unaffiliated from one another - that are governed with contractual mechanisms (Sluis and Giovanni 2016). These mechanisms target independence from suppliers, allowing buyers to threaten suppliers in negotiations with loss of business but also to benefit from better offers of different supplier. While they allow the buyer to continuously adjust purchasing prices, the transactions costs caused by contractual mechanisms suffer – often hidden in general expenses (Friedl and Wagner 2012). Relational mechanisms rely on interactions and experiences between the parties that reduce the required governance efforts but come at the expense of higher dependence. Trust is based on a party's experience if the other party complies with joint agreements, but is also affected by experiences made with other parties or reports from third parties (Chen and Lewis 2024). Commitment and benevolent behaviour relate to the level of experienced opportunism by or support from the other party. All three require a track record of experiences over a period of time, implying a continuous business relationship between the buyer and the supplier. Suppliers in developing or industrialising countries often supply goods that are also offered by or can be alternatively sourced from other suppliers. In such relationships with short contract durations, suppliers may experience adverse impacts by the buyer, little active interest in their development, coercive requests to invest into sustainability improvements. Combined with societal believes based on historical experiences from trade with the societies of the buyers, the trust of suppliers in developing or industrialising countries into

buyers from industrialised countries can be low. In consequence, both parties focus on contractual governance – with the side effect of creating extra transaction costs.

3.3.3 Distance in buyer-supplier relationships

Distance addresses the differences between the parties in business relationships (Ghemawat 2001). Differences require active coordination to ensure aligned action and efficiency but also to avoid expectations that would put the other party a risk. An established concept for distance between organisations is the CAGE framework that differentiates between cultural, administrative, geographic and economic distance.

Cultural distance refers to differences in languages and institutions. As language determines a unique, specific perspective and way of experiencing and explaining the perceived, parties unfamiliar with the other's language risk misunderstandings beyond errors in the translation of documents. Differences in communication or problem solution habits require approaches that cater to both parties. Institutional differences point to differences in values, norms, rules and practices between the two parties, requiring to negotiate and control matters that two parties sharing the same institution could take for granted.

Administrative distance refers to differences in organisational structures, processes, formats, or formal confirmations – or barriers to interoperability - between two parties. Such differences imply either necessary adjustments by one or both parties or require additional efforts to bridge the gap. The existence of similarly structured mandates allows efficient processes and problem solution. Administrative distance also covers the amount of intermediate entities that ultimately connect the two negotiating parties once in operations.

Geographic distance covers the distance between the locations of the two parties. Aspects are the physical distance, but also the difficulties encountered or efforts needed to travel from one location to the other. Geographic distance also points to differences in time zones, seasons, holidays or climate.

Economic distance describes differences between two parties on economic factors. Differences in company size suggest different needs on volume or scale, but also to the rigidity of processes, structures or objectives. Differences in strategic positioning or business models point to misalignments of interests and objectives. Differences in wealth or profitability describe challenges in the partners' ability to fund investments or go through tough times. Differences in perceptions by financial markets indicate that one partner faces higher difficulties in accessing external capital or needs to deal with unfavourable lending conditions – which the other partner may not understand when requesting changes or making recommendations.

4 Cost-benefit sharing in use per business approach and instrument

This chapter discusses current business practices that utilise the major approaches and instruments of sustainable supply chain management (SSCM) (introduced in Chapter 2) to share costs and benefits among buyers, suppliers, and third parties. It assesses how the use of these instruments and approaches contributes to a fair sharing of the costs and benefits for environmental protection and other sustainability goals, considering the actual context (see Chapter 3).

The chapter's first section addresses the actors' objectives with and, relatedly, the benefits from, the cost of, the perceived barriers and drivers for, and the perceived fairness of the distribution of costs and benefits. The following sections provide a generalised overview of the business practices that rely on SSCM, first for the context of focal companies with a coercive strategy, and then for the context of focal companies with a cooperative strategy.

4.1 General considerations

There are fundamental debates and disagreements in society, politics and business about the costs and benefits of improving the environmental or social performance of companies and their supply chains. Proponents and opponents take different perspectives or evaluation schemes when their arguments relate to assessments or expectations that point in various directions. Such differences concern, for example, the purpose of business (shareholder versus stakeholder focus, Clifton and Amran 2011), the evaluation period (short-term versus long-term, Slawinski and Bansal 2015), the kind of costs or benefits (investment versus operating expenses, or financial versus non-financial), or the factors used to translate between non-financial and financial values (Dossi and Patelli 2010). To enable companies to evaluate and compare their costs and benefits with those of other organisations, it would be necessary to use the same perspective and approaches.

Buyers and suppliers pursue strategic objectives when they use practices for sharing the costs and benefits of SSCM. Any use needs to help achieve these strategic objectives, directly or indirectly. One key consideration is where a company draws the boundaries for optimisation – from strictly within its legal boundaries (e.g. own operations) to considering the broader ecosystem (i.e. the whole value chain, as outlined in the UN Guiding Principles on Business and Human Rights (UN 2011).

The interests and objectives that buyers pursue through increased engagement in SSCM have received broad attention in academic research. Just as a supply chain strategy is derived from corporate strategy, the reasons for engagement in sustainability are in line or aligned with corporate purpose and objectives. One key differentiator between typical corporate strategies is whether a company is profit-focused (Schleper et al. 2022) or purpose-focused (Lee et al. 2023a), with the first being concerned about short-term financial results and the latter (often e.g. B Corp organisations or family firms) with the eventual contribution to their purpose. Key objectives for SSCM discussed in the literature include, in particular, legal compliance (Baier et al. 2020), risk mitigation (Gouda and Saranga 2018), financial performance (Wang and Sarkis 2013), economic performance (Busse 2016), supply chain resilience (Eggert and Hartmann 2023), and competitive advantage (Markley and Davis 2007). The economic, environmental or social development of suppliers or sub-suppliers is not a conventional buyer objective (UNIDO 2024) and the role of buyers in a just transition is also not clearly defined (Karaosman et al. 2024).

The interests and objectives that suppliers pursue through increased compliance with their customers' requirements for SSCM can be broadly summarised using conventional considerations. The heterogeneity among suppliers of different industries, world regions, size, ownership etc. makes it difficult for research to draw a comprehensive picture. Suppliers need to ensure legal compliance, secure long-term availability of the required input factors, increase their competitiveness in terms of pricing and range (including aspects that enable their customers to confirm legal compliance, e.g. by providing certified data), and align with customer requirements – taking into account the possibility that some suppliers may have the opportunity to switch to customers with requirements that better suit them (UNIDO 2024).

The interests and objectives that third parties pursue through offering services for SSCM appear to be split into the two groups of third parties introduced in Chapter 2 (see Figure 1): profit-focused versus impact-focused organisations. The first (e.g. auditing services, data services, analysts, consultants, investors, banks, or trade exchanges), enable buyers or suppliers to better achieve their objectives, which justifies their cost; the latter (e.g. non-government organisations or private funds) engage in activities that buyers or suppliers are not willing or able to pay for (e.g. ensuring the rights of rightsholders).

The benefits that organisations aspire to achieve from using business approaches and instruments of SSCM relate to these strategic objectives. The outcomes of the use of such business approaches and instruments can be positive – in the actual sense of benefit – or negative – in the actual sense of damage (Schleper et al. 2022). They may even combine both outcomes by generating benefits for some and damages for others. The following discusses two key dimensions related to the scope of benefits: the time horizon and the evaluation system.

Time, a key aspect in the sustainability discussion (Slawinski and Bansal 2015), is operationalised by a defined horizon until the point at which the desired benefits are realised: from immediate effects to benefits that develop slowly. In the context of sustainable supply chains where the performance of suppliers and sub-suppliers is in focus, the duration of buyer-supplier relationships and the duration of contracts plays a key role. Many cost-reduction strategies in procurement advocate for frequent price negotiations enabled by short contract times. In such a context, longer time horizons are often limited to strategic suppliers or to activities that engage with entire industries or regions.

Enabling recognition of the potentially broad range of benefits requires the existence and use of a defined multi-dimensional evaluation system. Strategic objectives need to be translated into operative aspects that can be measured and compared with the ambitions. Such measurement focuses on specific dimensions that are difficult to compare. Some dimensions are of a financial nature while many others are non-monetary and may be hard to translate into financial equivalents. Dimensions also differ in terms of the importance that companies attribute to them. This dilemma of many dimensions that are difficult to compare and differing evaluation systems is particularly challenging in SSCM, with its many actors and their respective tactics. Research has linked the various direct (often rather operational) outcomes of SSCM t practices with corporate (often rather strategic) objectives (Ambec and Lanoie 2008; McCarthy and Marshall 2015). Yet, the positive effects identified in the research seem to still face scepticism in business practice.

The costs to organisations related to using business approaches and instruments of SSCM (in the sense of input factors) relate to three phases: the development and establishment of these approaches and instruments, their use, and potential follow-up activities to realise the targeted sustainability performance. Costs comprise investments (one-time expenditures) and operational expenses (reoccurring expenditures). Costs for the use of such business approaches

and instruments may differ among the various actors; some facing higher additional expenditures, while others may even lower their expenses when the approaches or instruments reduce the need for input factors (King and Lenox 2001). Associated with cost is the allocation of limited resources, as well as a company's or a nation's ability to invest or cover higher operational expenses (Leal Filho et al. 2021).

There seems to be no consensus on what costs are considered necessary or legitimate to calculate the true total cost of SSCM. Expenses can be made explicit, kept covered in aggregates (e.g. as part of overheads), or even ignored (e.g. not relating employee sick days to causes). Cost transparency makes people aware of efforts. Attracting the interest of decision makers can be considered a potential threat to new initiatives, making cost intransparency important to securing the use of certain business approaches or instruments. The contributions of various actors are not necessarily evaluated the same way, requiring a higher workload for some or ensuring that specific resources remain available at no cost for some actors (i.e. socialisation of costs, Bezin and Ponthière 2019).

In particular in industries with high price pressure, companies fear situations that would "exclusively" require them, but not their competitors, to bear increased costs. To avoid such competitive disadvantages, they consequently argue for the need of establishing a level playing field (e.g. government regulation, industry standards or industry initiatives). Companies that bear extra costs are eager to ensure that competitors are required to invest the same amounts or that competitors do not benefit from their specific efforts, in this way safeguarding their investments or expenses – in particular if investments are made into legally independent organisations (Jap and Ganesan 2000).

Research on actors' perception of barriers or drivers to engage in SSCM suggests that many companies – i.e. buyers as well as suppliers – lack awareness of benefits but also lack knowledge about the actual cost implications (Sajjad et al. 2015; Menon and Ravi 2021). These findings suggest that this limited knowledge about both costs and benefits, including realistic expectations and actual transparency, hinders informed conversations about or negotiations on the sharing of costs and benefits.

This lack of clarity about the costs and benefits can lead to a perception among companies that distributive fairness[1] is not sufficiently guaranteed. Accordingly, this limits their motivation to invest in compliance with the requirements of their business partners. Some companies respond by focusing on their own costs and benefits and apply a coercive strategy to their business partners; this ignores the partners' costs and benefits – or aims to further increase benefits at the expense of the partners. In a collaborative setting, buyers and suppliers optimise beyond the boundaries of their respective organisations on shared objectives, considering the effects on the other parties involved. For the purpose of illustration, two extreme strategies will be discussed. In practice, a company may use less extreme forms, and may use different strategies for different supply chains.

4.2 Coercion strategy

The guiding principles of a coercion strategy are self-interest, efficiency, and forced changes to supplier practices that serve primarily the buyer's plans and objectives (building on Zhang et al. 2020). A focal company identifies specific opportunities in or threats to its supply chain, determines the means by which business partners must adopt and comply, and forces them to implement these changes. By using a coercive strategy, focal companies can limit change and

[1] Distributive fairness is a perception of equity in a relationship comparing output over input of both partners (Corsten et al. 2005).

costs within their organisation by achieving the targets (and benefits) through the changes implemented by their business partners in the supply chain and their industry (Clarke and Boersma 2017; Schleper et al. 2022).

Coercion strategies assume clear roles between the buyer and the supplier. The buyer provides specifications and tools to control compliance with these specifications. The supplier is responsible for meeting customer requirements, which includes the development and the maintenance of the required performance level. When sustainability requirements are not considered to add competitive advantage, collective approaches to sharing costs with companies that have similar needs during the development and establishing stage have become common. The logic in coercion strategies considers suppliers (and sub-suppliers) to be responsible for meeting the focal company's (customer) requirements and to bear the costs both for the use of the approaches and instruments and for the corrective action (investment or higher operational expenses).

Coercion strategies require power over business partners. The use of collective approaches and instruments (see Chapter 2.2) allows focal companies (buyers) to benefit from their combined scale and power. Often organisations (e.g. voluntary sector initiatives) have been established to run these collective approaches and instruments for its members, allowing focal companies to outsource these activities and reduce their internal efforts and costs by sharing with other users. However, this practice limits the focal company's understanding of the sustainability issues in the supply chain.

The following section discusses the use of approaches and instruments for SSCM in coercion strategies, and the practices of sharing costs and benefits.

For the definition of sustainability targets and standards in their supply chains, the use of well-established codes of conduct offered by collectives (such as industry associations, sustainability initiatives, multi-stakeholder initiatives (MSIs) or third parties) is a relatively cheap and broadly accepted solution (Haffar and Searcy 2018). Companies facing similar challenges benefit from a pre-competitive matter and share cost. It is unclear, however, if and how the organisation in charge of determining the standards has assessed how supply chain actors could achieve compliance with these standards, and at what cost. This step has major implications for which sustainability challenges receive more attention, but also for the magnitude of total cost and the cost sharing.

The public requests for increases in supply chain transparency are challenging for companies that consider suppliers as responsible for their respective supply chain path, since they rely on the disclosure and the knowledge of suppliers – who, in a hostile business relationship, have limited interest in lowering their negotiation power by reducing information asymmetries (Grimm et al. 2016). The ones answering are predominantly weak suppliers who often lack the resources to understand their supply chain. As a result, companies use alternative (indirect) approaches to increase their understanding of upstream supply chains and invest into commercial services of third parties that provide the approximations or benefit from information provided by government agencies (Jungmichel et al. 2017; for in depth analyses of certain industries see also Weiss et al. 2022; Grüning et al. 2023a; Grüning et al. 2023b; Grüning et al. 2024d; Grüning et al. 2024b; Grüning et al. 2024c; Grüning et al. 2024a) or the civil society.

In the same sense, companies with a coercive mindset for SSCM seem to prefer staying out of direct contact with sub-suppliers, leaving the part of the supply chain with which they have no contractual relationships to their suppliers (Tachizawa and Wong 2014). Engagement appears to be limited to the nomination of sub-suppliers, yet the effects still require broader investigation, both on costs and benefits.

The coercive mindset corresponds well with the practices of influencing governments to take leadership in improving issues in upstream supply chains. With governments taking over, these challenges lose relevance for a focal company with minimum competitive cost disadvantages. The burden then lies with all the businesses in an industry and with the government and any potential price increases level out in competition. While large companies often maintain contacts with governments, the interests of small and medium sized buyers are usually advocated by their industry associations. The efforts needed for lobbying have not received attention in the research. However, government regulation causes administrative costs and may enforce changes that are costly for suppliers – and still lack the desired effect (Salminen 2018).

Improving sustainability by procuring material that is certified based on specific sustainability criteria is a costly approach for buyers that may harm a company's competitiveness against businesses that do not buy certified materials. For various goods, in particular for raw materials, some of the largest companies (buyers) seem to identify the same certifications in their procurement specifications, potentially making these certifications a quasi-mandatory standard, with the increased price for certified materials becoming the industry's reference price. There are consulting services and government-funded websites (e.g. www.standardsmap.org) that make the market of certifications more transparent to users. The actual implications of increased operation costs on focal companies' performance appear heterogeneous. The high volumes realised by quasi-mandatory industry standardisation limit the cost increases with scale effects. The benefits for buyers and suppliers are broadly considered to be realised (Krumbiegel et al. 2018).

Supplier selection and negotiations in a coercive setting appear to address sustainability concerns predominantly after commercial matters have been defined. This two-step approach in procurement has long been criticised as not paying the necessary attention to sustainability and ignoring the need to include corrective action during contracting (Meehan and Bryde 2011). This separation allows the continued use of conventional purchasing practices, but weakens the focal company's ability to drive changes in supplier sustainability. The moderate improvements in supply chain sustainability may suggest that this dominant procurement practice is particularly effective in realising commercial objectives only. The emergence of exchange and trading platforms for sustainable goods appear to allow focal companies to keep their procurement practices, but have better access to suppliers that already meet the sustainability requirements.

In a coercive mindset, powerful buyers are motivated to use contracts to transfer risks or costs to the weaker contractual partner, to enforce compliance with the threat of penalties, or to ensure participation in realised benefits. A clear written contract makes expectations as well as consequences in case of performance gaps explicit (Ciliberti et al. 2011). The major concern about the cost related to contracts is not the contracting, but the consequences of the deal they regulate. Since buyers can take substantial financial benefit from opaque contractual agreements in power asymmetries, the costs of change are not transparent. Furthermore, in cross-cultural buyer-supplier relationships, interpretations of contracts vary, which leads to different perceptions in distributional fairness (Roehrich et al. 2024).

Focal companies mainly use monitoring approaches to identify the problematic business practices of supply chain partners. While it does limit costs for the focal company (compared to running and analysing a supplier survey), one challenge of the supplier self-assessment is that supplier performance data may be inaccurate due to the lack of control (or neutrality). The most common approach nowadays is the use of third-party auditing, in which a neutral third party is commissioned with the actual data generation (Short and Toffel 2015). In a coercive strategy, focal companies can push most of the efforts of third-party audits to suppliers: the powerful

buyer requires its suppliers to provide audit reports that follow a defined auditing system. Consequently, suppliers need to contract and pay a specified third party to run an audit. Suppliers can share their audit reports with any party they want, and are encouraged to also make it available in audit databases (e.g. Business Social Compliance Initiative (BSCI) for trade, Sedex or Ecovadis), which buyers can access for a fee. This can be beneficial for suppliers, as proof of third-party audited sustainability performance can lead to access to new customers or financing opportunities. Nevertheless, this setup eliminates the majority of auditing costs for the focal company by pushing it on to suppliers, and provides focal firms access to audit reports that suppliers made at the request of other companies. While focal firms face only few costs for auditing, it can be assumed that the suppliers try to include the extra expenses for the audits into the product prices (Short et al. 2016). In a coercive mindset, the focal company threatens suppliers with penalties – or even with ending the contractual relationship – if audit reports show non-compliance with their sustainability requirements. The sharing of audit reports with other business partners can put suppliers under pressure to achieve certain sustainability performance levels just to avoid a decline in business. This threat and the fact that they are the customers of auditing service providers are seen as causes for inaccuracies in auditing (Dogui et al. 2014). While weak suppliers have no alternative other than to engage in this business practice, powerful suppliers (e.g. vertically integrated facilities/composite units) can opt out. Suppliers participating in third-party auditing systems cover the majority of the auditing costs in supply chains, while the majority of the benefit (identification of suppliers with critically low sustainability performance) goes to the buyer.

Following up on audit reports is called corrective action. Lifting supplier sustainability performance up to the required level requires a combination of supplier capacity building and changes to key elements of the supplier's business context (UNIDO 2024). In a coercive setting, focal companies expect suppliers to find their own ways to improve – from hiring consulting services to investing in new technologies – and may follow up only in the next round of audit when a performance improvement is expected. Like in the case of auditing, in this setting the costs for corrective action need to be covered by the supplier – which ensures that the focal company has no financial commitments that would limit their degrees of freedom in future price negotiations. The lack of longer-term commitment to many of their suppliers makes it difficult for them to create a business case that is sufficiently reliable for banks to finance such transitions at affordable rates. The safeguarding of supplier specific investments is a key concern to buyers (Wagner and Bode 2014). This setup coerces weak suppliers to implement change at their own expense – often beyond their financial ability – and without clear incentives[2]. Suppliers participating in such systems cover the majority of the costs for sustainability in supply chains, while the majority of the benefit goes to the buyer.

A straightforward way of solving sustainability issues in the supply chain is to substitute non-compliant suppliers or sub-suppliers with compliant ones, or to eliminate problematic materials or processes by redesigning products or substituting with safer alternatives (e.g. chemicals). The substitution of supply chain actors is primarily a question of dependence and of access to the respective company. Terminating a supplier relationship at short notice is a difficult and often costly disruption to supply chains, and only makes sense if the alternative suppliers contribute to a major improvement (Friedl and Wagner 2012). In case of dependencies on a supplier, the focal company may need to develop a company up to the level of the current supplier. With regard to sub-suppliers, focal companies have no contractual relationships that could be

[2] It is unclear if audit reports showing high levels of compliance with sustainability requirements of buyers allow a supplier to grow its business. Considering that in the procurement processes of many focal companies, sustainability only plays a limited role for supplier selection, it is unclear if suppliers are actually rewarded with increasing business if their audit reports show high levels of compliance with certain sustainability standards.

terminated from their side. Instead, they depend on their suppliers to terminate their contract with the respective sub-supplier (Hofstetter 2018). For the supplier, this may be a decision between continuing business with the focal company and causing changes to all other clients, internal operations and other suppliers, or staying with the sub-supplier and potentially substituting the business with the focal company with another customer. In terms of substituting materials or processes, low shares of internal value-added make it likely that the decision on materials or production processes is taken by suppliers or sub-suppliers and not by the focal company. In such a case, the supplier takes the full risk caused by a fundamental design change. If the supplier has several customers for the same goods, any changes require consent from all customers. A coercive mindset quickly reaches limits in substituting supply chain actors, materials or processes.

Overall, the approaches and tools that are available to focal companies to support a coercive strategy in SSCM are limited. However, many of these approaches and tools are strongly applied by focal companies in practice. When focal companies focus on increasing benefits for themselves only, powerful business partners counter with tactics that serve to benefit them instead. Weak suppliers, however, suffer in such a context. Constant pressure from their customer leaves them little capacity to change their situation. This pressure makes it also difficult for them to get access to and benefit from the services (i.e. the use of their approaches and tools such as finance) offered by profit-focused third parties.

4.3 Collaboration strategy

The guiding principles of a collaboration strategy are shared interest, effectiveness, and aligned, co-developed changes in the practices of both the focal firm and other supply chain actors (building on Zhang et al. 2020). The focal firm identifies specific opportunities in or threats to its supply chain together with supply chain partners, and works with them to come up with and implement changes. This way, the focal firm and the supply chain partners can revise processes in their respective organisations while sharing the related costs and benefits (Reuter et al. 2010).

Collaboration strategies build upon the interconnectedness of supply chain actors. Although the buyer has a lead function, the definition of the sustainability requirements and targets is the result of interaction among various supply chain actors. These parties – including the buyer – are responsible for meeting the jointly defined requirements and targets by developing and maintaining the required performance level. Civil society organisations may contribute their insights as well, often triggered by the hope that the businesses take up and address their concerns in return for the information. There are also commercial services that research the broader public conversation about the sustainable supply chain issues of a specific company or brand. The logic of collaborative strategies is that all stakeholders are jointly responsible for meeting the jointly defined requirements, and therefore share the costs of both the use of the approaches and instruments, and of the corrective action, such as investments in more environmental friendly facilities or higher operational expenses for environmental protection (Morali and Searcy 2013).

Collaboration strategies require trust, shared interests and mutual commitment among supply chain actors. When supply chain challenges concern many suppliers, the development and implementation of solutions is a collective effort. When supply chain challenges are limited to a specific buyer-supplier relationship, the solution is co-developed and implemented by these two organisations. In both cases, the actors involved first analyse the unique context before engaging. However, with one-on-one relationships requiring dedicated efforts, focal firms are

limited in the number of supply chain partners they can engage with collaboratively. For all other cases, focal companies need to lower their active engagement.

The following discusses the use of approaches and instruments for SSCM in collaboration strategies, and the practices of sharing costs and benefits.

With the definition of sustainability targets and standards for its supply chains, a collaborative mindset aims to achieve a performance level on issues that improves the status-quo, but also prioritises factors and defines performance levels that are feasible for the related supply chain partners and acceptable to a wider group of stakeholders. This process requires the active participation of various supply chain partners in multi-stakeholder approaches (de Bakker et al. 2019). The objective is to identify common interests and ensure perceived benefits. Instead of simply joining established industry standards that are only partially aligned with the group's interests and needs, the group considers elements of industry standards as options. In reality, considering the large number of procured materials and limited resources, focal companies can follow a collaborative mindset only for a limited number of highly relevant supply chain paths and need to rely on approaches and tools that allow for low levels of interaction for the rest of their supply chain. The latter typically requires joining established industry standards to benefit from their reach and efficiency (Grimm et al. 2023). Understanding and considering the interests and limitations of others requires substantial efforts. The immediate benefit of collective target setting is restricted to the definition of objectives, which the involved actors share and commit to, and thus guide on the means taken to realise them (i.e. shared vision and mission).

In a collaborative mindset, supply chain transparency is a shared interest to ensure that all relevant supply chain actors are considered, heard, and ideally involved in decisions that affect them. For collaboration to happen, actors must trust one another. This level of trust determines how much information the supply chain actors disclose. The often longer-term business relationships in collaboration-driven supply chains limits dynamics and complexity in these supply chains, leading to higher accuracy of the identified supply chain. Commercial services for supply chain mapping by third parties and government publications are additional sources for further input. The costs for mapping depend on the complexity and dynamics of the supply chain and is reduced when supply chain actors share their respective knowledge.

In a collaborative approach, focal companies engage in key parts of their upstream supply chain. They are concerned about the alignment of these companies with the jointly defined requirements and objectives and engage in the selection and onboarding of sub-suppliers. Sub-suppliers benefit from such active engagement and report better understanding of expectations, resulting in increased compliance with the focal company's requirements (Fontana et al. 2021). In the collaborative setting, focal companies are more open to engage with relevant sub-suppliers in the upstream supply chain – usually together with the supplier that contracts these sub-suppliers in the lead (Hofstetter 2018). This upstream engagement requires substantial engagement by the focal firm, although such relationships, which are relation-specific investments, are hard to safeguard. Despite a lack of specific research on this matter, it appears that the additional costs for focal companies and suppliers from nominating and coordinating with sub-suppliers are balanced out by savings and higher sustainability alignment in the extended supply chain.

The collaborative mindset considers government involvement as an opportunity to adapt the respective institutional framework to enable better collaboration in supply chains (Bombardini and Trebbi 2020). Clear liabilities and requirements help the focal companies and supply chain actors to revise the business models to better align with their sustainability objectives. As structures in governments and with industry associations tend to reflect existing structures,

companies lobbying for change and innovation tend to face higher obstacles and require more lobbying engagement – capacity that companies attempting to innovate their business model can hardly afford.

Focal companies in a collaborative mindset can benefit from the availability of certified goods that go beyond the major certifications. On the basis of a good understanding, collaboration allows focal companies to understand less-established certifications and identify those that offer the highest fit with their own requirements and targets. Supplier-driven certifications focus on the suppliers' specific achievements and unique value propositions. Such certificates do not serve as labels for the communication to consumers; they serve governance in business-to-business relationships. For both suppliers and buyers, establishing or understanding niche certifications is costly, but allows them to focus on the aspects that align best with their objectives (see also Peng et al. 2022b).

Supplier selection and contract negotiations in a collaborative mindset address sustainability requirements and targets in their relation to and dependence on other objectives. Because of the shared commitment of the focal company and the suppliers to mutual development, the supply chain actors are dedicated to identifying performance gaps in the supply chain and defining corrective action during early stages of procurement (Pagell et al. 2010). The related costs range from extended efforts for finding and onboarding the best-aligned supplier to the decision to agree on a higher price to enable a supplier to better realise sustainability requirements. The benefits of such commitment include reliable estimates and plans on supplier development and ultimately also higher sustainability compliance in the supply chain (Schleper et al. 2022).

Supplier contracts in the context of a collaborative mindset pay particular attention to common targets, the joint approach to achieve these targets, mutual support, and incentives for realised performance, but avoid a guarantee for continuity (Villena et al. 2021). When contracts include specifications on the coverage of costs, the expected benefits per party and the main anticipated risks, the contractual parties are able to prepare and align with the other supply chain actors (Dubey et al. 2018). While the contracting itself is less of a cost concern, the transparency in such a collaboration-focused contract eliminates the conventional opportunities for focal companies to shift costs and risks to the contractual partner. The benefit is a reliable basis for all supply chain actors to engage in collaborative action – which is expected to realise better results at lower efforts.

The monitoring of the sustainability performance of suppliers and sub-suppliers in a collaborative mindset serves not to prevent all risks but to solve or mitigate risks through the joint development and implementation of solutions. Focal companies aim to understand the problems the actors in their supply chain are facing. Instead of the coercive approach of substituting the lowest performers in their supply chain with average performers, the collaborative approach values the existing supplier and aims to develop and implement a solution that improves performance for the supply chain and for this specific supplier as well. When suppliers understand and trust that the objective of monitoring is not to threaten them, but to help them where they have problems, this substantially reduces the problem of suppliers trying to provide incorrect data. Suppliers can be educated to self-assess their performance and response rates are high when they are sure to receive a service in return – in this way, suggesting self-assessment is an effective and cost-efficient approach in such a setup. Supplier audits run by the focal company are costly in particular for the buyer, but they help to understand the situation of the supplier and can deepen the buyer-supplier relationship. The combination of occasional supplier visits with more frequent self-assessments enables the focal company to get to the actual challenges the respective suppliers face at a reasonable cost (Tan et al. 2023). The main benefit for the focal companies is a reliable and comprehensive

understanding of the challenges in the supply chain, which enables them to increase efficiency when planning and taking action to improve sustainability performance.

The feedback on the audit results is an important element in the collaborative strategy. The focal company discusses the results with the supplier with the aim to better interpret them and ensure that the supplier engages in developing solutions. In contrast to the coercive strategy, where the supplier is informed about the results by the auditor, the focal company's buyers take the time to address the results and integrate them in the other, ongoing conversations in order to find systemic solutions (Pagell et al. 2010). In line with the feedback on audit results, focal companies benefit from providing the structure that allows them to listen to their suppliers. As the approach is collaborative, it is important to engage in the conversation. This conversation involves considerable cost for the focal company since buyer capacity is limited, but it creates a foundation of understanding and advances the trust required to get access to the suppliers' real challenges (Tan et al. 2023).

The core element of a collaborative strategy is to find and establish solutions beyond the boundaries of the supplier. In addition to capacity-building offers, suppliers need to be able to change the context they are part of to apply this new knowledge (UNIDO 2024). This can include practices related to communication ordering between the supplier and the focal company. In this way, changes are required not only from the supplier, but also the focal company, in a coordinated way. Staying informed about whether the supplier's senior management remains engaged and offering help is another important aspect to drive improvement (Wohlgezogen et al. 2021). The interaction between the focal company, the supplier and potentially further supply chain actors enables suppliers to access the help of actors they traditionally lack access to. A joint application to a fund or a request for a loan to a bank that is supported by a trustworthy customer of the supplier increases their success rate and makes these resources available not only to the supplier, but to the entire supply chain. Focal firms can also be helpful in changing organisational structures both within the supplier's boundaries and their local economy. The establishment of cooperatives has helped both smallholders and focal companies. For focal companies developing strong and highly efficient relationships in their supply chains, the question of safeguarding supplier-specific investments loses importance, since the supply chain becomes different from those of competitors, making it costly for them to access into this "unique" supply chain.

Overall, many business approaches and tools are available to focal companies to support a collaborative strategy in SSCM. These approaches and tools appear well-suited to balancing costs and benefits to ensure the perception of fairness by the actors involved. Once focal companies engage in a collaborative strategy, they discover the opportunities and benefits that justify the required efforts and costs. However, buyer-supplier relationships are predominantly approached with a coercive mindset, which limits both research and the available success stories (UNIDO 2024).

4.4 Discussion

The challenges in assessing the costs and benefits in SSCM reflect the very nature of supply chains: the sharing of work among independent organisations – focal company, suppliers, and many levels of sub-suppliers – not only entails a shifting of profits and losses, but also a shifting of risks, responsibilities, and liabilities, and so on. When individual supply chain actors optimise for themselves, they can improve their sustainability performance without considering the effects on other supply chain actors. Similar to the footprint perspective in greenhouse gas emissions, the costs and benefits with sustainability in supply chains needs a "total chain" perspective. Many business approaches and instruments SSCM exist. But most only deliver on

their promises in a collaborative mindset – a mindset defined here as aiming for the benefit for all actors involved.

5 Value-chain specific analysis

After presenting a broad selection of the many approaches and instruments available to companies to drive sustainability in their supply chains (Chapter 2) and placing them in the context of cost-benefit sharing (Chapter 3) and generic deployment options (Chapter 4), Chapter 5 aims to provide a "reality check". Based on five commodity-specific supply chains – cotton/ready-made garments, tin/solder, natural rubber/tyre, coffee, iron ore/steel – the sub-sections show which of the approaches and instruments are actually in use and to what extent. The information is based on desktop research, interviews with industry experts and consultation with an Expert Advisory Board comprising individuals from business, civil society and academia.

Critical reflection/methodological limitations

The sustainable supply chain management (SSCM) approaches and instruments described in Chapter 2 are often used in practice in different forms and combinations, embedded in a coercive or more collaborative strategy (Chapter 4). Buyers and sellers may use supply chain sustainability initiatives or activities from different categories, or combine them – for instance, when an initiative was originally founded by buying organisations only, but then evolved into a collaborative approach by including new members from the supply chain, or where companies refer in their individual activities to standards that were developed in a collaborative setting or by third parties. The following chapters therefore attempt to match the approaches and instruments observed in each raw material specific supply chain based on, as much as possible, the categorisation developed in Chapter 2, while acknowledging these limitations.

A further challenge arises from the many contextual factors described in Chapter 3, which can have a strong influence on the design, implementation and actual impact of a SSCM approach or instrument. For the five selected supply chains, this means that some statements are of a more general nature, while others are specific to the activities of individual stakeholders and cannot always be generalised. For example, audits vary according to the standard being assessed and whether it comes from a company or a certification organisation, all of which have different levels of power and resources. These contextual factors strongly determine the incentives to implement environmental protection measures and also lead to different costs for different stakeholders. This also highlights the limitations in quantifying the costs associated with the implementation of SSCM measures; since these are often confidential – costs are sometimes negotiated on a case-by-case basis and rarely publicly available – it is usually only possible to make rough estimations.

Major business approaches and instruments: evaluation based on perceived distributional fairness & on the trigger for change

Despite the aforementioned methodological limitations, the following chapters provide comprehensive information that also allows for a classification of the individual approaches and instruments in terms of their perceived distributional fairness and the respective trigger of change. The analysis of relevant approaches and instruments of SSCM takes into account that both buyers and suppliers invest inputs, such as human resources, financial capital or machinery, to achieve the desired output (e.g. a compliant factory, product, material). This results in benefits for both parties: suppliers, for instance, can receive more orders, have access to certain markets or can ask for a better price if they have certain certifications, while buyers can sell a certified product at a better price. At the same time, the implementation of SCCM approaches and instruments also comes at a cost that both parties must bear (either individually or collectively).

Each sub-chapter concludes with a matrix, developed as part of this project (and partly based on a graphic developed by Howland et al. 2021), in which the observed and described approaches and instruments are categorised. Within the matrix, the

- x-axis indicates the total perceived benefit or advantage, which is defined as the outcome divided by the input that one party (e.g. buyer) invests in a project minus the outcome/input of the other party (e.g. supplier). The perceived advantage lies with either the buyer or the supplier. Shared responsibility, which is increasingly discussed as a more realistic reflection of how human rights and environmental due diligence (HREDD) should be managed in supply chains, aims to distribute the cost-benefit ratio more fairly and establish a balance.
- y-axis shows whether the instruments tend to incentivise or punish the business partner(s). Incentives and penalties/sanctions are usually used to influence the desired outcome for the business partner. They also indicate the consequences business partners (both buyers and suppliers) may face in case of (non-)compliance with the required changes.

Not all of the SSCM approaches and tools described in the following raw material-specific chapters and positioned in the matrices are used to the same extent by a similarly large number of stakeholders along the respective supply chain. While some approaches and instruments are already widely applied, other approaches may only be used and tested by individual, pioneering stakeholders. The matrix attempts to do justice to these circumstances by distinguishing between "established approaches/instruments", "emerging approaches/instruments" and "niche approaches/instruments".

It should be noted that the matrix is only an approximation and does not claim to be exhaustive. We acknowledge that each SSCM approach and instrument can be designed in various ways, each of which may result in a different positioning on the x- and y-axis. The matrices contained in the individual raw material-specific chapters below are based on information gathered during desktop research, as well as expert interviews and exchanges with the Expert Advisory Board on the current typical design of the individual SSCM approaches and instruments.

5.1 Cotton-garment

The cotton-garment supply chain creates pressure on the environment along the entire supply chain, from cultivation to assembly. Table 1 highlights the negative impacts based on a review of relevant literature. The **water footprint** of the cotton-garment supply chain is particularly large, as cotton fields are irrigated in areas where cotton does not naturally occur (or where global warming has altered the climatic conditions) and conventional cotton is grown (Pal et al. 2021b). The wet processes in textile processing (e.g. washing, bleaching, dyeing, printing) also consume high amounts of water, which is often inefficiently used; in addition, wastewater is not treated appropriately (Zietlow et al. 2017). **Energy-intensive process steps**, such as spinning, knitting, weaving, drying and finishing, often use fossil fuels (e.g. coal) and are a major source of greenhouse gas (GHG) emissions. Energy consumption is also high where cultivation is mechanised (e.g. for planting, irrigation, fertilisation, harvesting). The use of **chemicals** such as fertilisers, insecticides and herbicides in conventional cotton cultivation affects soil health and emits pollutants into water and the air (Pal et al. 2021a). Process chemicals, such as detergents, wetting agents or stabilisers, and performance chemicals, such as dyes or finishing agents, are used in wet processing, i.e. during bleaching, dyeing, washing or finishing. These chemicals can be harmful to humans and the environment if they are substances of concern according to the EU REACH regulation, are not handled properly during processing, or are not treated correctly during wastewater treatment. **Soil** compaction is an immediate negative effect of the use of heavy machinery during planting and harvesting particularly in areas where large farms

dominate. The use of fertilisers, pesticides and other chemicals during cultivation result in degrading soil quality (EOS Data Analytics 2023). Organic cotton is usually grown less densely in order to promote the growth of cotton and other crops growing alongside it, which, while decreasing productivity, increases the amount of land used compared to conventional cotton (Textile Exchange 2016). **Air emissions** occur along the entire supply chain. Dust emissions are mostly produced during the manufacture of fabrics, singeing or during cutting and sewing/stitching (Roth et al. 2023). Other air emissions include volatile organic compounds (VOC) and formaldehyde (e.g. coating, finishing, printing, thermal treatment), ammonia (printing, coating, thermal treatment), waste gases from incineration to generate energy or steam (Roth et al. 2023). Solid **waste** is generated in different processes from cultivation (e.g. organic matter including hazardous substances, such as cotton stalk and cotton gin waste) to textile processing (e.g. sludges containing hazardous/non-hazardous substances, offcuts) and garment manufacturing (e.g. cutting/sewing waste) (CISL 2016; Roth et al. 2023). Depending on the region, the best-available techniques are used to reduce the amount of waste sent for disposal (e.g. EU) or disposed of in landfills, while wastewater often ends up untreated or inadequately treated in bodies of water (Hasan et al. 2018). Effluents may contain high loads of pollutants if they are not properly treated.

Table 1: Main environmental impacts along the cotton-garment supply chain

	Fibre production			Yarn and fabric production		Textile production	
	Cultivation	Raw material processing	Fibre preparation	Yarn preparation (spinning)	Weaving / knitting / bonding	Bleaching / dyeing / finishing	Assembly
Water	Water depletion through irrigation					Inefficient water use; high consumption	
Land use/Soil	Soil compaction by machinery; soil degradation due to high use of fertilisers and pesticides (e.g. eutrophication)		Fibre waste / trimming to landfill				Textile scrap to landfill
Energy	If mechanised, machinery for planting, fertilising, irrigation and harvesting			High consumption of energy, often fossil fuel-based			
Chemicals	Use of fertilisers, insecticides, herbicides in conventional and sustainable cultivation				Use of hazardous process and performance chemicals		
Air	Air emissions from use of pesticides and fertilisers			Air emissions from incineration to generate energy or steam (boiler)			
Waste		Seeds and trash removed from cotton lint	Fibre scrap / trimming to landfill		Fibre waste	Polluted effluent, sludge	Cutting waste, emission to air (e.g. dust)

Source: own illustration (adelphi), adapted from Petrie 2023; Roth et al. 2023 and Singh et al. 2018

To manage these impacts, the industry has a range of approaches and tools for sustainable supply chain management (SSCM) at its disposal.

Companies in the cotton-garment supply chain predominantly use **buyer-individual voluntary approaches**, such as audits and certifications, to manage risk in their supply base. Audits and certifications are key instruments of the coercive strategy, in which the roles of buyers (requesting sustainability data) and suppliers (providing sustainability data) are clearly divided. The distribution of cost and benefit varies with the business model, but is often perceived as unevenly distributed by suppliers (see Chapter 4 on distributional fairness). The **auction-based system** takes a very competitive approach as the number of collections (from 2 to 3) and thus styles have increased substantially over the years, while prices have remained stable or even decreased (Ljarja et al. 2023). Short lead times at a very competitive price while meeting sustainability requirements are an indication of the coercive strategy and are increasingly becoming a "must have" to gain a foothold in highly competitive markets such as the European fast fashion market. When taking on new suppliers, it is common practice for companies to subject them to internal (second-party) audits of social and environmental standards, before engaging a third party, which is usually paid for by the supplier. Interviews with **specialty brands/retailers** suggest that the approach with key/strategic suppliers is less rigorous and more collaborative and trust-based, which is reflected in supplier visits and second-party audits, thanks to their long-term business relationship (often more than 10-15 years). Here, the costs are borne by the buyer, who is sending a team of in-house experts to inspect the facilities. Occasional suppliers, i.e. suppliers with whom there is not yet an established partnership, are subject to third-party audits in order to verify that specifications are met. In this case, the audit cost would have to be covered by the supplier. Interviews confirm that well-performing suppliers are rewarded with further orders, increased quantities and training – i.e. a more cooperative approach to overcoming negative impacts is built in (Dreismann 2019). As confirmed by a major specialist brand/retailer, key/strategic suppliers benefit from **training** (**buyer individual/collective voluntary instrument**), usually provided free of charge either by the brand/retailer or by the development programme in which the brand/retailer is involved. Sometimes training is organised for a cluster of nominated suppliers. This may be accompanied by a range of support measures, such as an advisory process, a feasibility study or matchmaking events with machine suppliers on the use of proven high-efficiency and/or environmentally friendly technologies (e.g. water/energy saving; solar roof-top). According to the interviewed specialist brand/retailer, the investment in the hardware must be borne by the suppliers, while the **brand/retailer commits to placing more orders** for products manufactured with this technology, if it is applied. This incentive mechanism, if built into the contract, is quite effective for large key/strategic suppliers who have the necessary investment capacity – a prerequisite for being nominated as a supplier – but would not work for (M)SMEs.

Buyers can also request **certifications** to assure "the origin, specifications, level of quality or conformity of a product according to production, social and environmental standards" (ReSOURCE 2021), covering the entire chain from certified materials (e.g. Better Cotton, Organic Cotton Standard) to products (e.g. OEKO-Tex Standard 100) and processes at the facility level (e.g. ISO 9001 for quality management, ISO 14001 for environmental management, STeP by OEKO-TEX®). If the certification process requires third-party verification, the cost is usually borne by the supplier, which is indicative of a coercive approach to SSCM. Depending on the certification and the size of the facility, the complexity of the product or the process, the costs can amount to several thousand euros. In addition to the direct costs, audits and certifications tie up considerable human resources for the necessary preparatory and follow-up work. In general, the supplier alone is responsible for remedying any non-compliances and passing the audit,

which is why larger suppliers are more likely to be considered as nominated suppliers, since they have the financial means to make investments in equipment (e.g. machine safety, functionality of water and effluent treatment plant) or structural changes (e.g. building safety). In addition to individual approaches, companies increasingly join sustainability and/or MSIs (MSIs), such as Textile Exchange, the Zero Discharge of Hazardous Chemicals (ZDHC) initiative, the Higg Index, the Social & Labor Convergence Program (SLCP) or the apparel impact institute (aii), which offer tools and standards to address environmental impacts in the textile supply chain (**buyer-collective voluntary approaches**). These tools and standards provide guidance for companies and suppliers to understand and improve their sustainability performance, usually at the expense of suppliers. For example, the Higg Index by Cascale (formerly Sustainable Apparel Coalition) comprises a set of tools that enable brands, retailers and suppliers of all sizes to measure and assess the sustainability performance of a company or a product (e.g. Brand & Retail Module, Factory Environment Module, Material Sustainability Index). Once the results have been verified by an approved auditing firm (third party), they can be shared on an online platform that is recognised by other (Cascale) members, which in turn offers suppliers the advantage of presenting themselves as a supplier with robust management systems in place. Resource materials and improvement programmes are available for implementation at different stages of the supply chain. These initiatives and approaches focus on establishing a management system, while making incremental improvements in different areas. The Higg Factory Environment Module (FEM), for instance, covers management system, energy use and GHG emissions, water use, wastewater, air emissions, waste management, and chemical management. The Higg FEM score only can be published if the facilities, i.e. the suppliers, give their permission. Although (mostly large) suppliers are increasingly part of MSIs and sustainability initiatives, these tools are used by brands and retailers to manage risk in the supply chain. However, the requirements, i.e. the processes to be implemented, are often quite demanding for suppliers and not easy to fulfil – especially for SMEs, as they often lack the financial resources. Some of the tools (Material Sustainability Index, Product Module) have been criticised for not being fully aligned with ISO standards and for providing misleading information on product labels about impact (Bierling 2022).

The **cooperative business model** advocated by the Fair Wear Foundation (FWF) follows the collaboration strategy (see Section 4.3), which seeks to implement **shared responsibility** principles within the **buyer-collective voluntary approach** (see Section 2.2), where brand members bear the costs of the audit carried out by FWF itself. Audits, audit costs and reports can be shared with other FWF members sourcing from the same factory; sharing the corrective action plan is mandatory. This relieves suppliers of the burden of having to provide personnel for the audit process multiple times and provides a clear financial incentive. The Fair Wear audit helps to identify, assess and monitor risks and identify improvements where necessary, with a focus on human rights due diligence. Despite positive attempts in considering preventive measures (e.g. responsible purchasing practices), the Fair Wear approach can only have a limited impact, as it is restricted to human rights, labour and social aspects and only covers tier 1 suppliers. Similar collaborative approaches to assessing environmental performance and environmental management systems at the supplier level are not known.

Traceability tools in the cotton-garment sector are primarily used to identify and mitigate risks in the supply chain, with the buyer usually taking the initiative and implementing them with key suppliers (**buyer-individual approach**). Among the most important technologies used to confirm the origin or the content of the cotton are DNA-traceability solutions, Radio Frequency Identification (RFID), fibre tracing tools using pigments and blockchain-based technology (TÜV

SÜD AG 2023). RFID tags are increasingly deployed by luxury fashion brands to prevent counterfeiting (Buckulcikova et al. 2022). The blockchain technology stores information on the origin, ownership and lifecycle on a digital record of each good, which allows it to be tracked throughout the product life cycle (Freitag and Weber 2018; Köppe and Finkeldei 2022). It has reportedly been used by various brands and retailers of the garment industry, such as Walmart, adidas, Nike, Puma or Prada (Cuc 2023). The blockchain technology can have various positive effects if it enables the tracking of inputs as they are transformed to outputs. Use cases for blockchain technology aim for high impacts on transparency, sustainability and efficiency (Berger 2022). The most evident cases were the registry of legal (including audit) documents and the measurement of environmental parameters (e.g. water consumption, pH value, temperature, humidity, dust), which, enabled by a tamper-proof Internet of Things (IoT) device, could initiate automated processes via self-executing smart contracts. Assessing other environmental values (e.g. phosphate, ammonium) would require photometric equipment. Companies may realise an increase in efficiency levels, as blockchain seeks to reduce the work in progress, provide more information about the social and environmental sustainability claims of a product, and create a transparent register for documents such as audit reports, contracts or wage data (Berger 2022). Köppe and Finkeldei (2022) present several state-of-the-art blockchain technology solutions that trace each textile product back to its origin (e.g. my-trace by Remei; The Seedtrace Platform, Textile Genesis). According to an interview with a large specialist/retailer, the blockchain technology has been used for the purpose of traceability, which is a huge challenge in the cotton supply chain[3]. Textile Genesis, a blockchain-based traceability platform, claims to provide fibre traceability solutions that can trace sustainable and certified materials from the raw material to consumption. Several companies (e.g. Lensing, ArmedAngels, H&M Group), standard organisations (e.g. Textile Exchange) and textile suppliers have conducted or started pilots that focus on various standards, such as the Organic Cotton Standard (OCS), the Global Recycled Standard (GRS) and the Recycled Claim Standard (RCS), all focusing on the origin of the material composition (TextileGenesis 2023). Consortia like "texCHAINge", comprising the discount retailer KiK, the Bremer Baumwollbörse and ITA Academy GmbH, among others, have started promoting the development of an ecosystem for digital supply chain management in the German textile and clothing industry (Köppe and Finkeldei 2022). According to one major specialist brand/retailer who sources from different regions (e.g. USA, Pakistan, Australia), blockchain is not seen as a solution that can be deployed at scale, as cotton farming in some geographies is entirely dependent on smallholders picking the crop by hand. It can be assumed that due to the challenges of cost, communication, scalability and correct data entry (Freitag and Weber 2018; UNECE and UN/CEFACT 2021; Köppe and Finkeldei 2022), the adoption of blockchain technologies by smallholders and SMEs in the Global South, which still make up the vast majority of the supply base, is unlikely in the near future.

Smart contracts are automated, self-executing transactions that can (but do not have to) be based on blockchain technology. In smart contracts, agreements between buyers and suppliers are encoded and stored on the blockchain, and are executed automatically when certain conditions are met – for example, payment is approved when the quality of the ordered goods is met or the audit is passed (Cuc 2023). In terms of a collaboration strategy, the mechanism is therefore designed to incentivise good behaviour and sanction bad behaviour. According to Cuc, several fashion brands like adidas, Puma or Nike are using the Ethereum platform to facilitate

[3] After spinning, cotton usually cannot be traced back to cultivation. The mass balance system used by Better Cotton is implemented from the ginning plant onwards. Between farm and gin, Better Cotton seed cotton and lint bales must be separated from conventional cotton. After ginning, the Better Cotton mass balance chain of custody is applied, meaning that Better Cotton can be replaced by or mixed with conventional cotton, as long as the volume (mass) is recorded and does not differ (Better Cotton 2020).

smart contracts, although the implementation in practice and how costs are distributed could not be verified. The complexity of the contract determines the cost for designing and using it, which may range from $500 to $5000 (Davis 2023). The size of the bytecode, the gas price, or grid congestion can all add significantly to the cost (Davis 2023). Smart contracts facilitate the secure and automatised information exchange between buyers and sellers and make sure that each party fulfils its obligations. They can also be used to pass information to secondary systems, such as certification systems. The benefits for both parties are a higher level of trust, transparency and efficiency, as physical documentation (e.g. authenticated documents such as bill of lading) is significantly reduced, resulting in cost savings. Questions remain as to the extent of reliability, scalability and governance. The decentralised network structure of blockchain-based smart contracts reduce the dependence of single entities (e.g. banks), but also raise the question as to ownership and responsibility. The main barrier to making smart contracts a scalable solution is the complex and time-consuming process of setting up a secure contract and ensuring tamper-proof data entry. Even though smart contracts are expected to be secure, they do not have any legal validity yet, which may affect their adoption in the market.

It is known that in organic cotton trading models, as part of a **collaboration strategy** (**buyer-individual voluntary instrument**), suppliers are granted **price premia**, also called organic differentials (Truscott et al. 2021). In-conversion and organically farmed plantations yield positive outcomes for biodiversity, reduce costs for inputs (e.g. chemical fertilisers, irrigation) and improve the farmers profitability. Typically, organic differentials are calculated by taking the price of conventional cotton and adding a percentage to cover the organic value addition, which includes the costs for production, audit, certification, inspection, any yield losses, training and other extension services. The quality of the fibre or the material can also play a role. According to Fairtrade International, there is only an incentive for farmers to grow organic cotton if the market and governmental support prices do not exceed the Fairtrade minimum price (Fairtrade International 2021). Shifting farming methods from conventional to sustainable also has a positive impact on the environment and thus reduces costs for society. However, farmers producing cotton according to the Better Cotton standards are not paid a price premium (Voora et al. 2023). This standard only allows farmers to realise higher prices if the quality of the cotton and efficiency have increased. At the brand/retailer-tier 1 link, a repeated complaint voiced by suppliers is that their efforts to improve social compliance and environmental performance is not rewarded by their customers. In general, no price premium is paid, which is an indication of a coercive SSCM strategy; instead, sustainability is incorporated into the customer requirements. *"Buyers say point blank that they are not going to increase the price, other factories then take the order. 'You didn't do it, he (i.e. the other supplier) did'"* (interview with supplier BM2). The same supplier is increasingly faced with buyer requirements to use recycled content for packaging – which, however, is not rewarded. According to this supplier, the whole concept of sustainability only works if there is partnership between brands and suppliers. The literature widely recognises that value creation (i.e. environmental upgrading) does not necessarily result in value capture for suppliers (profit). Instead, buyers maintain prices while sustainability requirements are passed down the supply chain, building a competitive supply base (Khattak et al. 2015) (Khan et al. 2019). When, during the first lockdown, buyers cancelled their orders and pulled out of the market, leading to a significant drop in prices, many suppliers were compelled to sell below the cost of production. Sustainability requirements were the first areas to be compromised (e.g. late payments, cancellation of orders, no remediation of safety issues indicated by the RMG Sustainability Council in Bangladesh) (Ljarja et al. 2023).

Sustainability financing: access to finance is a challenge for both buyers and suppliers when it comes to investing in measures to reduce the environmental impact of their operations. Companies have several options to finance projects with high sustainability impact.

- Sustainability-linked bonds and green bonds have experienced a sharp increase over the past decade (Nguyen 2022). The issuance of green bonds enables companies to raise funding for environmentally friendly investments such as renewable energy, energy efficiency, circular products, green buildings, or sustainable water and wastewater management (ICMA 2021). Fashion brands and retailers like H&M, VF Corporation, adidas and Walmart, among others, have issued green bonds to finance specific projects. H&M, for instance, has adopted the Green Bond Principles (GBP) of the International Capital Market Association (ICMA), but has not yet selected and implemented any projects as of December 2023. Annual reports on how funds have been allocated and what impact has been generated are mandatory.

- Sustainability-linked finance schemes that follow ICMA's Sustainability-Linked Bond Principles (SLBP) issue sustainability-linked bonds or grant loans as an incentive to meet previously defined sustainability performance indicators. H&M issued a €500 million sustainability-linked bond in 2021 and linked it to three targets that are to be achieved by 2025: i) to increase the share of recycled materials to 30%; ii) reduce scope 1 and 2 GHG emissions by 20%; and iii) reduce scope 3 GHG emissions by 10%. If the targets are not met, the company would not only suffer reputational damage, but bond interest rates would also rise (Eggerstedt 2021). Consequently, the instrument's inherent incentivising and penalising effects balance each other out (see Figure 2). In general, this is an opportunity for investors to incentivise bond issuers to improve on sustainability. However, with H&M's base year set at 2017, when the market and absolute numbers were smaller, and relatively low target numbers, there is reason to doubt the ambitiousness of these targets (Nguyen 2022).

- Suppliers in the Global South have the option to get loans from commercial banks or apply for funding from public development banks or green refinancing instruments of central banks (United Nations Inter-agency Task Force on Financing for Development 2023). Loans from commercial banks do not always offer favourable conditions (e.g. high interest rates) or cannot be accessed as buyer orders are often given only informally by email and are not supported by contract documents. However, even when the funds are available and interest rates are acceptable, access is limited because of the bureaucratic application process involved. The Green Transformation Fund issued by Bangladesh Bank is a refinancing instrument that allows banks to give long-term loans to export-oriented industries for environmentally friendly equipment. Despite a comparatively low interest rate (5%), uptake has been slow due to an extremely bureaucratic application process, which was confirmed in supplier interviews: "*it doesn't make any sense [to apply for], it's just too cumbersome*".

Linking finance schemes to specific conditions and targets can improve environmental performance. The question here is – and there is a lack of transparency in reporting – to what extent the supply chain benefits from the investments made through sustainable financing. The industry's current focus is on meeting climate targets, while other challenges (e.g. water consumption, hazardous chemicals) are lower down on the agenda; these issues would also benefit from such solutions.

Voluntary sustainability initiatives and commitments/pledges: several buyer-collective voluntary sustainability initiatives have committed to achieving net zero by 2050 (e.g., Sustainable Apparel Coalition, Textile Exchange, Global Fashion Agenda), setting climate targets to reduce GHG emissions in line with the 1.5°C pathway on all scopes. In practice, few companies have actually presented tangible results to date. Sustainability claims are used to portray a company as green or sustainable, which usually is to the company's advantage, but can increase reputational risk if they are not substantiated. The EU Green Claims Directive aims to regulate false claims made about products. Interviews with country representatives have shown that

brands communicate their targets to their supply chain, for instance, in supplier days or direct communication, but rarely accompany them with appropriate measures, such as sustainable finance tools. Suppliers complain that they lack guidance on which data need to be collected and how they are expected to contribute to reducing their customers' scope 3 emissions. Other environmental impact areas are often addressed through capacity development programmes – which, however, normally only benefit key suppliers.

Emerging approaches of SSCM shift towards more proactive and collaborative buyer-supplier relationships and shared responsibility. The business model followed by FWF and its member brands seeks to strengthen cooperation among brands and take on a more **collaborative approach** with their supply chain by establishing **responsible purchasing practices** (Ethical Trading Initiative et al. 2022; Fair Wear Foundation n.d.). Companies are assessed on how due diligence is managed, taking into account their sourcing strategy and purchasing practices. An effective way to engage suppliers to minimise risk in their supply chain is for buyers to commit to long-term relationships and practice shared forecasting to improve production planning. **Shared audits** with other customers of the production site help streamline cooperation and reduce costs for suppliers. These are tangible benefits that reduce the number of corrective action plans (CAP) significantly and speed up documentation and reporting. As the aim is to establish fair practices rather than third-party verification of non-compliances, FWF members are expected to engage in remediation through guidance, but not financially. Continuous improvement, while recognising limitations of buyer influence, is central to this risk-based approach. A major constraint to this approach is that FWF has focused on tier 1 factories, ignoring the deeper supply chain. Only now are brands requesting to include tier 2 and 3 suppliers as they are increasingly required to provide data on the environmental impact further down the supply chain (e.g. scope 3 emissions).

Responsible contracting: Unfair trading practices are often rooted in contractual terms and conditions where risk is shifted from the buyer, usually the stronger party, to the supplier, who is weaker. Power imbalances in the cotton-garment industry are often reflected in late payments, prices that do not cover production costs, unrealistic lead times and clauses that allow buyers to cancel contracts in the event of force majeure, as happened during the Covid-19 lockdowns (Ljarja et al. 2023). Responsible contracting is a practice initiated by the not-for-profit organisations The Responsible Contracting Project (RCP) and The Chancery Lane Project (TCLP), in collaboration with other industry stakeholders like GIZ and the Sustainable Terms of Trade Initiative (STTI), which seeks to establish shared responsibility between buyers and suppliers to ensure human rights and environmental due diligence. Both organisations have developed Model Contract Clauses (MCC) that can be incorporated in contracts and purchase orders, setting out for both buyers and sellers their obligations to ensure human rights (RCP) and environmental due diligence (TCLP). This means buyers and suppliers are collaboratively responsible for establishing a due diligence process and defining means of resolution as well as of cost responsibility, if necessary. They explicitly move away from supplier-only responsibility to shared responsibility to ensure due diligence. In this context, both parties agree that the supplier is rewarded if, for instance, contractual climate obligations (e.g. reduction of carbon emissions) are fulfilled (The Chancery Lane Project 2024). MCC are sector-agnostic and should be adjusted by legal counsellors. While RCP started out on the US American market, a consultation version of the European Model Clauses (EMC) have been published in late 2023 (Responsible Contracting Project 2023). Zeeman textielSupers BV, a Dutch discount chain store and member of the FWF, is acknowledged to have started introducing responsible elements in its purchasing practices, such as payment within 14 days (including during the pandemic), sharing audit results with other buyers, early order placement, limited sampling or not changing contract terms (Fair Wear Foundation 2022). Other issues, such as buying prices still not being

linked to wage levels, a key requirement of the FWF's Fair Price approach, have not yet been addressed.

Integrated supply networks refer to collaborative ways of working in supply chains. Textile Exchange has identified several organic cotton trading models that achieve leverage through a partnership approach with supply chain actors (Truscott et al. 2021):

- Direct sourcing: brands (e.g. People Tree) want to have more control of the raw material in terms of quality, price or sustainability (e.g. organic content) and buy directly from spinners, fibre growers or corresponding initiatives (e.g. Organic Cotton Accelerator). They negotiate fair prices for the yarn and the production costs for a certain timeframe (e.g. 3-6 months) and make sure their business partners source from nominated suppliers. This gives them control over the product (e.g. organic content).
- Joint entities: companies pursuing a common goal, which is, for instance, to source organic cotton at fair prices, set up a joint venture to source cotton directly from farmers or ginners, thereby bypassing costly middlemen. The companies contribute a certain amount of equity and finance the rest through financial institutions. While it can be a useful mechanism to ensure stably supply/demand, it is costly to set up and involves certain risk-taking. The Cotton Sourcing Company Limited (COCSO) is an example.
- Cluster partnerships: public (local/national governments) and private stakeholders (farmers, manufacturers, brands, business associations, financial institutions) jointly develop mechanisms to improve the sector. Funding commitment from both public and private sector is required (e.g. South African Sustainable Cotton Cluster).
- Collaborative communities: companies, usually SMEs, that pursue a common purpose aim for shared value by joining forces with like-minded organisations and promoting sustainability through their coalition.

For these models to be effective, that is to ensure stable prices and a secure supply, several attributes need to be fulfilled, such as price transparency (e.g. open book costing, including a premium for sustainability efforts, also for the farmers), agreed prices and quality at the beginning of the commitment, long-term buying commitment, risk and reward sharing, KPI data collection and monitoring, and leveraging access to financial services, among others (Truscott et al. 2021).

Collaborative financing: green loan programmes can make funds available to suppliers to address negative environmental impacts. The H&M Group joined forces with the Singapore-based DBS bank to set up a collaborative finance tool that enables suppliers to finance decarbonising measures in various areas (H&M Group 2023). Along with access to direct funding, technical support is provided. While this is a promising first step towards joint solutions[4], questions remain as to the terms and conditions of the loans and the financial commitment of the buyers[5]. Further details are required to show potential impact areas.

Circular business models are increasingly gaining traction in textile and garment industry (Salmi and Kaipia 2022) and have the capacity to fundamentally change buyer-supplier relationships. While the linear business is dominated by speed, scale and cost, circular business models require more collaboration between supply chain partners. To become circular, buyers

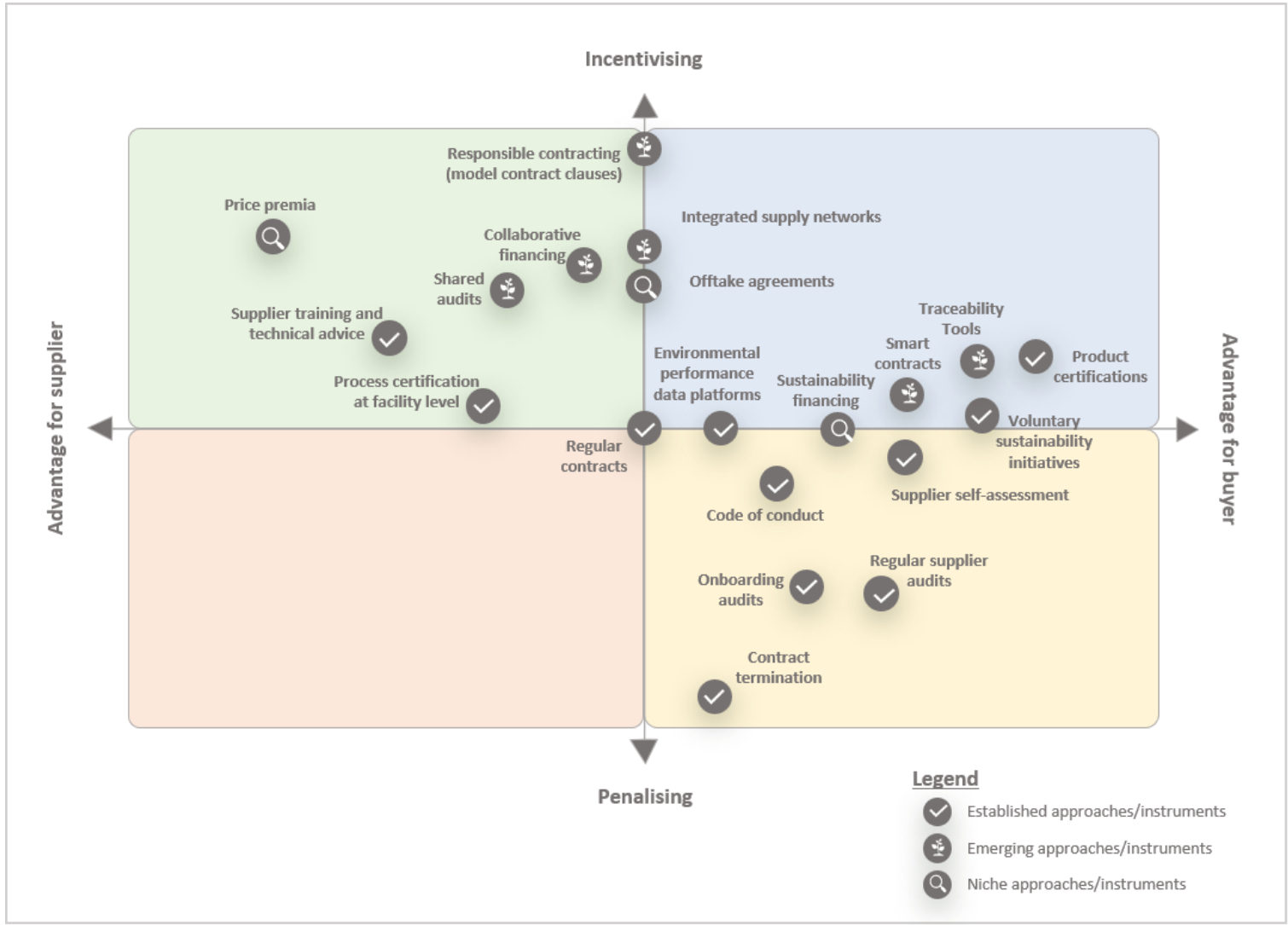
[4] In the green loan programme, which was only launched in November 2023, one project (solar panels, energy-efficient motors, water conservation technologies) has been financed with an Indian supplier (ESG News 2023).

[5] No information on terms and conditions of the loans have been made available (07.12.2023).

and suppliers need to closely work on joint solutions and coordinate their operations transparently. Manufacturers need to invest in new technologies and change their practices, which comes with costs and risks. An effective institutional environment (e.g. regulatory and policy framework, technical) and incentive schemes are crucial for a successful transition of linear business models to circular solutions. However, despite a few initiatives from clothing brands to invest in a collaborative partnership with their suppliers, incentive and reward systems are still lacking in the fashion industry (Loh et al. 2020; Schmid 2023). MSIs, like circular.fashion are increasingly bringing together supply chain partners to develop joint solutions. Schmid (Schmid 2023) portrays various forms of collaborations, from sharing knowledge, technology and other resources to product and material development. More details are needed to show potential impact areas.

Placing the business approaches and instruments described for the cotton-garment supply chain in a matrix that is structured by (perceived) distributional fairness (advantage for the buyer / advantage for the supplier) and the approach to influence the desirability of the required changes (incentivising/penalising), which is to achieve an improved environmental performance, as introduced in Chapters 2 and 5, reveals the following picture:

Figure 2: Matrix of instruments and approaches in the cotton-garment supply chain



Source: own illustration (adelphi)

As illustrated in Figure 2, the approaches that are primarily based on sanctions tend to result in a perceived advantage for the buyer, while incentive and reward-based instruments are associated with more (perceived) advantages for suppliers. We use the term "perceived" because calculating the total costs would be very complex, especially as the data is often not available and suppliers often feel disadvantaged. Most established instruments favour the buyer side, as they were not designed to redress the power imbalance between buyers and suppliers. Although niche instruments (e.g. price premia, sustainability financing, offtake agreements) are known in the market and have been around for some time, they have not been able to establish themselves for wider use for different reasons (e.g. contested market, tight margins, certain level of trust as a prerequisite). Incentive-based instruments that benefit suppliers are extremely rare, due in large part to the power imbalance in the cotton-garment supply chain. Process certifications of facilities are often not rewarded appropriately, but are now considered a "must have" in the market. Shared responsibility approaches and instruments that aim to involve both parties gravitate towards the centre of the x-axis, where buyers and suppliers benefit equally (e.g. carbon emission reduction against offtake agreements). They are among the emerging instruments that are intended either to compensate for power imbalances or to utilise new technologies (e.g. traceability solutions). It should be noted that this is a highly simplified representation only of those instruments and approaches that are used predominantly. It always depends on how both parties actually apply them or interpret their functionality in practice.

5.2 Tin

Environmental hotspots along the tin value chain, from mining to solder production, present several challenges, including water usage and contamination, soil degradation, marine ecosystem damage, air pollution, and waste management. Tin mining, in particular, undermines environmental stability, contributes to **pollution** (Nurtjahya et al. 2017) and results in the **destruction of the natural environment** (Yang et al. 2018). This sector, besides producing mining outputs, significantly alters land use and landscapes in ways that are often irreversible (Harahap et al. 2018) . **Land-clearing** for mining and using land as **waste dumps** for barren rock can lead to irreversible **topographical changes** and **soil degradation** (Vasters and Franken 2020). These practices complicate recultivation efforts and introduce pollutants like **acidic water** and increased **radioactivity** into the environment (Vasters and Franken 2020). Offshore tin extraction significantly damages marine ecosystems and **impacts biodiversity**. Mining operations reduce **water quality**, altering the sea bed and consequently affecting biodiversity (Nurtjahya et al. 2017). The **sediment clouds** resulting from these operations damage marine flora and fauna, including corals, even at considerable distances from the extraction point (Vasters and Franken 2020). In Bangka Belitung, Indonesia, the mining process has resulted in a 40% decrease in plankton species and a 70% drop in seagrass variety compared to less mined waters, along with a notable decline in coral reef-associated fish populations (Nurtjahya et al. 2017). These changes in marine habitats have adversely affected local fisheries, leading to significant economic impacts on local communities (Nurtjahya et al. 2017). In addition, the degradation and deposition activities along the coastlines of islands where tin is mined have negatively impacted ecosystems, affecting up to 70% of the Bangka Belitung coastlines (Vasters and Franken 2020). Rivers receiving tin sedimentation have shown a nearly 30% **reduction in fish species**, indicative of considerable ecological disturbances in riverine ecosystems due to mining activities (Nurtjahya et al. 2017).

While the mining stage of the supply chain exhibits the most prominent environmental impacts, subsequent steps also contribute to ecological concerns. Specifically, the processing and refining stages can lead to **water contamination** and **greenhouse gas (GHG) emissions**, especially if non-renewable energy resources are utilised (Vasters and Franken 2020). During the processing

phases, untreated contaminated water can include hazardous metals such as arsenic (As), cadmium (Cd), cobalt (Co), copper (Cu), mercury (Hg), lead (Pb), and zinc (Zn). In terms of air quality, dust emissions during the processing stages may contain hazardous metals such as arsenic (As), cadmium (Cd), lead (Pb), and mercury (Hg), accompanied by sulphur dioxide (SO2), total volatile organic compounds (TVOC), and polychlorinated dibenzo-p-dioxins/furans (PCDD/F). The specific composition of these emissions can vary, with additional pollutants like particulate matter (PM10) and nitrogen oxides (NOx) potentially present, depending on the ore's properties and the nature of the deposits. Table 2 provides an overview of these environmental impacts across various stages of the tin value chain.

Table 2: Main environmental impacts along the tin supply chain

	Mining	Processing		Solder production
		Smelting	Refining	
Water/ Chemicals	Untreated contaminated and acidic water	Untreated contaminated water. Main pollutants metals such as As, Cd, Co, Cu, Hg, Pb, Zn.		
Land use/ Soil	Onshore: land clearance, soil degradation, changes in topography, erosions, coarsely structured soil Offshore: change in seabed			
Energy		GHG emissions, in case of use of non-renewable energy sources		
Air	Dust particles	Dust emissions containing metals like As, Cd, Pb, Hg, SO2, TVOC, and PCDD/F. Depending on the characteristics of the ore and the deposits, additional pollutants may include particulate matter and nitrogen oxides.		
Waste	Hard rock waste, which can be radioactive	Tailings	Slag	
Biodiversity	Onshore: reduced fish stock in rivers Offshore: damage to collar reefs and mangroves, biodiversity loss, reduced fish stock			

Source: own illustration (adelphi), based on information from Vasters and Franken (2020), Nurtjahya et al. (2017) and expert interviews.

The tin industry, characterised by its fragmentation and the dominance of key global players in specific regions, faces challenges in implementing sustainable practices. According to Harayadi et al. (2023), mining activities are synonymous with environmental degradation and it is challenging to find a sustainable mining environment, an idea which is also supported by experts interviewed in the context of this study. The buyers of refined tin, such as solder and semiconductor producers, alongside smelters and other entities, are all important actors in mitigating the environmental impacts of tin listed in Table 2 (cf. also chapter 3.2 of Strasser et al. 2024). These stakeholders, particularly solder producers and Original Equipment Manufacturers[6] (OEMs), can hold significant influence over the industry's sustainability direction with their purchasing practices, following a coercive sustainable supply chain management (SSCM) strategy. However, according to experts, the adoption of sustainable measures is often met with resistance upstream, especially from miners who might be reluctant to implement (additional) sustainability approaches and measures due to the associated costs. In addition, the demand of tin as a product is assured, which can lead to confidence on the upstream actor's side that the product will be purchased regardless, even without any additional implemented measures. Also, the widespread presence of informal Artisanal and Small-scale Mining (ASM) adds to the complexity of implementing sustainable mining practices.

In order to address the environmental impacts of tin mining, there are different **government-enforced compulsory approaches and instruments,** such as laws, regulations, mandatory environmental impact assessments (EIAs), and risk assessments. The EIAs, as described in more detail in a report by Strasser et al. 2024), are required before the mining operations can begin, and need to be performed by the miners and at their cost. However, as discussed by (Strasser et al. 2024), the effectiveness of the EIAs remain questionable, due to the significant share of ASM operations that may operate with minimal oversight. In order to adhere to local laws, the companies are generally required to establish internal management systems for responsible sourcing in addition to investing into long-term supply-chain partner development, according to interview partners. In the case of Indonesia, in regions such as Bangka Belitung, the regulatory framework has been criticised for not being visionary enough to prevent environmental degradation (Haryadi et al. 2023). Despite local regulatory efforts aimed at managing the extraction of tin in a sustainable manner, challenges persist, highlighting significant issues such as a lack of supervision, poor implementation of sustainability principles, and inadequate enforcement of post-mining environmental and social obligations (Monteiro et al. 2021). This indicates that regulation, particularly in the upstream sector, remains a problematic area (Haryadi et al. 2023).

Voluntary sustainability programmes are a common method to promote responsible mining practices through strategies like reporting, monitoring, and independent verification. These initiatives address various concerns including human rights, environmental management, and corporate governance (Franken et al. 2020). Many of the approaches and instruments in the industry were first established as a response to tackle human rights issues, however the approaches also contain aspects related to environmental impact mitigations. With regard to the approaches and instruments that are discussed in Chapter 2, mainly **buyer-individual and buyer-collective voluntary approaches** are observed (some of which might overlap). In addition, there are several **third-party offered profit-focused approaches and instruments,** and a smaller number of **supply chain collective approaches** that are applied on a **voluntary**

[6] It should be noted that a limited number of solder producers list sustainability approaches on their websites. Among the several reviewed companies, only two demonstrated clear sustainability instruments. The scarcity of sustainability disclosures among solder producers led to an examination of OEMs and their approaches, due to their significant influence on to the upstream supply chain actors.

basis. Several of the approaches and instruments described in the following sections are applied by selected buyers or suppliers in the industry and do not apply to all stakeholders.

In the tin industry, power dynamics between buyers and suppliers fluctuate with market conditions, yet buyers maintain a degree of leverage in guiding suppliers towards more sustainable business practices. OEMs[7], who procure either refined tin or tin-containing components, are more exposed to their customers, which subjects them to public scrutiny if the sustainability of their end-products is questioned. As a result, despite the shifting power relations, it is predominantly these OEMs and the solder producers at the downstream end of the supply chain that are steering the industry towards environmental protection as part of a **coercive strategy**.

Most common approaches and instruments in the tin industry are **buyer-individual/collective voluntary approaches and instruments**. Many companies, especially large, public organisations, often apply sustainability commitments and targets which are made public in their yearly sustainability and/or ESG reports. ROHM Semiconductor's approach includes a comprehensive focus on environmental issues which are detailed in their CSR Procurement Guidelines (ROHM 2017).

In response to the US Dodd-Frank Act and the EU Conflict Minerals Regulation, ROHM Semiconductor established the ROHM Group Procedures for Responsible Mineral Procurement (ROHM n.d.). Under the initiative, the company conducts a Mineral Procurement Survey Process in line with the OECD Due Diligence Guidance, which involves requiring suppliers to engage with the Responsible Minerals Initiative's (RMI) Responsible Mineral Assurance Process (RMAP)-certified smelters. With this, ROHM ensures involved tin smelters have undergone or completed third-party audits, including RMAP, and collaborates with suppliers to initiate such audits where necessary. By reviewing RMI and smelter websites, ROHM verifies participation and audit schedules. According to survey results published on ROHM's website, 100% of smelters were RMAP-certified. In addition, the company sets annual auditing goals for tin suppliers. The website indicates that in the financial years 2022 and 2023, audits were conducted on two suppliers of 3TG[8] metals, with one supplier in 2022 agreeing to enhance their operational procedures to meet ROHM's requirements minerals (ROHM n.d.).

In the case of Apple Inc., as described in their annual progress report "People and Environment in Our Supply Chain," the company is actively mapping 3TG smelters and refiners, and achieved 100% assessment compliance in 2022 (Apple 2023). Their Supplier Code and Standards, which are annually updated, cover a range of areas including labour, health, safety, and environmental management, adhering to international guidelines from the ILO, UNGPs, OECD, and the Responsible Business Alliance (RBA) Code of Conduct. Addressing the tin supply chain, Apple has focused on responsible mineral procurement by conducting regular smelter and refinery audits, including surprise assessments (a classical measure within a coercive SSCM strategy) to ensure compliance with required standards. These assessments are carried out globally by independent, third-party auditing firms accredited to meet international standards and often certified by the RBA. Based on the Apple's progress report, the company ensures its suppliers adhere to its requirements by engaging in **capability-building** activities, which help suppliers quickly rectifying non-compliance issues, and by providing ongoing **training,** including virtual

[7] It should be noted that a limited number of solder producers explicitly list sustainability approaches on their websites. Among the reviewed companies, only two demonstrated clear sustainability instruments. One was identified as having a comprehensive sustainability framework, while another company was holding ISO 14001 certification. This scarcity of sustainability disclosures among solder producers led to examination of OEMs, who have influence on the sustainability practices and who's instruments and approaches influence other actors upstream the tin supply chain.

[8] 3TG stands for tin, tantalum, tungsten and gold

learning materials which are distributed via supplier communication programme, and access to experts for personalised coaching. The company has established a $50 million Supplier Employee Development Fund (SEDF) which is dedicated to expanding workers' rights awareness, empowering employee voices, and broadening educational and skill-building opportunities within the supply chain and local communities (Apple 2023). The report remains ambiguous when it comes to whether the fund covers supplier-focused capability-building and training designed to ensure compliance with Apple's supplier requirements. Consequently, it remains uncertain who finances these capability-enhancing activities. According to expert interviews, Apple as a large public company may be exposed to public scrutiny in case of unethical practices, therefore their approaches for ensuring ethical and environmentally sound supply chains as well as supplier capacity building is above the industry average, and not the standard practice. However, their top-down approach to ensuring SSCM is a clear indication of a coercive strategy.

In order to enable supply chains transparency, some companies publish the lists of smelters and refiners with whom they engage in business activities (**buyer-collective voluntary approach and instrument)**. In the case of Apple, the company makes their Smelter and Refiner List public (Apple 2022a). ROHM does not publish the names of the companies with whom they cooperate with, however, they indicate on their website that 100% of their suppliers are certified by the RMAP of the RMI (ROHM n.d.). The RMI publishes on their website the lists for tin smelters who are participating in RMAP and are willing to complete the RMAP audit as well as the smelters who are already conformant with RMAP audits (**supply chain-collective voluntary approach and instrument)** (RMI n.d.). Smelters that voluntarily choose to participate in the RMAP are required to **pay for their audits** (RMI n.d.). The RBA Foundation, established in 2015, supports the Responsible Business Alliance's (RBA) activities, focusing on responsible mineral sourcing while utilising public funding to develop special programmes, research projects, and tools for public benefit in this area (RMI n.d.). The RBA also manages the RMAP audit fund, which provides **financial assistance for initial assessments** for new eligible fascilities, and **upstream due diligence** activities (RMI n.d.).

In case a smelter or refiner is removed[9] from the RMI list for not meeting their requirements, the buyer might stop business activities with the supplier (both **punishment-based approaches**). However, some industry experts argue that relying on certified smelter lists, such as RMI's, may not accurately reflect on-the-ground realities. They claim that the RMAP smelter list is unreliable and inconsistently applied. This information can lead buyers to de-risk by avoiding challenging supply areas needing investment, favoring easier sources instead.

There are several **third-party offered voluntary profit-focused approaches and instruments** applied in the tin supply chain. Suppliers can apply for certification schemes as discussed in (Strasser et al. 2024). Certification for ISO 14001 seems to be the industry standard, as seen on company websites like AIM Metals & Alloys LP, PT Timah and Minsur (PT TIMAH TBK n.d.; AIM Metals & Alloys LP 2019; Minsur 2022). PT Timah, an integrated company, allocates a budget for various certifications related to waste management, emission, and remediation, (Harahap et al. 2018). However, taking into consideration the large scale of ASMs in the tin supply chain there is limited evidence that (voluntary) certification schemes improve working conditions or miner capacities (Franken et al. 2020). Issues such as unrecognised land titles complicate responsible sourcing, potentially **increasing costs without external financial support** (Franken et al. 2020). Research by (Matthysen et al.) suggests that increased regulation in ASM might negatively impact the socioeconomic status of miners. This is supported by (Hilson

[9] In addition to not adhering to the RMAP, smelters can be removed from the list due end of economic activity or due to smelters decision not to continue participating in the program.

et al. 2016), who highlight the limitations of certification schemes (and other voluntary sustainability initiatives) in supporting ASM development. According to the civil society organisation Electronics Watch, the example of mining cooperatives in Bolivia (**supplier-collective voluntary approach**) highlights the challenges miners face in adopting sustainable practices (Electronics Watch 2023). Miners struggle financially due to late payments from smelters and fluctuating tin prices, which makes it difficult to invest in modernising equipment as required by evolving environmental regulations. Despite these constraints, mining cooperatives in Bolivia are addressing their environmental impact. With limited resources, they have innovated by developing systems to recycle water, substituting harmful solvents with less polluting alternatives like soap, and reprocessing minerals typically discarded as waste. In addition, the lack of access to credit further hinders their ability to adopt sustainable practices. However, a potential solution lies in a **cooperative approach with smelters** to access affordable and sustainable financing (Electronics Watch 2023). Similarly, in industrial mining, identifying and managing additional costs, from compliance to on-site improvements, remains a challenge, according to (Franken et al. 2020).

The Tin Code standards are designed for global tin mining, smelting, and recycling operations and aim for harmonised reporting, progressive improvement. They also include provisions for third-party verification, especially benefiting small-scale and artisanal miners (**supplier-collective voluntary approach**) (ITA n.d.a). Initiated by the producers, the Tin Code provides a systematic format for providing information to buyers. Originally a voluntary initiative, the International Tin Association's (ITA) requires its members to adhere to the Tin Code and publish the reports on ITA's platform. For example, the smelting company Thaisarco adheres to the International Tin Association's (ITA) Tin Code, focusing on risk identification and regular mine visits, with findings published in their yearly mine-visit reports (Thaisarco 2022).

The London Metal Exchange (LME) has introduced a Responsible Sourcing Policy for LME-Listed Brands, focusing on ensuring supply chains respect human rights and avoid contributing to conflict financing or corruption (LME 2024). In addition, the policy mandates that all producers manage environmental risks at their facilities (**third-party offered voluntary profit-focused approaches and instruments**). By December 31, 2023, producers had to demonstrate their implementation of the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas, and submit ISO 14001 and ISO 45001 certificates to demonstrate their environmental and safety management systems. Non-compliance can result in the LME suspending or delisting the brands (LME 2024). According to the LME presentation "ESG Transparency on the Exchange" (2022), the exchange collects information on 160 data points listed on LMEpassport which cover, among others, data related to the GHG emission reporting (scopes 1, 2, and 3), ISO 14001, and the ITA Tin Code. In this presentation the LME acknowledges the potential of **green premiums** to promote sustainable practices and aims to empower its users to base their procurement choices on ESG criteria. This will be enabled by analysing and pricing of relevant sustainability and ESG data and pricing premium into contracts (Hanson 2022). However, this practice is not yet available.

According to Loch et al. (2023), the above-mentioned RMI is the only organisation that has a programme targeting the tin industry, which in turn poses some limitations for the smelters, since they don't have alternative programmes to switch to. In addition, there is limited visibility for the downstream actors in terms of where the smelters source their metal from (Loch et al. 2023). The **chain of custody/traceability** is a **buyer-individual approach**, ensuring that suppliers meet the sustainability criteria set by the downstream actors (e.g. through tier-specific supplier code of conduct) (van den Brink et al. 2019). One of the traceability approaches in use is

the iTSCi scheme[10], established after 2010, which has been functioning effectively but also has its own challenges (Postma et al. 2021). Focused primarily on mines, iTSCi involves tagging and sealing sacks of mineral concentrate. If the seals are cut, it indicates potential tampering with the minerals, allowing for follow-up actions. By 2019, the scheme covered more than 2,000 mines (Pact n.d.); however, some industry experts question the scheme's effectiveness, particularly due to the management of mining sites where contraband tin can still be smuggled in between the audits by upstream actors. Ensuring the traceability would require permanent on-site representation of the **downstream buyers at their own cost**, however this approach is too expensive to implement. In addition, it would require set-up costs from the supplier's side. While different traceability schemes and approaches ensure market access for the mines under these schemes (Franken et al. 2020), the associated costs must be covered by the miners.

According to some industry experts, it is very challenging to track exactly from which mine the supplied tin originated without having integrated supply chains. The smelting and refining company Thairasco, however, determines the origin of tin by requesting origin information for each transaction (buyer-individual voluntary approach and instrument). According to the Thairasco's public due diligence report (Thaisarco), this approach ensures the transparency for the mineral origin and its supply chain, the supplier names and locations. One interviewed industry expert confirmed that this approach could be successfully applicable by other companies and in different countries. However, this would require investment by the companies into the development of internal processes and supply chain tracking capacities.

One company interviewed for this study has taken a more unique approach to tackle this challenge of transparency and environmental-protection data by developing its own supplier auditing standards (**buyer-individual voluntary approach)**. This was motivated by the company's assessment that existing public standards and guidelines are not meticulous enough to address all relevant sustainability issues in tin mining. By setting its own standards, this company pursues a coercive strategy and ensures that it only works with a select group of suppliers who meet these criteria and discontinues their engagement with the remaining suppliers (**punishment-based approach**). The company pointed out that suppliers are not offered financial incentives or price-premiums for meeting these standards.

The tin supply chain has seen the development of various voluntary sustainability initiatives aimed at addressing industry impacts, involving multiple stakeholders. The initiative the Tin Working Group (TWG)[11], supported by companies like Apple, includes aid for land reclamation and helps secure external funding for sustainable land reclamation projects area (**civil society-enabled voluntary impact-focused approaches and instrument)** (TWG 2015). The TWG has also created the TWG Incentives Guide, outlining approaches for responsible tin mining in Indonesia, and developed best practice guidelines, offering broader applicability within the industry (TWG 2015).

Emerging approaches:

Blockchain: leading mining companies and downstream industries are adopting and improving innovative data exchange techniques, such as decentralised databases like blockchain, to enhance their operations (Franken et al. 2020). One of the key advantages of this technology is its ability to share information among participants securely and without manipulation, while maintaining business confidentiality (Franken et al. 2020). However, Franken et al. (2020) highlight a challenge: ensuring the accuracy of the data initially entered into the system.

[10] ITSCI framework to assist companies with traceability, due diligence and audit requirements from purchasing 3T minerals, from the DRC, Burundi, Uganda and Rwanda.

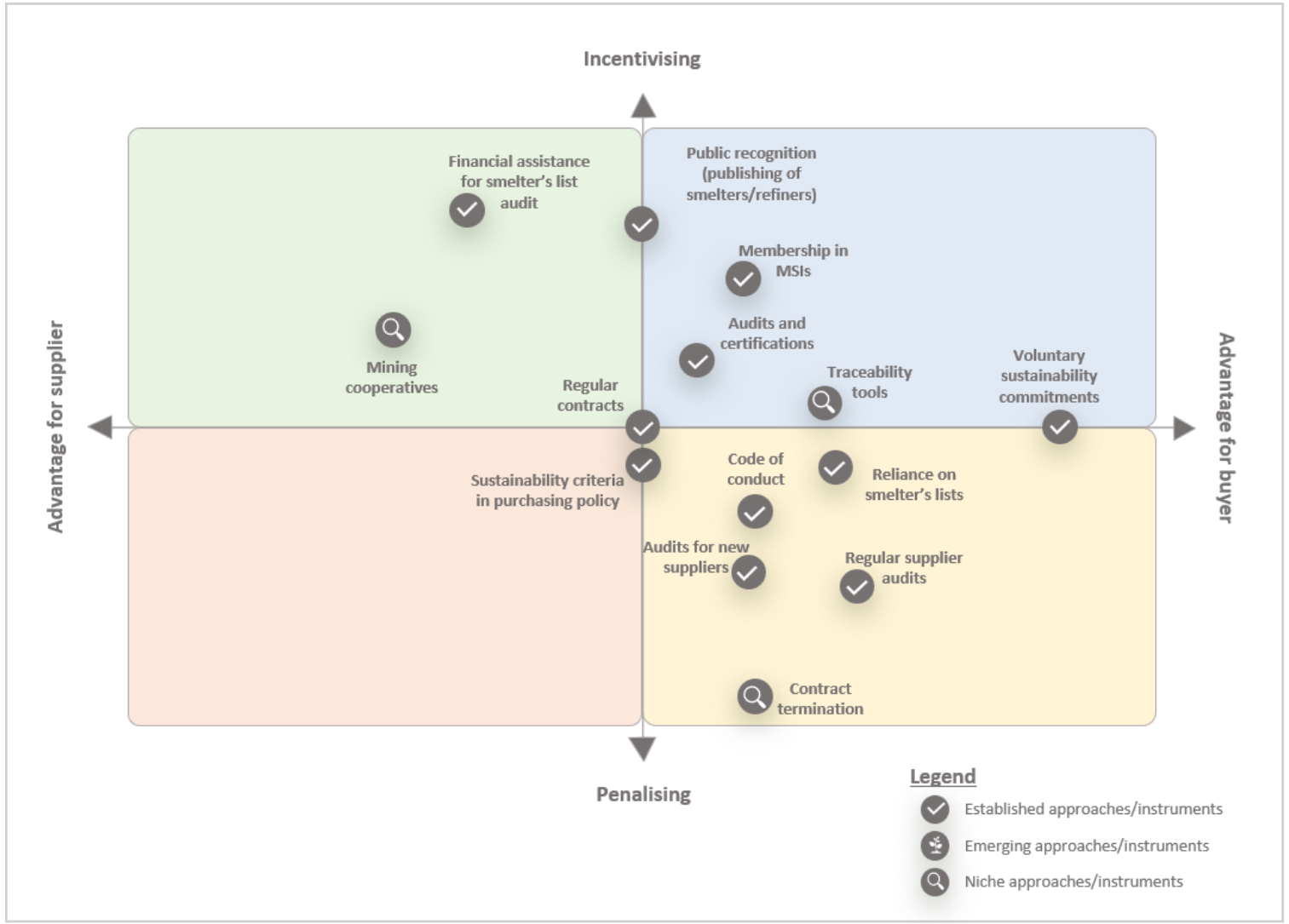
[11] The TWG activities were focused and located in Indonesia.

Addressing this issue effectively requires robust on-the-ground monitoring and capacity-building efforts (Franken et al. 2020). The use of blockchain technology is currently being tested in pilot projects to improve traceability and accountability within the supply chain. For instance, Apple has implemented blockchain traceability for their 3TG minerals supply chain as of 2022, as reported in their conflict mineral disclosure report (Apple 2022b). It is not clear to what extent the suppliers were involved in setting up this system or were simply following Apple's standard (coercive) practices. In addition to pilots, there are some examples where the blockchain technology is applied on a company level, such as in the case of one smelter in Uganda (Adetimilehin 2023). The RMI has provided guidelines on using blockchain in mineral supply chains (RMI 2020). However, this approach is not yet a standard in the industry. A key challenge in utilising blockchain for mineral traceability lies in verifying physical transactions, which could be addressed by integrating it with a reliable sustainability scheme, particularly in the relevant locations (van den Brink et al. 2019).

Circular economy: due to its properties and economic value, tin can be recycled without sacrificing quality (ITA n.d.b). This presents an opportunity for the tin industry to close the loop on tin usage by prioritising reuse and recycling, and by contributing to enhanced resource productivity, reduced energy consumption and emissions, as well as minimised waste disposal (ITA n.d.b). A leading example is Apple, which has committed to using only recycled materials in its products. As of 2021, their efforts have led to achieving 100% recycled tin utilisation according to their 2022 Environmental Progress Report (Apple 2023). Additionally, a company interviewed for this study reported sourcing 75% of their tin from recycled sources, highlighting the growing trend towards circular practices within the industry. According to the company, the cost of recycled tin is similar to the price of virgin tin, however, the recycled metal has lower GHG impact.

Placing the described business approaches and instruments observed in the tin ore-solder industry in a matrix, according to the definition of (perceived) distributional fairness (advantage for supplier/advantage for buyer) and approach to influence the desirability of the requested changes for the business partner (incentivising/penalising) presented in Chapter 2 and Chapter 5, the following pattern emerges:

Figure 3: Matrix of instruments and approaches in the tin supply chain



Source: own illustration (adelphi).

As illustrated in Figure 3, approaches primarily based on penalties typically provide a (perceived) advantage for the buyer. In contrast, incentive and reward-based instruments often offer benefits to both buyers and suppliers. However, only a few approaches and instruments are positioned centrally on the x-axis, indicating a more balanced benefit for both parties. Despite most of the instruments and tools being established practices within the industry, there are some niche instruments that have been applied only in specific instances by few stakeholders. For instance, traceability tools are not uniformly applied across all industry players, categorising them as more of a niche instrument.

It should be noted that the representation of the instruments and approaches described here is simplified and primarily illustrates the main practices. The actual application of these instruments and approaches can vary between parties. In addition, not all the instruments and approaches are utilised across the sector. As indicated before, some are specific to individual cases and are only implemented by certain stakeholders.

5.3 Natural Rubber

Various environmental impacts are generated along the supply chain from natural rubber cultivation to the manufacturing of automotive tyres, which can have negative effects depending on the regional context. Table 3 provides an overview of such potential impacts at selected supply chain stages. Deforestation (at cultivation level) is currently the most widely discussed environmental topic in the natural rubber supply chain. The expansion of natural rubber cultivation is the second largest driver of tropical deforestation in Southeast Asia (where much of the world's natural rubber is harvested) after the cultivation of palm oil. While around 86,000 km^2 of land was occupied by rubber plantations in Thailand, Indonesia, Malaysia, India, Sri Lanka and other neighbouring countries in 2014, it is expected that an additional 43,000 to 85,000 km^2 of new rubber plantations will have been added in the region by 2024 (Cho et al. 2022).[12] This expansion could lead to significant environmental degradation, as rubber plantations, which are largely established as monocultures, do not offer native plants and animal species the same conditions as tropical rainforest, which threatens biodiversity and fragments habitats (Haustermann and Knoke 2019; Millard 2019; Otten et al. 2020; Cho et al. 2022). In addition, smallholder farmers often use slash-and-burn techniques to clear new land for cultivation, which releases significant amounts of greenhouse gases (GHGs), particles and other air pollutants (Haustermann and Knoke 2019; Cho et al. 2022).[13] Natural rubber processing factories require large quantities of water for the processes of washing, factory cleaning, diluting chemicals and field latex, as well as for cooling the equipment (Dunuwila et al. 2018). Inefficient water management can lead to very high fresh water consumption, which can increase regional or local water scarcity. In addition, various chemicals are used in the manufacturing of different raw rubber types, which must be filtered out of the wastewater so that they are not released into the environment to pollute surrounding waterbodies or soil (Dunuwila et al. 2018; Sitepu et al. 2019). Additional negative environmental impacts along the supply chain can result from the use of pesticides and herbicides, amongst other chemicals, as well as from energy consumption based on non-renewable energy sources (cf. Dunuwila et al. 2018; Tanielian 2018; Haustermann and Knoke 2019; Millard 2019; Sitepu et al. 2019; Cho et al. 2022; WBCSD 2022).

[12] The relationship between the (volatile and currently relatively low) price of natural rubber and the increase in deforestation for cultivation is somewhat ambiguous. On the one hand, some studies show that rising prices motivate the planting of new rubber trees. On the other hand, rising prices may mean that smallholders can live better off their existing plantations and are not forced to plant additional trees for more income (Haustermann und Knoke 2019). Warren-Thomas et al. (2023) also point out that if prices for natural rubber fall, farmers might develop new land for alternative crops to generate additional income until natural rubber prices rise again, leading to "indirect" deforestation.

[13] The second factor driving companies in the natural rubber supply chain to take action against deforestation is the adoption of the EU Regulation on Deforestation-Free Products (EUDR), which will require companies to track their supply chains to prove that their products are not linked to deforestation or forest degradation from the end of 2024. To meet these requirements, companies must establish a due diligence system to identify risks of deforestation in their supply chain and take appropriate corrective action. This requires transparency and traceability down to the plot of land. Companies are required to indicate in their due diligence declaration the geographical coordinates of the plots on which their commodities were produced before they are allowed to place their goods on the European market. This is to be done with the help of mobile phones and digital applications such as geographical information systems (GIS). For plots larger than four hectares, geolocation should be done using polygons (European Commission 2023).

Table 3: Main environmental impacts along the natural rubber-tyre supply chain

	Cultivation & harvest		Processing			Tyre manufacturing	
	Planting, cultivation of rubber trees	Tapping, collection of latex in cups	Cutting/ shredding	Washing	Drying	Cutting/portioning	Mixing & Assembly
Water	Irrigation of plantations, sedimentation through erosion of land			High fresh water consumption, inefficient water use, toxic wastewater			
Land use/ Soil	Soil degradation through monocultures, deforestation						
Energy			Fuel choices, low machine efficiency			Generation of steam and compressed air, cooling and powering industrial machinery	
Chemicals	Improper use of fertilisers, herbicides, insecticides and fungicides		Application of various chemicals such as sodium bisulfite, acids, bleaching agents, diammonium hydrogen phosphate, tetramethylthiuram disulfide and zinc oxide, and ammonia				
Air	Land clearing via slash-and-burn technique	Usage of old machinery and fuel choices	Lack of pollutant removal techniques				Emission of volatile organic compounds
Waste						Downgraded manufacturing waste (e.g. elastomers, non-compliant tyres); industrial waste (sludges, electrical equipment, packaging)	

Source: own illustration (adelphi), based on information from Dunuwila et al. 2018; Tanielian 2018; Haustermann and Knoke 2019; Millard 2019; Sitepu et al. 2019; Cho et al. 2022; WBCSD 2022.

The industry has introduced different approaches and tools for sustainable supply chain management (SSCM) in order to address some of the most pressing environmental issues mentioned above. However, it should be emphasised that the natural rubber-tyre sector only began to move towards improved sustainability a few years ago (Millard 2019). Haar and Simons (2019) describe the sector as being in its "inception" phase of the sustainability transformation, which is marked by fragmented pilot projects and innovation, little collaboration on sustainability and a lack of structural improvement (ibid.; Millard 2019). This is also reflected in a rather limited number of approaches and instruments for incentivising stakeholders in the natural rubber-tyre supply chain to implement environmental protection measures, which were identified during the research and interviews for this study. These findings also support the general observation formulated in Chapter 4.3, i.e. that relationships between buyers and suppliers today are still predominantly characterised by a coercive attitude. From the extensive range of different instruments and approaches described in Chapter 2, a mix of **buyer-individual**, **third-party initiated** and some initial **supply chain-collective** approaches and instruments, which are generally applied on a **voluntary basis**, were observed in the natural rubber-tyre supply chain. Many of the approaches and tools described in the following sections have only been applied by selected buyers or suppliers in the industry and do not (yet) apply to all stakeholders.[14] Due to their position of power in the natural rubber supply chain, tyre manufacturers[15] are said to have the greatest influence on industry initiatives and are likely to drive the movement towards sustainable production (Millard 2019); for this reason, the chapter focuses mainly on the tools and instruments applied by them towards and in cooperation with their suppliers (processing factories and farmers/plantations).

Purchasing companies in the natural rubber-tyre supply chain apply a number of **buyer-individual voluntary approaches and instruments**, including sustainability policies, supplier codes of conduct and supplier contracts that specify their expectations in terms of minimum requirements and target performance levels towards their suppliers, mostly taking a coercive approach where the implementation of standards is demanded unilaterally by the suppliers. In defining their expectations i.e. regarding "adequate standards" for wastewater management that go beyond legal minimum requirements, companies sometimes refer to joint voluntary standards established in **supply chain-collective voluntary** settings. An example: criteria developed by the Global Platform for Sustainable Natural Rubber (GPSNR), a multi-stakeholder platform which includes members from all levels of the supply chain, from farmers to car manufacturers, thus taking a more collaborative approach to developing industry standards for sustainable natural rubber production (GPSNR 2020). The GPSNR Policy Framework provides for key components that GPSNR members have to include in their natural rubber purchasing (and production) policy documents. Those include commitments to healthy, functioning ecosystems and supply chain assessment, traceability, and management, i.e. via a renouncement of using open burning/fire in natural rubber farming and preventing water contamination from agricultural chemicals (GPSNR 2020). Another relevant MSI is the Sustainable Natural Rubber Initiative (SNR-i), which was established by the International Rubber Study Group (IRSG) and also supplies its members with (environmental) performance criteria, indicators and KPIs for "sustainable natural rubber," which can be used on a voluntary basis as guidance for the inclusion of sustainability criteria, e.g. in purchasing policy documents (IRSG 2014). Some purchasing companies have drawn up individual guidelines describing the basic principles that

[14] In providing concrete examples of tools and instruments, this chapter draws in particular on the Global Platform for Sustainable Natural Rubber (GPSNR) Reporting Requirements Submissions of various member companies from 2022, which are (almost completely) publicly available online (GPSNR 2022a).

[15] The top five leading manufacturers are: Michelin, Bridgestone, Goodyear Tire & Rubber Co., Continental, Sumitomo Rubber Industries Ltd. (Kraft et al. 2022).

should guide their entire supplier relationship and the purchasing department, in particular (**buyer-individual voluntary approaches/instruments: sustainable procurement practices**) (cf. Michelin 2020a). In 2016, tyre manufacturer Michelin was the first company to establish a dedicated "Sustainable Natural Rubber Policy", which includes specific commitments for the environmental performance of joint ventures, suppliers and their subcontractors within their natural rubber supply chain; business partners are expected to establish management systems to ensure compliance with laws and regulations as well as all aspects described in the policy. The environmental provisions of the policy include a commitment to using best management practices to protect soils and peat, not using open flames in operations and reducing energy consumption (Michelin 2021). Such policies usually do not include commitments on the part of the buying company to financially support the implementation of requested environmental best practices at suppliers; rather, these are formulated as a necessary prerequisite for the establishment of a business relationship – i.e. indicative of a coercive approach.

Several purchasing companies state that, when admitting potential new suppliers to their approved supplier list, candidates are already assessed with regard to their environmental performance; this represents a penalty-based and coercive approach, as suppliers that fail to meet certain environmental standards during the approval process lose a potential business opportunity (cf. GPSNR 2022c; Michelin 2022; Southland Global Pte Ltd 2022). For example, Michelin describes that, in order to be approved as new suppliers for the bidding process, manufacturers must meet certain CSR criteria, which include requirements for energy consumption and emissions, water use and biodiversity (in line with Global Compact and ISO 26000 standards). The assessment is carried out via a questionnaire to be completed by the potential suppliers themselves and can be supplemented by an on-site visit (this can include a supplier audit, tours of one or several supplier sites or tests at Michelin sites). Michelin also reserves the right to ask potential new suppliers for information in order to carry out a product or service life cycle analysis (cf. Michelin 2020a; Michelin 2020b; Michelin 2022). We do not have any information on who pays the costs for these one-off audits during the supplier approval process and whether they are carried out by the buyer's own staff or by third parties; it can be assumed, however, that they are borne by the purchasing company, as suppliers are not certain to pass the process and would otherwise run a high financial risk by participating in the approval procedure.

Suppliers who have successfully passed the onboarding process and are included in the approved supplier list can then apply for tenders and/or are specifically asked by the purchasing company for a quotation. Only then is a contract or purchase order concluded through negotiation (Michelin n.d.) (**Buyer-individual voluntary approaches/ instruments: supplier contracts**). For suppliers with whom a contract has been concluded, further audits can be carried out on a regular basis (i.e. annually or bi-annually) in order to check compliance with e.g. environmental requirements (cf. Michelin 2020b). Michelin, for example, has set itself the target of auditing over 98% of its purchasing volume by 2025 with regard to certain "basic standards on environmental aspects" (including: evidence of provisions to mitigate risk of environmental impacts, including treatment of effluent, management of hazardous waste, and storage of chemicals). If serious violations are identified during the audit, suppliers must implement time-bound, corrective action plans – which is a rather penalty-based, coercive approach (Michelin 2020b). However, this process often does not cover all stages of the natural rubber-tyre supply chain. While most tyre manufacturers know all the processing factories they buy from and car manufacturers know their tyre suppliers, audits typically fail to capture the more complex structure of the supply chain at the smallholder and intermediary level, as many processing factories and downstream actors state that they cannot (yet) trace their supply chain back to the

individual farmer (cf. Cocoasource PTE LTD 2022; Michelin 2022; Southland Global Pte Ltd 2022; SPOTT 2023). We do not have any information on who pays the costs for these regular audits and whether they are carried out by the buyer's own staff or by third parties. The research team is also not aware of any cases in which purchasing companies have provided financial support for the implementation of the corrective action plan by their suppliers.

Several buyer companies (mainly tyre manufacturers) also use third-party verified sustainability rankings (**third-party initiated: civil society-enabled voluntary for profit approach**) (e.g. provided by Ecovadis) in order to regularly collect sustainability information from their tier 1 suppliers (mainly processing factories) and map their supplier basis in order to understand the relative risk with regards to e.g. environmental impacts and identify weak performers. Such systems are key instruments of the coercive strategy, in which the roles of buyer (requesting sustainability data) and supplier (providing sustainability data) are clearly divided. The provider Ecovadis, which is mentioned by several tyre manufacturers and automotive OEMs, offers different levels of audit approaches. The most comprehensive Ecovadis assessment, including the creation of a sustainability performance scorecard for each supplier, entails additional costs for suppliers, but also leads to non-financial benefits. [16] According to an interview with an Ecovadis representative, suppliers can use their Ecovadis rating scorecard for their own marketing purposes to acquire new customers, or if, for example, loans or tenders are tied to the achievement of a certain Ecovadis score or a third-party-legitimised sustainability performance audit.[17] Ecovadis scores can be used by buyers to communicate specific improvement suggestions to their suppliers, to agree on corrective action plans or to make a selection from their broad supplier base for the implementation of environmental upgrading measures (i.e. start with the worst-rated suppliers or set up pilot projects with well-rated companies). If suppliers fail to fulfil the provisions defined in corrective action plans or suppliers refuse to undergo an Ecovadis assessment, this can ultimately lead to a suspension of a supplier contract – which likewise indicates a rather coercive and penalty-based approach (Michelin 2022; WBCSD 2022). In an interview with Ecovadis, they shared their experience that the response rate from suppliers who are part of a sector initiative is significantly higher than for other suppliers.

In contrast to the traditional, coercive approach to supplier contracts and auditing processes, some more incentive- and reward-based **buyer-individual voluntary instruments** can be observed as emerging approaches: several tyre manufacturers report that they provide selected suppliers with training courses (in-person or online) or technical advice during on-site quality

[16] For example, an unlimited number of suppliers can be checked for potential risks based on their location and industry using AI-supported risk mapping (IQ Plus) based on publicly available data and documents (this requires information from the buyer about its supplier base, the suppliers are not actively involved) (Ecovadis n.d.b). According to the outcome of this initial screening, buying companies can accordingly ask selected (or all) suppliers to be audited by Ecovadis and have an individual scorecard drawn up. During this comprehensive assessment, suppliers, supported by Ecovadis (i.e. via the Ecovadis Academy), must complete a questionnaire adapted to the size and location of the company and supporting documents must be submitted to the Ecovadis analysis team to verify environmental claims (Ecovadis n.d.d). For the comprehensive audit and creation of an Ecovadis scorecard, both the buyer and the supplier must pay a fee (depending on the size of the company) (Ecovadis n.d.c). In addition to the fee-based, comprehensive supplier audit with the creation of a separate scorecard for each company, Ecovadis has also been offering a shorter, free Vitals questionnaire since 2024. Buyers can send this to their suppliers and ask them to provide them with sustainability-relevant data (Ecovadis then calculates the company-specific sustainability risk based on the information provided). The digital Vitalis questionnaire is intended to target suppliers for whom buyers do not have enough leverage to convince them to undergo a full Ecovadis audit for which a fee is charged (Ecovadis n.d.a). However, in the interview it was emphasised that the information provided by suppliers in the Vitals questionnaire is not verified by Ecovadis and no supporting documents need to be submitted for the verification of the claims.

[17] According to an interview with Ecovadis, this is an important incentive that companies present to their suppliers as an argument when they ask them to undergo an Ecovadis audit. According to an interview with Ecovadis, the number of companies (buyers and suppliers) that voluntarily choose to be assessed by Ecovadis (without being directly requested to do so by a buyer) is also growing, as banks are increasingly linking the granting of loans to a specific Ecovadis (or comparable sustainability) score and offering best performers more favourable interest conditions, for example. Accordingly, a certain Ecovadis (or comparable sustainability) rating is also sometimes referred to as a minimum requirement in tenders issued by companies for new services to be purchased.

audits, in order to raise their awareness for environmental issues, improve efficiency and support the implementation of environmental standards. In this way, they are taking a more collaborative approach (GPSNR 2022c; Michelin 2022; WBCSD 2022) (**supplier or sub-supplier development for sustainability**). We do not have any information on who pays the costs for these trainings or whether they are carried out by the buyer's own staff or by third parties, but it can be assumed that they are borne by the purchasing company, thus representing direct non-financial support from buyers to supplier for the implementation of environmental upgrading activities. In line with a more collaborative mindset, these measures enable suppliers to put certain sustainability requirements of their buyers into practice.

Another reward-based approach to incentivise suppliers in implementing environmental good practices that was observed among a few individual buyers is the introduction of awards: for example, Tyre manufacturer Pirelli has introduced a "Best Supplier Award", which includes criteria such as "lower CO2 emissions, high quality, innovation, speed and global presence" (Pirelli 2021). Every year, Pirelli hands out an award to nine of their 14,000 suppliers throughout its global chain; in 2021, Thai Eastern Group Holdings Co, which is an FSC-certified natural rubber supplier from Thailand, received the sustainability award "for its role in the production of the first tyre with Forest Stewardship Council (FSC) certified natural rubber, as well as for its commitment to reducing CO2 emissions and increasing the use of electricity from renewable sources" (Pirelli 2021). It is unclear, however, whether any direct financial rewards are connected to the award, or if it is mainly a (non-financial) sign of recognition aimed at incentivising suppliers to improve their environmental performance.

Several stakeholders from different tiers along the supply chain (including natural rubber farmers, processors, traders, tyre manufacturers and automotive manufacturers) have started to implement **supply chain-collective voluntary approaches and instruments** in addition to their individual activities. The initiative with the highest industry participation at the moment is the aforementioned GPSNR, which was founded in 2018 through an initiative from the tyre manufacturer sustainability initiative the Tire Industry project (TIP) (WBCSD 2022). Within this initiative, member companies develop common standards for good environmental practice along the natural rubber-tyre supply chain and commit to voluntary public pledges to comply with environmental standards that go beyond the legal minimum. However, these pledges and targets, e.g. achieving a reduction in deforestation, are rarely specified with cut-off dates and clear implementation steps, which makes it difficult to measure the impact on the ground (Lambin et al. 2018). The GPSNR has developed several collaboration-based approaches, such as a joint grievance mechanism allowing stakeholders (rightsholders, civil society organisations, other GPSNR members etc.) to file reports about the misbehaviour of GPSNR members. The mechanism is designed to supplement existing, company-individual grievance mechanisms and legal avenues and should therefore only be used if a complaint could not be resolved via company-internal structures. The platform is also offering incentive- and reward-based supplier and/or sub-supplier development activities, such as capacity-building workshops on topics such as income diversification and rubber agroforestry for natural rubber farmers in selected geographical settings that are designed to incentivise smallholder farmers to implement environmental best practices (GPSNR n.d.). In addition, Working Groups (WGs) have been initiated that are e.g. developing an approach for supply chain-collective tracing and transparency instruments. The joint development of such approaches and uniform standards is intended, among other things, to save costs and efforts for both buying and selling companies along the supply chain (GPSNR 2023). As a voluntary and self-monitored membership organisation, the GPSNR takes a rather incentive-based approach to implementing environmental protection in the supply chain. Interested purchasing companies are only required to incorporate policy components defined in a toolkit into their own company policy;

interested smallholder producers must sign a self-declaration in order to become members. The GPSNR finances its current activities via an annual membership fee (the amount of the fee depends on the type of member company as well as company size and turnover; special reductions for non-profit or start-up applicants are possible), some of the capacity-building activities are additionally financed by funding pledges from the member companies so that they can be offered free of charge to smallholder farmers (GPSNR n.d.; GPSNR 2022b). In 2020, a GPSNR WG tasked to develop a "Shared Responsibility Framework" was established, intended to "ensure that the burden of developing sustainable natural rubber production practices does not disproportionately fall on any single node of the value chain" (GPSNR 2021). Unfortunately, at the time of publication of this study, the work of the WG had not yet been completed and no further details on the design of a shared responsibility approach in the MSI were available.

The policy statements that members of the GPSNR must publish as an entry requirement for membership also contain the commitment that companies will not use or purchase natural rubber that is associated with deforestation (GPSNR 2020). This is in line with the legal provisions of the EUDR (**fourth-party initiated; government enforced compulsory**), whose requirements regarding the traceability of the natural rubber supply chain has led tyre manufacturers (that sell their products on the EU market) to introduce digital solutions to track their tier n+x suppliers and assess their performance regarding several environmental topics, including deforestation and land use (SPOTT 2023; Warren-Thomas et al. 2023; Ginger 2023). Many companies communicate that they are still in the early stages of establishing traceability /mapping for their full supply base due to the highly fragmented natural rubber supply chain, in which there are a large number of smallholders and multiple levels of intermediaries between farmers and processing factories (Millard 2019; Cho et al. 2022; ETRMA 2022; SPOTT 2023). Various digital tools have been established that aim to enable data collection at the smallholder farmer level. One **third-party initiated, voluntary** tool mentioned by several companies is RubberWay (cf. Continental AG 2022a; Michelin 2022; Southland Global Pte Ltd 2022; Radke and Tan 2023) (**third-party initiated voluntary profit-focused approach**). This tool provides a structured survey on environmental, social and agricultural practices that can be opened on mobile devices, so that employees in processing factories and small farmers with a smartphone can also access it. RubberWay is usually facilitated by a natural rubber processing factory, which either interviews farmers directly or obtains information regarding the cultivation level through intermediary traders (Michelin n.d.; RubberWay n.d.b). According to RubberWay, as of November 2023, processing factories, whose production account for 38% of the tyre industry, were using the tool (RubberWay n.d.a). For reporting year 2021, tyre manufacturer Michelin stated that 64% of its supply volume responded to the RubberWay survey (Michelin 2022).[18] According to a study on the potentials of the RubberWay tool to improve sustainability in the natural rubber supply chain, as of June 2022, it was not mandatory for suppliers to provide all information requested in the questionnaire; e.g. the provision of a GPS point was optional and thus "commonly avoided by investigators" in the context of a field test carried out for the study (CIRAD and Agrarian Systems Consulting 2022).

[18] Due to the difficulties of traceability and the implementation and verification of anti-deforestation measures in supply chains based on smallholder cultivation (most prevalent in South East Asia), it has been observed that some companies are increasingly sourcing from larger plantations, mainly in Africa, in response to pressure to comply with EUDR requirements (Lambin and Thorlakson 2018; Lambin et al. 2018; Kennedy et al. 2017; Global Witness 2022). Lambin et al. (2018) refer to a selection bias in this context, in which suppliers are chosen who can more easily fulfil certain requirements, e.g. traceability or proof that no deforestation has taken place in a region in the last 20 years (possibly, because land use change for plantation already happened long ago) (ibid.). However, this does not improve the deforestation situation in Southeast Asia/worldwide and leakage can occur if Southeast Asian producers increasingly serve other markets with lower transparency and sustainability requirements due to declining demand from Europe (Warren-Thomas et al. 2023). In addition, Global Witness (2022) reports that European rubber imports from West and Central Africa have become the biggest driver of deforestation in the region.

Against the background of the mandatory requirements for transparency in the natural rubber supply chain for many buyers resulting from the EUDR (**fourth-party initiated; government enforced compulsory**), it is to be expected that the disclosure of such information will become increasingly mandatory for suppliers and withholding it will be subject to sanctions. The costs of using RubberWay are generally borne by the purchasing company that commissions the survey. However, CIRAD and Agrarian Systems Consulting (2022) highlight that its design allows for the collection of large amounts of data at a comparatively low cost. While there are not yet any comprehensive studies on the actual impact of digital traceability and risk mapping solutions like RubberWay available, as the application has not been in use for long, it can be assumed that answering the questionnaires results in additional work for suppliers. For this reason, the civil society organisation Solidaridad and others propose the introduction of "Fairdata" principles, in which economic benefits arising from the collection of smallholder farmer data should be translated into benefits for the data providers (Solidaridad 2021).

Another option to incentivise the implementation of environmental protection measures at the lower supply chain levels is to purchase products and raw materials from suppliers that are certified according to particular sustainability standards (**third-party initiated voluntary profit-focused approaches and instruments: certification organisations and standards developed in supply chain-collective voluntary settings**) (cf. also Chapter 3.3.6 of Strasser et al. 2024). In the natural rubber supply chain, only limited use has been made of this option to date, without established certificates (more indicative of a coercive approach) or niche certificates (more indicative of a collaborative approach) gaining traction. According to a 2023 assessment of the Zoological Society of London of 30 natural rubber producers, processors, traders and manufacturers, only two companies reported to have certified some of their estates under the FSC management scheme and only one company reported the percentage of all FSC-certified natural rubber products handled, traded and processed (SPOTT 2023). So far, only one automotive tyre type has been proven to use FSC-certified natural rubber, for a specific car model (see FSC-Pirelli cooperation in the production of an FSC-certified tyre for the BMW X5 plug-in hybrid model) (FSC 2021). In addition, PEFC[19], as another major forest certification standard, also offers certification for rubber growers and Chain of Custody (CoC) certification for companies that manufacture, process, trade or sell rubber (PEFC n.d.b; Lambin et al. 2018; SPOTT 2023). At the level of larger plantations and processing factories, ISO 14001 environmental management system certification is applied by many stakeholders. According to the Tire Industry Project (TIP), a voluntary initiative of leading tyre manufacturers[20], 96% of the 241 production sites of its member companies were ISO 14001 certified as of 2021, which also includes water management, for example (WBCSD 2022). In addition, tyre manufacturer Continental, for example, reports that 94% of their tier 1 suppliers are ISO 14001 certified (Continental AG 2022a); this aligns with a report from a natural rubber processor (Southland), which also states that, as of 2021, 92% of their processing facilities have been certified for ISO 14001 (Southland Global Pte Ltd 2022). Certification is usually costly; compliance with the requirements for improved management processes, separation of certified from non-certified goods, verification of conformity, etc. is often associated with high expenses for producers. However, obtaining a third-party verified sustainability certificate does not guarantee the payment of a price premium from the buyer.[21] Instead of paying higher prices for certified

[19] In addition, FairRubber etc. also offer natural rubber certification, but this has so far only been applied to latex products, bicycle tyres etc., not in the production of automotive tyres (FairRubber Association n.d.).

[20] Members of TIP: Bridgestone, Continental, Goodyear, Hankook, Kumho Tire, Michelin, Pirelli, Sumitomo Rubber, Toyo Tires, and Yokohama Rubber (WBCSD 2022).

[21] Neither FSC nor PEFC foresee the payment of a fixes price premium to producers – this is subject to individual negotiations between buyers and suppliers. However, e.g. FSC points out that in the long term and depending on the current market situation,

products, global brands often point to other benefits for suppliers in obtaining certification, such as a preferential market access and improved farm management practices, which can lead to savings for the supplier in the longer term (Lambin et al. 2018).

As confirmed in interviews, individual smallholder farmers are generally unable to bear these costs due to a lack of financial and technical resources, so that certification and environmental upgrading often become an option only for larger plantations or supplier cooperatives (**supplier-collective voluntary approach/instrument**) in which several farmers work together. FSC and PEFC both offer "group certification" as an incentive for rubber growers, which is meant to allow smallholder farmers in particular to share the high costs of ecologically improved farming and certification (PEFC n.d.a; FSC 2020). According to interviews with industry experts, the production of the first and, as of yet, only car tyre made from certified natural rubber (see FSC-Pirelli cooperation in the production of an FSC-certified tyre for the BMW X5 plug-in hybrid model) is based on a supply chain-collective approach between the buyer Pirelli and a cooperative of natural rubber farmers in Thailand. Supplier cooperatives generally offer farmers the possibility of better negotiating positions vis-à-vis traders and processors (Sasmi et al. 2023); by joining forces they can (similar to larger plantations) also serve the quantitative demand of buyers for a certain quantity of certified natural rubber, for example. A jointly operated infrastructure not only saves the time that individual farmers have to spend on cultivation and tapping (so that they can devote themselves to other sources of income), but also facilitates, for example, the purchase of equipment needed for the production of higher-quality natural rubber (Suttipong and Koichi 2019) and the storage of raw materials so that they can be sold at a favourable time when natural rubber prices are quite high in order to achieve a higher price premium.

In the case of CoC certification that applies a segregation approach (**supply chain collective voluntary approach/instrument**), there are also additional costs for each trader and intermediary along the supply chain, as it must be ensured at all times that certified and non-certified material is handled separately and that each link in the chain is subject to regular inspections (ISEAL Alliance 2016; ISO 2020).

Especially with regard to deforestation at cultivation level, the use of blockchain or satellite monitoring, among other things, is intended to solve the problem of verification instead of costly CoC certification (Lambin et al. 2018). Various buyers are also piloting further digital solutions to establish traceability and reduce deforestation on a region-specific basis. Tyre manufacturer Continental, for example, is researching the possibility of using marker technology (immutable chemical-based barcodes) in combination with blockchain technology to ensure that natural rubber declared as sustainable can be traced back to its source (Continental AG 2022b). As of today, however, such initiatives still remain at a **buyer-individual voluntary level** and are usually not (yet) implemented at scale, but rather in small-scale piloting/testing settings.

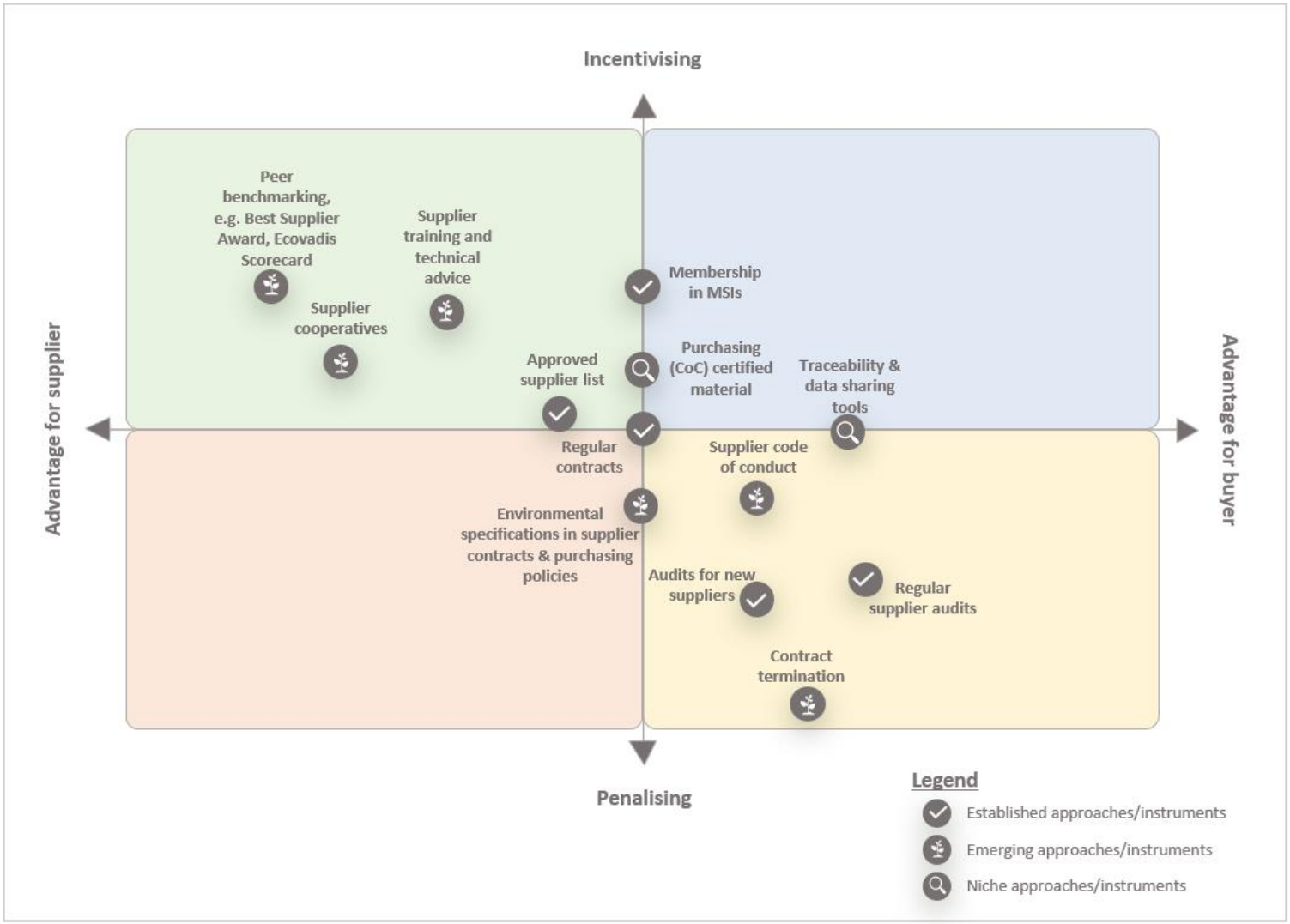
While the research team is not aware of the application of fixed price premiums for "sustainably sourced" products in the natural rubber-tyre supply chain and information regarding contractual details in existing purchasing agreements for e.g. FSC certified natural rubber is not available to the public, several experts pointed out in interviews that offsetting the additional cost of the implementation of sustainability standards via the payment of price premiums or

suppliers can achieve higher prices for their certified products (Kahn 2020; PEFC 2021). In contrast, FairRubber certification does foresee a fixed Fair trade premium of € 0.50 per kg of dry matter (Fair Rubber Association 2021). However, so far, FairRubber certification has only been applied to natural rubber used in latex products and bicycles tyres, not car tyres (FairRubber Association n.d.).

higher prices would be and is one of the biggest pull factor for suppliers to implement sustainability measures.

Placing the described business approaches and instruments observed in the natural rubber-tyre industry in a matrix based on the definition of (perceived) distributional fairness (advantage for supplier/advantage for buyer) and approach to influence the desirability of the requested changes for the business partner (incentivising/penalising) presented in Chapter 2 and Chapter 5, the following pattern emerges:

Figure 4: Matrix of instruments and approaches in the natural rubber-tyre supply chain



Source: own illustration (adelphi).

As shown in Figure 4, the approaches that are based primarily on penalties tend to lead to a perceived advantage for the buyer, while newer approaches that operate more strongly via incentives and rewards are associated with more perceived advantages for suppliers. We use the term "perceived" because calculating the total costs would be very complex, especially as the data is often not available. When taking into account that many of the incentive-based approaches and instruments are still only emerging in the sector or even just implemented by a few stakeholders as niche instruments, it becomes clear that, as of yet, penalty-based approaches have been dominant. However, the growing number of incentive- and collaboration-based approaches contribute to a more balanced picture in which suppliers increasingly gain a perceived advantage if the instruments develop from being "niche" or "emerging" to "established" in the future. The matrix can therefore serve as an indication of which approaches and instruments are particularly promising and should be investigated further with regards to their potential scaling.

5.4 Coffee

The sustainability of the coffee supply chain is influenced by various social, economic, and environmental factors. Environmental concerns, particularly related to land use, carbon and water footprint, and waste, play a significant role. Different segments of the supply chain contribute to distinct environmental impacts. Table 4 provides a summary of these impacts along to the various stages of the supply chain.

Land and land use: coffee cultivation is associated with a critical issue – **deforestation**. Deforestation not only exacerbates other environmental problems, it also serves as a catalyst for them. It is identified as the second-largest contributor to anthropogenic greenhouse gas emissions and a major driver of **biodiversity loss** (Pendrill et al. 2019). The surge in international demand for agricultural commodities is the primary force behind deforestation and its subsequent adverse effects on the environment. It was estimated that the top ten global coffee producers (Brazil, Vietnam, Colombia, Honduras, Ethiopia, among others) emitted 21 million tons of CO_2 due to deforestation associated with coffee production in 2017 (Naomi Basik Treanor and Jade Saunders 2021). Furthermore, the intensive farming practices, such as the excessive application of agrochemicals like pesticides and fertilisers, leads to **soil degradation**, increased soil acidification, reduced soil fertility for plant growth, and pollution of water streams and groundwater. Consequently, coffee yields are adversely affected (Le et al. 2021; UNEP 2021; Manson et al. 2022). Prolonged monoculture in coffee farming has been demonstrated to significantly impede the growth of coffee plants and reduce yields by diminishing soil pH, organic matter content, and the richness of soil bacteria and fungi, while simultaneously increasing electrical conductivity (Zhao et al. 2018). It also has a detrimental impact on **biodiversity** (Fernández, Abraham de Jesús Romero et al. 2023).

Water and wastewater: in cultivation and coffee processing, a **large volume of water** is used for irrigation and for the wet processing of harvested coffee cherries (Martins et al. 2018; Ijanu et al. 2020; Ho et al. 2022). Some coffee cultivation areas are experiencing water scarcity – for example, Minas Gerais and São Paulo (Brazil), (Slater 2019), or the Central Highlands in Vietnam (VietnamPlus 2024). As noted, coffee cultivation requires a substantial amount of water; only approximately 25% of the demand is met by rainfall (Amarasinghe et al. 2015). At present, preliminary estimates indicate that the water consumption for producing one kilogram of green coffee ranges from 8.2 to 29.3 cubic meters, with an average of 18.9 cubic meters, with variations based on regions, coffee species, and cultivation systems (Eriyagama et al. 2014). The projected water footprint for a single cup of coffee is approximately 140 litres in case of the Netherlands, as an example (Chapagain and Hoekstra 2007), with the majority of water being

attributed to the cultivation of coffee trees (Martins et al. 2018). The wet-processing system employs a substantial amount of water, averaging around 15–20 litres per one kilogram of coffee beans, resulting in a significant volume of polluted effluent or **wastewater**. By-products of coffee processing consist of pulp (43%), mucilage (12%), and parchment (6.1%), all of which end up in the wastewater stream. The effluent contains high levels of organic matter and suspended solids and is acidic. Consequently, proper treatment of the wastewater is necessary before discharge into the environment (Ijanu et al. 2020).

Solid waste: the primary contributors include **coffee husks** generated from the processing of cherries using the dry method, bags and sacks discharged after unloading coffee packages, and the waste stream emerging from used coffee capsules or pots. Annually, the coffee industry produces in excess of 10 million tons of coffee waste, which includes husks, pulp, mucilage, silverskins, and spent coffee grounds (Lee et al. 2023b). Coffee husks constitute approximately 12% of the dry cherries by mass (Murthy and Madhava Naidu 2012). For every ton of fresh coffee fruit, around 0.18 tons of husks are generated, and approximately 150 to 200 kg of commercial green beans are produced (Blinová et al. 2017). The husk poses a significant environmental pollution issue because most coffee-processing companies discharge them into the open environment near their sites. The compounds present in coffee husks pose a threat to both health (e.g. respiratory problem, dizziness, eye irritation) and the environment (e.g. from the release of acid, tannins, methane) (Tolessa Amena et al. 2022). **Coffee capsules**, typically composed of around 27% metal and 73% plastic, amounted to a consumption of 48 billion units in 2016. This volume of capsules equates to approximately 576,000 tons of global waste, based on the average weight of a capsule being 12 grams. Unfortunately, this waste stream exhibits low levels of recovery and treatment (Marinello et al. 2021). In addition, most prevalent residues after brewing process in coffee industry are **spent coffee grounds (SCG)**, known for their organic content and acidic characteristics. Typically, one ton of green coffee produces approximately 650 kg of SCG, and each kilogram of soluble coffee produced generates around 2 kg of wet SCG. An estimate indicates a global annual generation of approximately 6 million tons of SCG. The organic compounds within SCG can have various beneficial applications, including the production of biodiesel and activated carbon (Colantoni et al. 2021).

Chemicals: similar to other crops, agrochemicals are employed to manage pests and plant diseases affecting coffee plants. The use of these chemicals has intensified in recent years as farmers seek to boost production and increase profits (Alves dos Santos et al. 2022). For example, Vietnamese farmers use on average 0.6 kg of chemical fertilisers per plant per year, while an optimal application rate of those chemicals is at 0.24 kg per plant per year (Nab and Maslin 2020). Consequently, soil and water become contaminated with these chemicals. Furthermore, the residues of these chemicals in coffee beans may pose health risks to humans due to their toxicity (Alves dos Santos et al. 2022; Merhi et al. 2022).

Energy: coffee stands out as “one of the most energy-intensive food products” (Gosalvitr et al. 2023). According to a European Commission study by Monforti-Ferrario et al. (2015), the embedded energy in the life cycle of coffee is estimated to be around 230 MJ/kg. The processing stage accounts for 33% of the total energy consumption, primarily due to the roasting process occurring at temperatures ranging from 190°C to 245°C (Gosalvitr et al. 2023). Although the brewing (use) stage makes significant contribution to the total energy consumption (Monforti-Ferrario et al. 2015), the energy consumption varies among different methods of preparing coffee (Figueiredo Tavares and Mourad 2020).

Table 4: Main environmental impacts along the coffee supply chain

	Cultivation and Harvesting	Processing	Roasting
Water	Substantial volume of water for irrigation	Processing water used for wet processing	
Land use / soil	Deforestation: relocation or expansion of coffee farms Soil degradation, includes erosion, soil compaction or salination, from intensive farming practices: use of agrochemicals and monoculture plantations		
GHG emissions	GHG emissions from deforestation GHG emissions from fertilizer production and application GHG emissions from the transportation of cherries	GHG emissions from energy-intensive processes: drying and/or milling GHG emissions from the transportation of green beans	GHG emissions from energy for roasting and packaging GHG emissions from the transportation and distribution of coffee products
Chemicals	Chemicals used for pest control, chemical fertilisers		
Waste		Wastewater from wet processing Solid waste from dry processing (coffee husks) Packaging waste (bags, sags)	Packaging waste (bags, capsules)

Source: own illustration (adelphi), based on information from Marinello et al. (2021), Barreto Peixoto et a. (2023)

There have been various sustainable supply chain management (SSCM) approaches and tools used to address these impacts. They can be **individual or collective approaches**, in which, in the coffee sector, most are **voluntary** and initiated by **buyers**. Many of them can be categorised as **supply chain collective approaches** as they involve different stakeholders and require collaboration to succeed. Or, in other words, they reflect the collaboration strategies among supply chain actors. The classification of an approach as collective, individual, or supply chain-oriented depends on the assessment and applications. For instance, certification encourages collective adherence to social, environmental, and ethical standards and involves collaboration among producers, processors, and distributors to ensure fair compensation, environmentally friendly practices, and sustainable agriculture. However, certification can be seen as an individual voluntary approach for coffee suppliers and buyers. The adoption of technology involves individual companies investing in advanced supply chain management technologies like blockchain for traceability, which amounts to an individual, voluntary approach. However, when these technologies are integrated into a platform, like a supply chain transparency or traceability platform, it transforms into a collective approach.

Audits and certification: audit and certification schemes, including ISO 9001, ISO 14001, Fairtrade, Rainforest Alliance, and Organic, serve various purposes. The certification programmes involve collaboration among producers, processors, and distributors to ensure fair compensation, environmentally friendly practices, and sustainable agriculture (**supply chain collective voluntary approach**). They may certify a company's adherence to international standards set by the International Organisation for Standardisation (ISO), endorse farming practices that promote sustainable development, or consider the protection of ecosystems and biodiversity (**buyer- / supplier-individual voluntary approach**). These certifications have been utilised as marketing tools for products, addressing competition and public scrutiny. Consumers often view certified products as safe and environmentally friendly. Sustainability certification schemes aim to assist coffee farmers in maintaining high yields while production costs and environmental degradation can be reduced. This is achieved through educational initiatives on optimal use of fertiliser, energy, and water. Some certificates, like Fairtrade, guarantee a **price premium**. The combination of lower production cost and price premium has been identified as bringing more profits to sustainable coffee agriculture than conventional methods. However, there are limitations, such as difficulties in monitoring certain criteria, a lack of specific requirements for local context to uphold environment and biodiversity protection, overestimation in coffee quantity, or posing a barrier for new producers who have not yet obtained certification (Schmidt et al. 2019; Nab and Maslin 2020).

Companies like Starbucks (2024), Tchibo (2023b) and others deploy **codes of conduct** to align their supply chains with sustainable and ethical practices. Codes of conduct are sets of rules and standards that suppliers in the coffee supply chain are expected to follow to maintain business relationships. These typically cover aspects such as environmental management, social responsibility, and economic practices. Third party certificates also include many codes of conducts. For example, the 4C Code of Conduct (4C Services GmbH 2024) focuses on sustainable production of coffee green bean and post-harvest activities.

Buyers conduct **audits of new suppliers** as essential tools for verifying that suppliers comply with the established codes of conduct. They involve evaluating potential suppliers on their practices and infrastructure, **regular audits** to conduct scheduled checks their suppliers for ongoing compliance, and **corrective actions** to implement necessary changes when discrepancies or violations are found. As a last resort, if suppliers fail to correct their actions, the contract may be terminated. Given the power buyers hold over suppliers, they can impose third-party-verified certifications and codes of conduct that include mandatory certification

requirements, frequent audits, required data reporting, and transparency demands. These instruments are part of coercion strategies. While these strategies ensure compliance with sustainability and ethical standards, they can also place significant financial and administrative burdens on suppliers, particularly smallholder farmers.

Farmer cooperatives (**supplier collective voluntary approach**): many coffee-producing regions, such as Ethiopia and Brazil, have established farmer cooperatives where individual growers join forces to collectively negotiate prices, access resources, and share knowledge. These cooperatives empower small-scale farmers and enhance their bargaining power in the supply chain to a certain extent (see also Chapter 3.4 of Strasser et al. 2024 for more information).

Price premium (**buyer individual voluntary approach**): obtaining certification involves the payment of inspection fees, with some cooperatives and supply chain partners able to bear the economic cost, while, in many cases, it falls on the farmers. This cost burden has the potential to limit farmer participation ability. Moreover, following certification principles and standards may result in lower yields while farmers need to cope with higher operational costs, especially when price premiums are not factored in. The profitability of adhering to sustainable standards and certifications depends on the existence of a demand willing to pay a price premium that compensates farmers for their efforts and the costs associated with altering their production systems (Gatti et al. 2022). From the perspective of international roasters, there is a tendency to pay a price premium for certified coffee. For instance, Nespresso pays an average of 30-40% more for green coffee and 10-15% more for specialty coffees compared to market prices from coffee farmed under sustainable principles (Nespresso 2023b). Consumers also express willingness to pay a premium. In Germany, consumers express their willingness to pay 68% more for carbon neutral-certified coffee over uncertified coffee (Birkenberg et al. 2021). In the United States, a price premium of 27% for organic certified coffee was paid by consumers (van Loo et al. 2015). They expressed a readiness to pay an additional $2.20 per 12 oz (or 0.34 kg) for Bird Friendly coffee in comparison to conventional coffee. The premium prices for certified coffee are not the same; for example, organic coffee was bought at the highest premium at $5.80 per 12 oz, followed by pesticide-free coffee at $3.60, and shade-grown coffee at a lower premium of $1.40 (Gatti et al. 2022).

Traceability tools: traceability has the potential to gain competitive advantages, enhancing operational efficiencies, reducing costs, boosting productivity, securing reputational benefits, and improving environmental performance throughout the coffee supply chain (**supply chain collective voluntary approach**) (León-Bravo et al. 2022). The ongoing discussion is about whether Traceability Systems (TS) are primarily driven by quality or sustainability performance targets – or by the desire to gain recognition and acceptance in consumer markets. TSs can take on various forms, ranging from simple approaches like including product information on packaging or adhering to the Hazard Analysis and Critical Control Points (HACCP) standard, or to more advanced methods such as purchases of certified coffee (e.g. organic and fair trade). Some companies also adopt integrated systems, like blockchain or real-time monitoring. Companies deploy varied TSs based on their capabilities and interests to achieve multiple benefits, including sustainability (**buyer individual voluntary approach**). However, traceability and sustainability are not always managed together, as sustainability is often driven by a company's values and commitment (León-Bravo et al. 2022). The implementation cost of traceability remains a significant barrier, requiring substantial technology and process investments. These features prove useful in addressing operational challenges across various supply chains. Additionally, blockchain supports "**smart contracts**", i.e. computer programmes that automate transactions when predetermined conditions are satisfied (Bettín-Díaz et al.

2022). A noteworthy traceability development in recent years is the emphasis on the origin of coffee. Farmers are leveraging their geographical location to safeguard the reputation and increase the value of their single-origin coffee. This trend presents a new market opportunity by providing consumers with credibility and offering economic advancement for farmers (Sepúlveda et al. 2016).

Sustainable Supply Chain Finance (**supply chain collective voluntary approach**): Supply Chain Finance (SCF) comprises a set of solutions designed to enhance the optimisation and balance working capital within supply chains by leveraging the relationships between buyers and suppliers. These SCF solutions can be deployed to provide financial support to suppliers in need and contribute to supply chain sustainability – in this way, SCF has the potential to serve as an instrument for promoting and disseminating sustainability practices in the supply chains. The Sustainable Supply Chain Finance (SSCF) involve various activities, including financing schemes or trade credit solutions. They act as a means for buyers to enhance the sustainable performance of their suppliers and overall supply chain sustainability. For instance, financing schemes may be implemented wherein the buyer, in collaboration with a financial institution, extends financing at favourable interest rates or offers technical assistance to suppliers engaged in sustainability practices. This support aims to assist suppliers in improving their sustainability performance, with financial incentives provided by the buyer serving as incentives for suppliers (Medina et al. 2023). A number of funding sources under SSCF includes Green Climate Fund (GCF), which uses "a flexible combination of grant, concessional debt, guarantees or equity instruments", to "support developing countries raise and realise their Nationally Determined Contributions (NDC) ambitions towards low-emissions, climate-resilient pathways" (GCF 2023); Coffee Innovation Fund, which is financed by the German Federal Ministry for Economic Cooperation and Development (BMZ), aims to support "pioneering projects that make coffee cultivation more profitable for farmers in innovative ways" (INA 2019). Brands also lead some initiatives linked to SSCF. For example, Coca-Cola Europacific Partners (CCEP), in collaboration with Rabobank, implements a new sustainability supply chain finance programme (CCEP 2022) and coffee was identified as one among 13 priority ingredients and bio-based packaging materials. Another instance is the Starbucks Global Farmer Fund, which extends financial support to coffee farmers through loans for initiatives related to restoration, improvements of agronomy and infrastructure (Starbucks 2023).

Smart contracts (Buyer individual voluntary approach): built upon blockchain technology and Internet of Things (IoT) devices, smart contracts have been developed in the coffee supply chain through various projects. One example is the work of Ramachandra et al. (2023), which seeks to address multiple risks and challenges in the coffee supply chain, including issues related to inadequate storage and transportation facilities, fraud, and data manipulation in coffee trade. The aim is to enhance trading transparency by leveraging advanced technologies. Another instance involves the development and utilisation of a smart contract by Cristian et al. (2022) for monitoring the transportation and storage status of coffee, with data verification mechanisms in place. In essence, smart contracts offer various advantages. They contribute to economic benefits through the deployment of reliable, standardised, fast, and automatically executed transactions, and supporting the reduction of transaction costs. However, the primary components of blockchain infrastructure, including data centres for computation, data storage and transmission, and the creation of smart contracts, land use for data centres, among others, constitute a substantial portion of the overall costs. Smart contracts play a role in promoting sustainability within the supply chain by enabling the verification of pre-defined quality standards or environmental conditions for transaction approval. Nevertheless, the energy consumption associated with the operation of blockchain technology systems contributes to

greenhouse gas emissions, presenting a complex and contradictory relationship between smart contracts and environmental sustainability (Groschopf et al. 2021b).

Company initiatives (buyer individual voluntary approach): some companies take the initiative to implement sustainability practices within their operations. This may include adopting eco-friendly packaging, reducing carbon emissions, or implementing fair labour practices. These efforts contribute to the company's overall commitment to social and environmental responsibility. Some prominent coffee roasters have established their own private certification initiatives. Starbucks, through its Coffee and Farmer Equity (C.A.F.E.) Practices (Starbucks 2020), and Nespresso, with the Nespresso AAA Sustainable Quality™ Program (Nespresso 2023a), have introduced proprietary standards. These standards primarily focus on aspects such as quality, productivity, and sustainable coffee, encompassing economic transparency, social responsibility, and environmental protection. As highlighted in the preceding section, multinational companies within the global coffee supply chain also offer financial initiatives to assist coffee growers. Furthermore, there are other **sectoral initiatives** (**supply chain collective voluntary or supplier collective voluntary approach**) like the Global Coffee Platform (GCP) (GCP 2023), functioning as a multi-stakeholder membership association, and the International Coffee Organisation (ICO) (ICO 2023), serving as an intergovernmental organisation dedicated to advancing sustainability across global coffee value chains.

Educational and training programmes (supply chain collective voluntary approach): collaborative initiatives focused on providing education and training to coffee farmers contribute to improved crop management, sustainable farming practices, and increased productivity. These programmes are often conducted in partnership with NGOs, governments, and industry stakeholders. When they are a part of company initiatives, they might be considered as a **buyer collective voluntary approach**. When suppliers are required to participate in training programmes organised by buyers to ensure they understand and implement the required standards or receive technical assistance offered by buyers, they can serve as a form of coercion strategy if participation is mandatory and linked to the continuation of business relationships.

Climate resilience initiatives (**supply chain collective voluntary approach**): with climate change impacting coffee-growing regions, collective efforts underway to address these challenges. Collaboration involves implementing climate-smart agricultural practices, developing drought-resistant varieties, and sharing resources to build resilience against climate-related risks. Examples of climate resilience initiatives include agroforestry practices (Wienhold and Goulao 2023), diversification in coffee farming (Fadah and Prihandono 2019), and more (water conservation and management, soil management, education and training). If these activities are initiatives in the part of buyers, they can be categorised as representing a **buyer collective voluntary approach**.

Responsible contracting and sustainable sourcing practices (**buyer collective voluntary approach**): the significance of responsible contracting is emphasised for sustainable participants in the supply chain. Companies uphold responsible contracting practices through the implementation of responsible contract policies, agreements, or other instruments related to responsible supply chain operations with enforcement mechanisms (NELP 2017). Critically, the shift towards sustainable sourcing by buyers, as seen in changes to their selection practices, can reshape the dynamics between procurement and sustainability. This transformation influences sourcing criteria and how buyers assess the performance of their suppliers, often facilitated through mechanisms like supplier codes (Cafaggi 2016). International brands, such as Tchibo (Tchibo 2023a), Starbucks (Starbucks 2023), or Jacobs Douwe Egberts (JDE 2021), have

underlined responsible sourcing principles that encompass various sustainability aspects, including land protection, equality, livelihood improvement for farmers, coffee quality, among others.

Direct sourcing (**buyer individual voluntary approach**): companies may choose to directly source coffee beans from specific farms or regions either with or without the Direct Trade label. Direct Trade is an uncertified label indicating a method where coffee roasters directly engage with farmers to negotiate both the price and quality of the coffee, bypassing intermediaries; the process aims to increase income for farmers (Gerard et al. 2019; Direct Trade 2024). This approach allows for closer relationships with coffee producers, quality control, and the ability to establish unique supply agreements that meet the company's specific requirements.

Integrated supply networks (**supply chain collective voluntary approach**): the integration of supply networks involves the sharing of information and resources, collaboration, and organisational linkages among suppliers and purchasers as members. In the coffee industry, increased integration has been observed at regional and national levels, as evidenced by studies in Peru (Ramos et al. 2023), Seka Chekorsa, Ethiopia (Gemechu et al. 2020) and Indonesia, which focuses on digitalisation integration as demonstrated in the study by (Tseng et al. 2022). The advantages of supply network integration include the creation of market competitiveness, increased business profits, total cost reduction, and the development of sustainable customer satisfaction (Gemechu et al. 2020). Furthermore, it enhances accessibility to labour conditions, supply chain finance, and social responsibility (Tseng et al. 2022). Supply network integration has also demonstrated positive effects in responding to crises, such as the COVID-19 pandemic, ensuring higher performance for the coffee supply chain compared to high levels of supply chain agility (Ramos et al. 2023). Some companies in the coffee sector, such as Starbucks (Modum 2020), opt for **vertical integration** by owning and controlling various stages of the supply chain, from coffee plantations to processing facilities and distribution. This can provide greater control over quality, efficiency, and cost.

Circular business models (**supply chain collective voluntary approach**): in a circular economy in the coffee supply chain, resources and materials are maximally utilised through processes of reduce, reuse, recycling, and composting. Circular economy approaches play a pivotal role in facilitating the transition to a sustainable coffee supply chain. Within this framework, circular business models offer solutions to reduce waste and enhance resource efficiency in coffee production (e.g. water efficiency, adoption of organic farming practices, improved harvesting techniques, and regenerative farming practices) and coffee processing (incorporating renewable energy, reusing coffee by-products, recycling packaging, and utilising biodegradable coffee capsules). Other initiatives include implementing take-back systems for coffee packaging, among other measures. Numerous studies showcase instances of reusing coffee by-products, such as ethanol production through the fermentation of coffee husks and pulp, gasification of dry coffee husks, and the cultivation of mushrooms (Lagrasta et al. 2021). Other initiatives involve the production and distribution of coffee cups with the capacity to collect and recover aluminium shells while composting the coffee waste from the cup washing step (Aarikka-Stenroos et al. 2022). There are many other innovative practices.

Government enforced compulsory and collective approaches, such as EUDR (as mentioned in Interim Report 1) and Germany's Act on Corporate Due Diligence Obligations in Supply Chains impact SSCM within the coffee sector. EUDR focuses on curbing deforestation-related imports, compelling the coffee industry to adopt responsible-sourcing practices that prioritise environmental conservation. The German law mandates companies to identify and address human rights and environmental risks in their supply chains, thereby promoting a holistic approach to sustainability in the coffee sector. These regulations collectively encourage

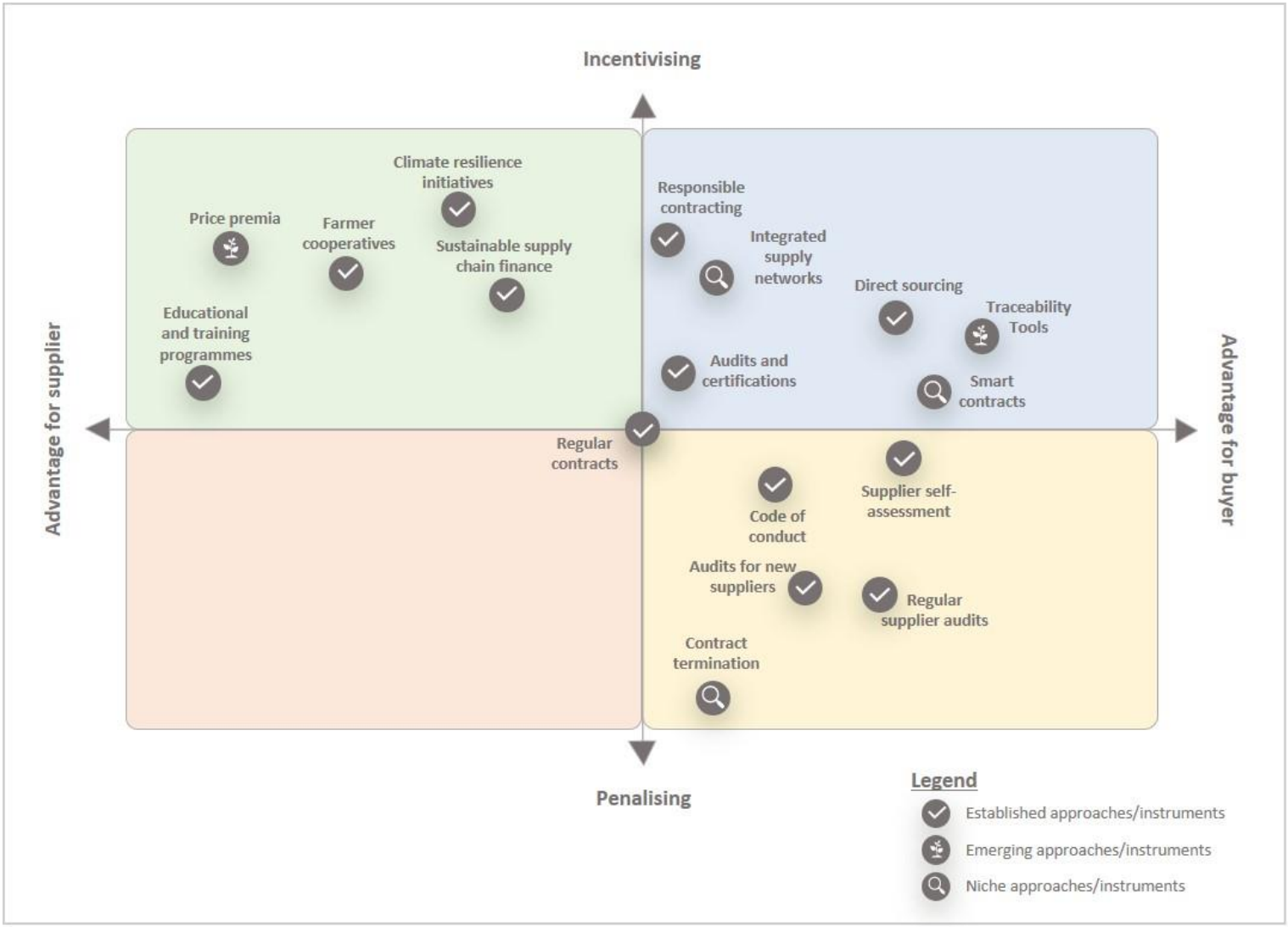
transparency, ethical sourcing, and responsible business conduct throughout the entire coffee supply chain. The costs related to compliance with these regulations are borne by actors in the supply chain. The distribution of costs among stakeholders can vary depending on the specific regulations, industry practices, and market dynamics. In many cases, there is a growing recognition of the shared responsibility for sustainable and ethical practices throughout the supply chain. Collaborative efforts and partnerships between stakeholders are essential to address challenges and ensure the effective implementation of regulations without unduly burdening any particular segment of the supply chain.

The approaches and tools employed for SSCM in the coffee sector contribute to various degrees of improvement in environmental sustainability. These approaches are inherently associated with both advantages and disadvantages/costs for both buyers and suppliers.

Generally, approaches and instruments that promote transparency, fair pricing, and collaboration between suppliers and buyers create a win-win situation for both parties in the coffee supply chain. In other words, most instruments bring advantages to both buyers and suppliers. However, the perception of advantages may vary when viewed from the perspectives of buyers or suppliers, considering factors such as bargaining power or initiation of instruments. As seen from Figure 5, farmer cooperatives clearly bring more advantages for coffee farmers (suppliers) through improving their bargaining powers, improving market access, and supporting shared resources and expertise, but they also offer advantages for buyers through consistent quality and supply, traceability and ethical sourcing. The same assessment can be applied for price premium, circular business models, climate resilient initiatives, educational and training programmes, sustainable supply chain finance, and certificates (e.g. ISO 9001, ISO 14001, Rainforest Alliance, organic). When evaluating other instruments, for example, direct sourcing, company initiatives, certifications (e.g. ISO 9001, ISO 14001), traceability tools, smart contract, responsible contracting and sustainable sourcing, integrated supply network, tend to favour buyers with more advantages. The government enforced compulsory and collective approaches are considered to offer equal advantages for both suppliers and buyers.

Placing the described business approaches and instruments in the coffee supply chain in a matrix based on the definition of (perceived) distributional fairness (advantage for supplier/advantage for buyer) and approach to influence the desirability of the requested changes for the business partner (incentivising/penalising) presented in Chapter 2 and Chapter 5, the following pattern emerges:

Figure 5: Matrix of instruments and approaches in the coffee supply chain



Source: own illustration (adelphi).

As shown in Figure 5, traditional, penalty-based approaches in supply chains are perceived to favour buyers, while newer approaches that emphasise incentives and rewards are seen as more beneficial for suppliers. A variety of instruments and approaches are used within supply chains. Some are well-established practices; others are considered as emerging instruments, such as price premia, or traceability tools that might be driven by recent regulatory requirements. Others, like smart contracts and contract termination, are less commonly used. This analysis can help identify promising approaches and instruments that warrant further investigation for potential wider adoption.

5.5 Iron ore-steel

Various environmental impacts are generated along the supply chain from the mining of iron ore to the manufacturing of steel products for the automotive industry, which can have negative effects depending on the regional context and applied technology. Table 5 provides an overview of such impacts at selected supply chain stages.

At the level of mining and beneficiation, there are high risks for a wide range of negative environmental impacts. Iron ore mining, like other mining activities, consumes large quantities of water, e.g. for extraction, washing, dust control and slurry transport. The wet processes used to beneficiate the ore, such as flotation, can also consume significant amounts of water. Depending on the location of the mines and water management systems, this can pose a threat to groundwater levels, local water supplies and biodiversity (Drive Sustainability n.d.; Kerkow et al. 2012; Weiss et al. 2022). Ecosystems and biodiversity are also strongly impacted by the use of land and the fragmentation of habitats for mines (mostly open-pit), mining infrastructure and the transportation of the ore to ports (Groneweg 2020). According to Drive Sustainability (n.d.), 49% of all global iron ore mines (especially in Brazil, India and Russia) are located in forests, making iron one of the top three (by volume) minerals that are mined in forests. Large areas of native forest are repeatedly cleared for the development of new mines; for example, 9% of the deforestation in the Brazilian Amazon between 2005 and 2015 has been attributed to mining activities (Sonter et al. 2017). Air pollution caused by dust emissions that result from blasting, drilling, or excavating as well as transportation is a major environmental problem and has strong negative impacts on the local ecosystems as well as livelihoods (e.g. agriculture) and health of the local population (Drive Sustainability n.d.; Groneweg 2020). Additionally, the beneficiation of the ore causes massive amounts of waste in the form of solid or wastewater tailings and can lead to the contamination of water (and soil) through the release of waste water (containing heavy metals and industrial refuse like chemical reactants that are used for beneficiation), which may result from the possible leakage from tailing ponds or breach of tailing dams (Drive Sustainability n.d.; Groneweg 2020; Weiss et al. 2022).

Next to water consumption and air pollution, which are relevant in the production of iron, steel and finished steel products (Drive Sustainability n.d.), one of the most important environmental hotspots in the steel industry is energy use. Due to the use of non-renewable energy sources (e.g. coking coal that is used as a reducing agent) in the energy-intensive production processes of steel, the sector accounts for very high GHG emissions (Drive Sustainability n.d.; IEA 2020; Bookhagen et al. 2022; Harpprecht et al. 2022). This energy use does not only make the steel industry the emitter of between 7-10% of total global CO2 emissions, it also accounts for 95% for GHG emissions in the whole iron ore-steel supply chain (Deloitte n.d.; Drive Sustainability n.d.; Voigt et al. 2023). The decarbonisation of steel is therefore one of the single largest levers for the reduction of GHG emissions in the supply chain. In addition, iron and steelmaking are highly material-intensive processes; according to the European Environment Agency (2019) "[m]ore than half of the mass input becomes outputs in the form of off-gases and solid wastes or

by-products". Steel production also uses large quantities of water for cooling, descaling of intermediate products, dust emission abatement etc., which needs to be collected and reused in order to avoid negative environmental impacts on the local/regional water availability (WSA 2020).

Table 5: Main environmental impacts along the iron ore-steel supply chain

	Raw material extraction and processing		Iron and crude steel production		Steel sheet manufacturing	
	Mining	**Beneficiation**	**(Pig/sponge) iron production**	**Crude steel production**	**Refined steel and alloy production**	**Casting and rolling**
Water	Water used for extraction process, washing, dust suppression, slurry transport	Water used for flotation beneficiation and slurry transport; risk of contamination with waste water (containing heavy metals and industrial refuse) through leakage from tailing ponds/breach of tailing dams	High water usage for quenching of coking coal	Water used e.g. in cooling operations, descaling of intermediate products, dust scrubbing; discharge of cooling water can raise temperature in receiving water body (impact on aquatic ecosystem)		
Land use / soil	Use of land for (mostly open-pit) mines, infrastructure & transportation of the ore to ports; risk of contamination with waste water (containing heavy metals and industrial refuse) through leakage from tailing ponds/breach of tailing dams					
Energy	Diesel generators often used to generate power at mining sites		Highly energy-intensive processes lead to high GHG emissions (depending on energy source and technology)			
Chemicals		Usage of chemical reactants				
Air	Dust emissions from blasting, drilling, excavating & transportation of ores; emissions from diesel generators		Sinter plant operation produces emissions of nitrogen oxides (NOx), sulphur oxides (SOx) & on group from combustion activities; dust emissions from coking coal input (for BF	Process emissions include particulates, heavy metals, NOx, CO and SOx		

	Raw material extraction and processing		Iron and crude steel production		Steel sheet manufacturing
			route), sinter plants and stockyards		
Waste		Significant amounts of solid waste and/or wastewater tailings, risk of tailing dam failure	Large amounts of solid waste (sludge), wastewater & off-gases		

Source: adelphi, based on information from based on information from Drive Sustainability n.d.; Kerkow et al. 2012; EEA 2019; WSA 2020; Groneweg 2020; Weiss et al. 2022; ENCORE n.d., and expert interviews.

In recent years, unsustainable practices in the mining industry have been subject to increasing attention (Böhling et al. 2019). This also holds true for the mining of iron ore. Schmidt et al. (2019) highlight that "there is still a huge gap between aspirations for sustainable transformation of the sector and existing mining practices, especially in countries with transitional economies". Accordingly, many of the above-mentioned negative environmental impacts associated with the mining and processing of iron ore remain unaddressed, depending strongly on the extent of local environmental regulations and legislation governing mining operations (Andersen and Noailly 2022) (lack of **government-enforced compulsory approaches/instruments: regulation from developing or industrialising countries;** cf. also chapter 3.5.6 of Strasser et al. 2024). In the steel sector, the implementation of environmental sustainability measures has a longer history. But while there is a growing focus on reducing greenhouse gas emissions, primarily in steel plants themselves, but increasingly also in the supply chain, other environmental issues have received less attention as of yet (Conejo et al. 2020; WSA 2020; Fastmarkets 2022).

As part of the efforts to lower the industry's negative environmental impact, a growing number of tools for sustainable supply chain management (SSCM) are being introduced along the iron ore-steel supply chain. However, many of those instruments that aim to incentivise stakeholders to implement environmental protection have only been developed in recent years and are only applied by selected frontrunners, so that the overall impacts on the actual environmental performance remains ambiguous. With regard to the instruments and approaches described in Chapter 2, mainly **buyer-individual and buyer-collective** approaches as well as **supply chain collective** approaches that are applied on a **voluntary** basis have been observed. In this context, there are many indications that, while more coercive approaches currently prevail, many collaborative projects are simultaneously being piloted and developed. As suppliers in the iron ore-steel supply chain are generally more powerful than in other supply chains in this study (e.g. agricultural and crop-based), buyers have less leverage in directing suppliers. Nevertheless, due to greater customer exposure and stronger regulations, it is still mainly buyers from the automotive industry at the downstream end of the supply chain that drive the process towards environmental protection and the sustainable production of steel. An increasing number of regulations in industrialised countries to achieve decarbonisation have led these stakeholders to focus primarily on reducing GHG emissions along the entire iron ore-steel supply chain (**government-enforced compulsory approaches/instruments: regulation from industrialised country governments;** cf. also chapter 3.5.6 of Strasser et al. 2024).

Most common in the steel and automotive industry are **buyer-individual voluntary approaches and instruments**. Large companies across the industry often apply self-set commitments, sustainability targets, indices or sustainability reports. For example, ArcelorMittal, one of the largest steel producers, has developed a roadmap to carbon neutrality (ArcelorMittal 2021; Deutsche Bank 2021) and Nippon steel, another of the world's leading steel producers, included a commitment to carbon neutrality by 2050 in the company's sustainability report (Nippon Steel 2023). Such commitments usually do not cover the provision of financial support to suppliers to implement environmental upgrading activities, or the obligation of the buyer to provide non-financial support to achieve the target, which is indicative of a coercive approach. The "Green Steel Tracker" by LeadIT (2023) provides an overview of which steel companies have already committed publicly to a carbon neutral target year. Some buying companies translate these self-set environmental targets into requirements for their suppliers, e.g. by developing supplier codes of conduct (CoCs) that include environmental clauses (Rechlin et al. 2022). For example, Thyssenkrupp's supplier CoC includes the expectation for suppliers to apply an appropriate environmental management system (e.g. in accordance with ISO14001). The company states that it regularly audits its suppliers to determine the fulfilment of the

expectations and that it "reserves the right to terminate individual or all contractual relationships" in case the supplier fails to meet expectations or to strive for improvement (thyssenkrupp AG 2022), thus applying a penalty-based and coercive approach. In the automotive industry, Toyota is aiming for zero carbon emissions from its products and plants by 2050; BMW lists its suppliers' carbon footprint as one criterion for the awarding of contracts (Paragamian et al. 2021). Given that specific mixtures of iron ore grades are necessary as input material for the production of high-quality steel products, regular product quality controls are carried out along the iron ore steel supply chain and interviews with industry experts confirmed that technical exchange between the mining and steel sector happens regularly. However, according to interviews with experts, these regular audits and exchanges do not generally include inspections of compliance with environmental standards.

In order to emphasise their commitment to the environment, companies also frequently refer to their membership and engagement in voluntary sustainability initiatives. Nippon Steel, for instance, refers to its involvement in the environment committee of the World Steel Association (WSA) (Nippon Steel 2023). Such organisations exemplify **buyer-collective approaches** that are particularly present at the level of steel production, often aimed at harmonising voluntary standards across the industry. One example: the sustainability indicators, including those related to environmental performance[22], that were developed by the WSA. In 2023, the steel producers whose sustainability performance was assessed either on the basis of voluntary or publicly available data accounted for 53% of global crude steel production (WSA 2023b). The WSA also has a reward-based recognition programme that includes the awarding of "Sustainability Champions". The World Steel Association and its activities are being paid for with annual membership dues that are calculated on the basis of steel production volumes (WSA 2023a). At the automotive industry level, there are also voluntary buyer-collective approaches aimed at improving environmental performance along the supply chain. For example, the Automotive Industry Action Group (AIAG) and the Drive Sustainability initiative have jointly developed "Guiding Principles to enhance Sustainability in the Supply Chain", which were last updated in 2022 and, together with a practical guidance, are intended to support car manufacturers in the uniform implementation of sustainable purchasing practices (AIAG and Drive Sustainability 2022). Another joint approach initiated in 2020 by frontrunner companies in the automotive industry, the Catena-X Automotive Network, aims to increase the exchange of data along the automotive supply chain. The data can not only be used for quality management but also to improve traceability and support decarbonisation efforts, e.g. by making possible the measurement of carbon footprints for products. The network offers certification for its standards, which is carried out by third-party auditors that have undergone training and are paid for by the customers from the automotive industry and its suppliers (Catena-X n.d.a; Catena-X 2023). According to an interview with WorldSteel, the development of joint standards in more collaborative initiatives such as Catena-X is an important prerequisite for improved sharing of environmental data (such as CO2 emission values) along global supply chains. Today, many companies along the various stages of the iron ore/steel supply chain use individual IT systems for their data management that hinder the effective sharing, compilation and processing of information from and with suppliers or buyers. According to Catena-X, the application of uniform rules and standards would result in added value for all stakeholders along the supply chain by reducing cost and data loss. Antitrust concerns are a sensitive topic in the development of uniform standards and the sharing of e.g. CO2 emissions-related data and need to be addressed while providing as much data transparency as possible (Catena-X n.d.b).

[22] CO2 emissions intensity, energy intensity, material efficiency and the existence of an environmental management system

As the iron ore-steel supply chain is characterised by large, financially powerful companies even at supplier level, mining companies increasingly implement **supplier-individual voluntary approaches and instruments** that appear to be guided less by direct pressure of their buyers, but can rather be traced back to increasing attention with regard to the lack of sustainability of their practices and business models, and global regulation of the sector (cf. Chapter 3.5.6 of Strasser et al. 2024). For example, major mining companies such as BHP, Rio Tinto and Vale publish self-set commitments, sustainability targets, indices and sustainability reports (BHP n.d.; Rio Tinto n.d.; Vale n.d.). Beyond such pledges, the activities of mining companies are still rather limited.

While **supplier-collective voluntary** initiatives are often not raw-material specific, some do play a role for the mining of iron ore. Among these is the "Towards Sustainable Mining" (TSM) standard, which was established by the Mining Association of Canada in 2004 (The Mining Association of Canada n.d.a). It addresses issues from water and tailings management to biodiversity conservation and climate change. TSM participants are obligated to publish performance protocols that inform about their management of certain indicators, including "environmental stewardship" at facility level. The initiative offers trainings for participants as well as for verifiers. Its standard is based on yearly self-assessments and reporting with the results verified through external verification by a "trained and accredited verifier" where the client carries the cost of verification audits (The Mining Association of Canada 2021). Innovative projects and initiatives can be awarded with the TSM "Environmental Excellence Award" (The Mining Association of Canada n.d.b), providing for a reward-based approach to the implementation of environmental best practices. The International Council for Mining and Minerals' (ICMM) Mining Principles, including the "Global Industry Standards on Tailings Management" (Global Tailings Review 2020; Global Tailings Review n.d.), are another example of supplier-collective efforts to address sustainability in the iron ore industry and are being referred to throughout the industry (ICMM n.d.b). The ICMM is an industry initiative whose members' performance is subject to self-assessments, third-party validation that the member has to pay for, and disclosure (ICMM 2023).

With regard to the **buyer- and supplier-initiated approaches and instruments** listed until now, it can be said that power relations between different actors in the supply chain, the voluntary character of existing initiatives as well as the variety of standards that do not follow a consistent methodology mitigate the impact of these initial advances, an issue that is acknowledged by industry experts as well as industry bodies such as the International Council on Mining and Minerals (ICMM) (ICMM n.d.a; Palekhov and Palekhova 2019). It has been argued that sustainability initiatives along the iron ore-steel supply chain often lack more collaborative approaches. According to Palekhov and Palekhova (2019), "original equipment manufacturers in the automotive industry are failing to account for environmental risks and difficulties, especially in early stages of the value chain, because contact with and control of companies beyond first-tier suppliers is limited or considered irrelevant for business success". However, in recent years, the growing salience of environmental issues and an increase in regulations, particularly with regard to GHG emissions, has led to an increase in **supply chain-collective approaches and instruments**, a development that may point to changing practices in the future.

ResponsibleSteel is an independent standard and certification initiative and belongs to the more collaborative approaches, as business organisations from the whole supply chain, organisations from civil society, government and standard setting are among its members (ResponsibleSteel 2024). The initiative first published their ResponsibleSteel Standard in 2019 for the voluntary certification of steel producers, which covers environmental (i.e. GHG emissions, biodiversity, waste management, water use), social and governance issues on the basis of twelve principles.

Until recently, the standard only applied to operational steel mills and production facilities that process raw materials for steelmaking (ResponsibleSteel 2024). The revised ResponsibleSteel International Standard V2.0, which was launched in September 2022 as a preliminary version, now also includes criteria on GHG emissions and the responsible sourcing of input materials through the recognition of existing certification schemes for mining companies. The new version stipulates that in order to obtain a "Certified Steel" certification, steel companies must have at least "good visibility of their supply chain links" (ResponsibleSteel 2022), and be able to verify whether their suppliers are certified under one of the three recognised standards Bettercoal, TSM and the Initiative for Responsible Mining Assurance (IRMA). According to RSI, the inclusion of responsible sourcing criteria is intended to create a market demand for responsibly sourced input materials. However, these additional requirements are not (yet) mandatory in order to achieve a "Certified Steel" certificate, but can be obtained voluntarily by ResponsibleSteel members[23]. According to RSI, a mandatory introduction of these requirements is currently not possible, as "participation by suppliers in recognised input material programmes is too low to achieve them" (ResponsibleSteel 2022). ResponsibleSteel explains that first, market demand for responsibly sourced material has to grow and that instead of an obligation, the organisation foresees that "expectations from downstream customers, investors, regulators, civil society and other stakeholders will provide incentives" to purchase certified/verifiably sustainably produced input material in the future, thus taking a rather reward-based approach (ResponsibleSteel 2021). The revised and expanded standard is currently being put through a one-year testing phase with public consultations before the official and complete revision of the standard begins in 2024 (ResponsibleSteel 2022). The audits that are necessary for certification with the standard "are carried out by independent third-party certification bodies approved by ResponsibleSteel and contracted by the site applying for certification" and are paid for by the steelmakers to the certifier (ResponsibleSteel 2022).

Within the context of ResponsibleSteel's ambitions to recognise mining-level standards, it should also be highlighted that such **third-party offered voluntary profit-focused approaches and instruments** are still in their infancy in the iron ore sector. One example for such an approach is IRMA, a voluntary certification initiative established in 2006, whose members come from the mining sector, downstream industries, civil society and trade unions. IRMA has developed one of the most comprehensive and widely recognised standards for responsible (large-scale) mining, covering environmental issues (e.g. waste management, water, air quality, greenhouse gas emissions, biodiversity) as well as various social and corporate responsibility requirements (IRMA 2018; Groneweg 2020). In February 2024, the first independent third-party assessment (audit) of an iron ore mine against the IRMA Standard was completed (IRMA 2024). As of May 2024, independent third-party assessments have been completed for four iron ore mines in Brazil and two in South Africa (IRMA n.d.). Companies undergoing the assurance process at site level have to pay for the necessary audits by an independent service provider (IRMA 2021). IRMA charges a certification fee (a combination of administration and licensing fee) which is charged to all mines that undergo an independent third-party assessment and wish to declare IRMA-related information on their performance (IRMA 2021). Another way to demonstrate compliance with certain social and environmental standards in steel production facilities and iron ore mines is to certify facilities in accordance with the requirements of environmental management standards such as ISO 14001 or ISO 2600,

[23] The ResponsibleSteel Guidance document for suppliers of mined material suggest amongst others, the implementation of a CoC whose implementation should be assessed by the suppliers and their sub-suppliers. Compliance could be checked by the buying company via audits. The guidance also explains that, if a supplier was to be found non-compliant with sustainability requirements, the buyer could implement either soft (i.e. provision of trainings, survey on KPIs, formal warnings) or hard (i.e. contractual penalties) measures to increase the suppliers level of CoC implementation (ResponsibleSteel 2023).

which are already being applied by various companies along the supply chain (Rechlin et al. 2022).

The ResponsibleSteel standard and similar approaches also aim to improve traceability and information sharing along the entire supply chain. The guidance for responsible sourcing of the ResponsibleSteel standard mentions chains of custody as part of their certification process. In this context it means that "input material from different suppliers can be blended and mixed throughout the supply chain, but that the share of input material from mine sites and processing sites that are part of a recognised programme is recorded at each supply chain stage and that related information is transferred from one stage to the next. Suppliers may sell this share as 'CoC Input Material'" (ResponsibleSteel 2023). The guidance states that certain levels of certification with TSM, IRMA and Bettercoal include a chain of custody element (ibid.).[24] Blockchain technology is discussed as another solution to the problem of traceability, but the discussion of its advantages often does not include improvements to sustainability. Nevertheless, some companies in the iron ore-steel supply chain are experimenting with the technology. For example, BHP mentions its benefits for tracking emissions and environmental sustainability but does not yet use it for iron and steel. Vale has completed first iron ore sale using blockchain technology (sold to Chinese steelmaker Nanjing iron & steel) but sees it as a technological innovation that is applied for reasons of efficiency and security (Vale 2020). The increasing interest in the technology is also reflected in a research project on traceability in the steel industry that is financed by the Canadian state (ISED n.d.).

For the future sustainable transformation of the iron ore-steel supply chain, **third-party initiated voluntary profit-focused approaches and instrument** such as the provision of green finance could also be important: sustainability and environmental protection in the mining and steel industry require large scale investments. A study by the Mission Possible Partnership states that while "one might think that giant, multinational firms can readily implement innovations for decarbonisation […], the capital intensive and oligopolistic nature of the iron and steel sector hinders the low-carbon transformation of the industry, although it is true that the companies can invest in big research and development projects" (Mission Possible Partnership 2021). Therefore, initiatives and actions that assure mining and metal companies that more sustainable products such as green steel will find a market and that the additional costs will be covered by buyers (price premiums) are therefore essential (Mission Possible Partnership 2021; Kim et al. 2022). Government regulations often provide initial incentives as well as security for investments but changes in sourcing strategies need to be negotiated directly between buyers and suppliers. Such collaborative agreements have started to become more and more common over the course of the last few years.

The HYBRIT (Hydrogen Breakthrough Ironmaking Technology) initiative, a collaboration between SSAB (steel producer) LKAB (mining company) and Vattenfall (electricity provider) is as of yet the only example of a **supply chain-collective approach** that aims to minimise CO2 emissions in the whole supply chain from iron ore pellets to steel, and that makes use of third-party financial support. Through the use of green energy and hydrogen, it aims to create the first fossil-free steel by 2026. The initiative is incorporated into a research project and financially supported by Sweden and the EU (Hybrit n.d.). In terms of costs, this collaborative project is only

[24] Another third-party initiated voluntary approach that aims to improve disclosure and information/data sharing on environmental impact management along the supply chains for mineral raw materials is the "Extractive minerals transparency initiative" (EITI). EITI is a "global standard to promote the open and accountable management of oil, gas and mineral resources", also covering disclosure of information related to companies' environmental impact (Palekhov and Palekhova 2019). Of the four big global mining corporations, three (Vale, Rio Tinto, BHP) are assessed by EITI and mostly meet the expectations (EITI 2023). However, as EITI is implemented on a national level and none of the largest iron ore producing countries (Australia, Brazil, China and India) have committed themselves to the standard and undergone validation, the impact of EITI on the supply of iron ore is still limited (EITI n.d.).

possible through public financing and even so, there is uncertainty as to how the steel will fare on the market.

For the commercialisation of green steel, there are different possibilities, depending on whether or not it is perceived as a differentiated product. Price premiums or closer relationships with downstream supply chain partners in the form of offtake agreements might be an instrument to make sustainable steel competitive (Olsson and Nykvist 2020). There are several examples of this change of procurement models establishing the longer-term certainty that is necessary to enable investments in sustainability and environmental protection measures, with some sources stating that "green-material sourcing has already begun to disrupt traditional buyer–supplier relationships" (Fredershausen et al. n.d.) in the iron ore-steel supply chain. There are examples of bilateral supply chain-collective approaches developed jointly by steelmakers and mining companies that apply such offtake agreements, but also memorandums of understanding (MoUs) and joint ventures (this also signifies strategic changes in **buyer-individual voluntary approaches/instruments: supplier contracts**). Some steel producers have adopted MoUs with mining companies, mainly to secure their future access to high-grade iron ore necessary for the production of green steel. Nippon Steel and Anglo American have agreed "to jointly deliberate and discuss solutions for accelerating the transition towards carbon neutral steelmaking" (Nippon Steel 2023). Rio Tinto and Baowu state that they want to collaborate for the research and development of technology, e.g. for the production of low-carbon iron. In collaboration with Salzgitter AG, Rio Tinto has decided to invest 10 million over the next ten years to "improve environmental performance along the value chain" and "explore the potential for greenhouse gas emission certification across the steel value chain" (Rio Tinto n.d.). Such collaborative settings are also applied by new players in the steel industry who focus only on the production of low carbon/green steel. For example, H2 green steel (H2GS) which builds a "green-steel plant and a green-hydrogen plant that will produce the fuel needed for steelmaking" (Fredershausen et al. n.d.), has signed MoUs with AngloAmerican and Rio Tinto (Stegra 2023).

Similar developments can be observed in partnerships between the automotive industry and the steel industry, where "some companies are financing innovation and production-capacity increases for the low-emissions materials they require" (Fredershausen et al. n.d.). In light of tightening regulations, car manufacturers are eager to secure their supply of low-carbon steel. Volvo is partnering with SSAB, while BMW and BHP have invested in Boston Metal, and Scania, Daimler and Kingspan's are cooperating with H2GS (Mission Possible Partnership 2021) and Volkswagen has and signed an MoU with Salzgitter "to source near-zero-emission steel starting in late 2025" (World Economic Forum 2023). A study by the World Economic Forum states that such "bilateral offtake agreements with steel producers are impacting the market, offering convenient access to buyers who secure their supply in advance" (ibid.). A recent study argues that indirect signals of future demands, such as the definition of the terms of investments many years into the future, are essential to approve investments to decarbonise supply chains (Mission Possible Partnership 2021). These examples show that the decarbonisation commitments and pledges that have been made by stakeholders along the supply chain do translate into real actions and can be the basis on which partnerships are agreed.

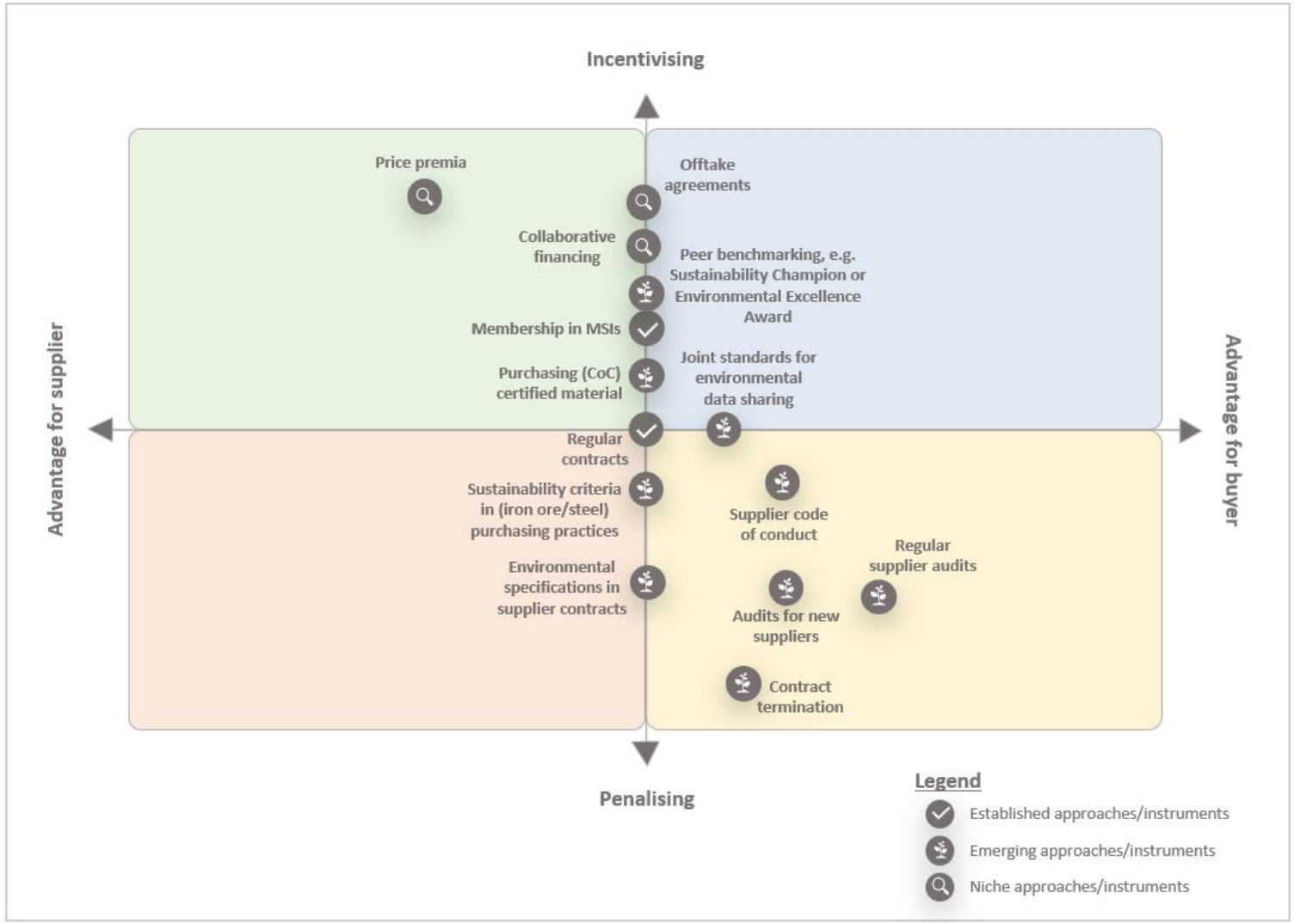
Offtake agreements are closely linked to the debate regarding price premiums paid for input materials necessary for the production of green steel (Morgan Stanley 2023). A study states "that the automotive industry is a likely candidate for green steel demand, where a market could be supported by price premiums paid by willing consumers, such as those of high-end luxury and heavy-duty vehicles" (Muslemani et al. 2021). According to other reports, the first steelmakers have already started to demand such price premiums for green steel in negotiations for long-term contracts with car makers, among others (Richardson 2021; Bolotova et al. 2023).

According to Voigt et al. (2023) as of 2023, "green steel in Europe already includes significant premiums of 25-40%" per ton of hot rolled coil (HRC). As the production of green steel requires, among other things, high-quality iron ore[25], in the future there could also be price premiums for "green iron ore" that meets the higher quality requirements for the production of "green steel" (Fastmarkets 2022). However, higher prices are already being charged for high-grade iron ore products, which enable low-emission steel production, but these are the result of a combination of their higher quality, costs for processing and demand – not necessarily the implementation of stricter environmental standards or the mitigation of environmental impacts during the mining process (Hannah and Fan 2021). While the ability of customers to absorb the resulting premiums is "untested beyond prototype projects" (World Economic Forum 2023) such as the ones mentioned above, increases in the cost of steel translates into much lower green premiums for end consumers (estimates are around 0,5% per passenger car (Zinchenko 2023; World Economic Forum 2023)]) and could therefore possibly be passed on to the consumer "without disrupting the economic model of companies" (Mission Possible Partnership 2021).

Placing the described business approaches and instruments observed in the iron ore-steel sheet industry in a matrix, according to the definition of (perceived) distributional fairness (advantage for supplier/advantage for buyer) and approach to influence the desirability of the requested changes for the business partner (incentivising/penalising) presented in Chapter 2 and Chapter 5, the following pattern emerges:

[25] Alternative input material: steel scrap.

Figure 6: Matrix of instruments and approaches in the iron ore-steel sheet supply chain



Source: own illustration (adelphi)

As shown in Figure 6, the approaches that rely primarily on penalties tend to result in a perceived advantage for the buyer, while more collaborative approaches that operate via incentives, joint commitments of different stakeholders and rewards lead to an equitable situation in which both buyers and suppliers gain a perceived benefit. We use the term "perceived" because calculating the total costs would be very complex, especially as the data is often not available. However, when looking at the figure, it also becomes clear once again that not all of the approaches and instruments placed in the matrix are used across the whole sector, but, as described in the text, many of them are only emerging and some are even just niche approaches and instruments that are only used by a few stakeholders. In particular, approaches in which, for example, steel companies and automotive manufacturers jointly invest in the development of more environmentally friendly technologies continue to be the exception across the industry (in fact, these are mostly small pilot projects) and there has so far been very little cooperation between iron ore mining companies and steel producers to improve environmental and climate protection in the supply chain, as can be seen from the previous text. The matrix should therefore serve primarily as an indication of which measures are particularly promising and should be investigated further with regard to their potential scaling.

6 Synthesis

Awareness about the scale and impact of supply chain practices on social and environmental issues has steadily increased and reached intense levels of societal debate in recent decades. A large set of actors contributes to finding solutions for these challenges; these actors have different agendas and objectives, backgrounds, and recommendations. Two decades of voluntary industry self-regulation have led to the establishment of different kinds of business organisations, accompanied by a universe of supporting organisations. As government regulations have come to the fore and partly substituted for voluntary industry self-regulation, new actors are emerging with new approaches and instruments. Due to varying contextual conditions, e.g. different regulations, levels of competition and supply chain structures, SSCM measures are implemented to varying degrees and intensities in the five supply chains examined. Nevertheless, it is possible to draw some overarching conclusions.

The conventional approach to sustainability in supply chains is dominated by buyer risk mitigation without changes to the business model. Most buyers, throughout the analysed supply chains, have a code of conduct for themselves and their supply chain that links to their marketing strategy. Most of the action is dedicated to identifying and mitigating risks from suppliers and sub-suppliers to ensure that there is no media coverage of sustainability issues. Such an approach has no consequences for a company's competitive advantage, suggesting that corrective action limits costs while ensuring a level playing field within the sector. Corrective action is limited to high-risk supplier behaviour that is shared by the industry, as that company is likely to supply other buyers in the sector. This setup of cost-conscious risk mitigation has led to an evolution of cost-benefit sharing that keeps explicit sustainability costs low for buyers and accepts that these costs may be priced in by suppliers, a finding that has been confirmed for all conventional business models in the examined supply chains. Other costs (e.g. for information and awareness raising, capacity building, and sometimes for auditing) are shared in sector initiatives. This approach aims to streamline interventions and cost, but rarely includes the interests of suppliers and does not necessarily address innovativeness or supply chain responsibility. More cooperative, partnership-based approaches, such as that of the Fair Wear Foundation (FWF) in the textile industry, show that they can contribute to reducing costs on both sides – for example through shared audits – without compromising output and outcome, which means the product has been manufactured under better working conditions (the FWF only marginally addresses environmental protection measures).

The way SSCM instruments are used often varies based on the importance (and size) of the supplier. Strategic suppliers in the textile industry who have built a long-term relationship with their customers often benefit more from sustainable practices, such as capacity building measures either funded by the buyer, MSIs or development programmes, or from advisory services provided by their buyers on environmentally friendly technologies (e.g. more resource-efficient machinery, renewable energies). They are in a position to decide whether or not to invest in environmentally friendly technologies (although they often have no choice but to invest if they want to stay in business), while SMEs often do not have the (financial) capacity to be even considered for upgrades. In the tin industry, the relatively large informal sector of artisanal and small miners (ASM) further hinders investment into sustainable practices. Similarly, many companies in the natural rubber-tyre supply chain still struggle with tracing their product back to the original plot of farming land, limiting sustainability incentives and initiatives to known suppliers. For cotton-garment buyers, a commitment to placing more orders if products are manufactured with a certain technology seems to be an incentive mechanism that is quite effective for larger (nominated) suppliers that have the necessary investment capacity. Instruments that are continually claimed to be fair, such as price premia, are only implemented

in a few selected, partnership-based trading models, such as in organic cotton, fair trade-certified coffee, or initial pilot projects with joint investments into the production of green steel. Partnership-based approaches are on the rise in the cotton-garment and coffee supply chains. Noteworthy examples in the coffee value chain include Starbucks' Coffee and Farmer Equity (C.A.F.E.) Practices, Nespresso's AAA Sustainable Quality™ Program, and Tchibo's Truemorrow initiative. In the natural rubber-tyre supply chain, such models remain at a level of rare individual cooperation between companies implementing regional projects with the support of civil society organisations; the payment of price premia has not yet been adopted at scale. These initiatives are often part of larger buyer-led programmes or strategies that include elements like capacity building, climate change initiatives, responsible contracting, and sustainable (sometimes even direct) sourcing practices. In general, however, sustainable practices are not rewarded, but must be factored in by suppliers, a finding that has been confirmed across all five sectors. The adoption of emerging technologies, such as blockchain or smart contracts, remains limited and is constrained by various factors, such as the comparatively high cost for setting up the infrastructure particularly for smallholder farmers, SMEs and ASMs who are still a significant if not the dominant supply base in almost all five sectors, the complex technology, and the actual benefit to the environment (e.g. high energy consumption).

New approaches to sustainable supply chain management (SSCM) are moving towards more proactive and collaborative buyer-supplier relationships and shared responsibility, which has been partly taken up by some sustainability and MSIs in the textile (e.g. FWF, Responsible Contracting Project – RCP, The Chancery Lane Project – TCLP), coffee (e.g. Global Coffee Platform - GCP), natural rubber (Global Platform for Sustainable Natural Rubber – GPSNR), iron ore/steel and tin (e.g. Responsible Minerals Initiative – RMI) supply chain. Some sector-agnostic approaches such as RCP or TLCP attempt to redress power imbalances by incorporating responsible business practices based on human rights and environmental due diligence (e.g. payment terms, realistic lead times, fair pricing) into model contract clauses. It is worth observing whether and how these approaches will be adopted by the industry.

Emerging business models of established firms and start-ups may substantially change the field soon. Developments related to the transition to a circular economy are leading to new business models that are less dependent on materials and physical production, and consequently less reliant on the lowest cost to increase consumption and sales. The new business models are all about the benefit (value) created for the consumer and the uniqueness of the brand, including in terms of production and origin. In these business models, suppliers and sub-suppliers play a key role as contributors of unique value. In this environment, suppliers are not selected on the basis of price, quality and availability, but on the basis of shared values and a commitment to mutual development in areas that need to be improved. The selection of suppliers based on shared values and norms eliminates a large number of conventional activities, such as the question of supply chain transparency or suppliers substituting certain practices for others. Such crafted, naturally sustainable supply chains reduce transaction costs, increase uniqueness and protection against commoditisation, cut down supply chain monitoring to a minimum, benefit from largely untapped and unique value contributions from suppliers, and not only allow, but encourage suppliers in developing and industrialising countries to upgrade their business to higher levels to the benefit of the supply chain. Joint brand ownerships that are shared among the relevant partners in a supply chain appears as a logical step to coordinate and motivate alignment and share further economic development.

In essence: the transition from a linear to a circular economy is likely to be accompanied by a shift from risk mitigation and cost avoidance to value co-creation and mutual development. This trend should significantly reduce current spending on risk mitigation in favour of value co-

creation. However, with many sectors still in the early stages of this transition, conventional practices are likely to continue to dominate our conversations for years to come.

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Annex

A Additional remarks and explanations on business approaches and instruments

A.1 Buyer-individual voluntary approaches and instruments

Buyer-individual approaches and instruments serve the company itself (internal use) and are voluntary. They exist because buyers decided to develop, further progress and maintain them, without obligation from public policy. The decision may be the result of internal or external (except law) pressures or the conviction about a business opportunity. The efforts for their development and maintenance are covered by the respective buyer.

A.1.1 Sustainability-related structures and responsibilities

Essentially rather a prerequisite than an approach or instrument itself, buyers require structures (e.g. organisational entities, business processes), capabilities and culture to address sustainability issues in their supply chains and use the various approaches and instruments outlined below. New roles and mandates with objectives, responsibilities and power need to be created, business processes need to be revised or set up, budgets need to be created and allocated, processes to negotiate solutions for new problems need to be specified, controlling and reporting formats are needed, goals and incentive systems need to be revised – to name only a few major requirements. The deep integration of sustainability into a company – instead of approaching it with an add-on entity – plays a key factor for success (Sroufe 2017). However, such integration is costly and work intensive, can be perceived as a risk to efficiency, and causes challenges in staffing, upskilling, or equipping.

A.1.2 Supply chain mapping and risk identification with first- and second-party auditing

The public pressures on companies to avoid sustainability issues in their upstream supply chain beyond direct suppliers and the hesitation of suppliers to share details on their supply chains requires new means for supply chain mapping and risk identification. Buyers have little access to information beyond direct suppliers, which limits their options to create transparency either through desk research (consulting publicly available information e.g. on specific materials, business practices or world regions) or asking their suppliers about their upstream supply chains and the related companies, regions or sectors (Farris 2010). However, supply chains are dynamic, often cover a large number of companies and intermediate goods, and the information – if provided at all - is quickly outdated. Life cycle assessments can be run individually, combining internal and external resources (Hellweg and Milà i Canals 2014), but often also rely on historical data. With supplier self-assessments, also called a first-party audit, buyers request suppliers to evaluate their practices or performance based on a provided questionnaire and share the results with them (Tan et al. 2023). Other approaches include supplier site visits, second party supplier audits (conducted by the buyer), or attending supplier events (Chen et al. 2020a). Risks need to be evaluated upon relevance for the buyer, in two directions: what sustainability issues in the supply chain the buyer is associated with (and the strength of those associations), and how sustainability issues in the supply chain impact the buyer. Costs for the development, improvement and maintenance of these approaches and instruments are limited.

A.1.3 Supplier code of conduct

A supplier code of conduct is a document that specifies the buyer's expectations in terms of minimum requirements and target performance levels for environmental, social and legal aspects to be fulfilled by the supplier as well as the buyer's approach to monitoring and developing performance at the suppler (Vandenbroucke 2024). In the past, companies aimed to stand out from their competitors through distinct specifications in their code of conduct. Today, companies base a major part of their supplier code of conduct on international or sector standards and individualise it by adding aspects that are particularly relevant for the company (Altura et al. 2021). Companies facing public scrutiny in particular engage in multi-stakeholder dialogue to ensure that the requirements and goals as well as the aspects covered in the supplier code of conduct are relevant (Cao et al. 2024). The involvement of suppliers is crucial to understanding not only the status-quo in performance, but also what targets are possible and in which context suppliers and sub-suppliers operate. While the main actor in developing, improving and maintaining a supplier code of conduct is the buyer (who must cover most of the expense), multi-stakeholder consultations can also involve costs for all parties.

A.1.4 Nomination of sub-suppliers

To lower supply chain risks or to benefit from opportunities, buyers may nominate specific companies to their suppliers, defining from which companies the supplier is allowed to procure specific goods or services (Grimm et al. 2023). Commercially, such nominations limit the supplier's ability to negotiate good conditions on their procurement side. Technically, nominations can be difficult to realise if the concerned goods or services are part of the supplier's development or subject to quality concerns. Operationally, suppliers fear the requirement of having to work together with a company that does not fit their own structures or business practices. Dependent (and often weak) suppliers have no alternative but to accept the nominated suppliers, while powerful independent suppliers often ignore the nominations. Costs for then development, improvement and maintenance of these approaches and instruments can be noteworthy if one considers the development and maintenance of sourcing market knowledge.

A.1.5 Sustainable sourcing practices

Buyers' sourcing practices – starting with creating the specifications of the needed goods or services and ending with supplier contracts – directly impact suppliers and are thus key drivers in order to change sustainability in supply chains. Sourcing practices are guided by strategic goals. Conventionally, the reduction of purchasing costs is considered procurement's main contribution to a company's success (Pagell et al. 2010); however, more recently, a small but growing number of buyers started defining the contribution of procurement to a company's success to be much broader by showing the benefits from value co-creation with suppliers (still requiring a contract on how to share value). This shift in strategy goes along with a more general trend in change in the time horizon for business partner relationships and business case evaluation: from short-term to mid/long-term (Chick and Handfield 2015). For sustainability requirements to be considered during sourcing, they need to be part of the specifications of goods and services; and need to be accompanied by processes and evaluation schemes to assess supplier offers or consult supplier audit results. For this, buyers need dedicated structures and capacities that are mandated to create relevant, realisable and measurable sustainability requirements – like engineers for technical or managers for commercial specifications,

sustainability experts are needed for sustainability specifications. Buyers may use their own definitions or benefit from drawing on a wide range of existing specifications or even certifications for sustainability criteria. Buyers need to decide whether they require supplier compliance with their requirements (excluding all suppliers that cannot prove compliance, potentially meeting their demand with specific certified goods) or define minimum mandatory requirements and engage in developing the contracted suppliers to achieve the targeted performance level over time. To evaluate potential supplier fit with these requirements, buyers require reliable data on their performance. Costs for the development, improvement and maintenance of these approaches and instruments are noteworthy considering the structures that are required to develop and add the sustainability requirements into specifications.

A.1.6 Supplier contracts

A supplier contract is a legal document, usually results from a negotiation between a buyer and a supplier, and defines in particular the transactions, the expectations of both parties, enforcement as well as terms and conditions – and goes beyond verbal agreements or the reliance on general laws (Suchman 2003). Buyers typically follow specific procurement strategies that lead to particular attention on specific factors, and may neglect interdependencies among them (Dubey et al. 2018). Specifications in supplier contracts may dis- or enable specific ways of interaction that hinder or support suppliers in realising the buyer's sustainability goals (Sluis and Giovanni 2016). For example, long payment terms can cause cash-flow concerns for suppliers with limited assets. Performance penalties or bonuses or remunerations are contractual elements that can directly penalise or incentivise performance upon sustainability requirements. The duration of contracts plays a key role for any contracting party when considering investments requested from the business partner – both in terms of return of investment but also in the future benefit of the created resource. With the emergence of blockchain tools, smart contracts fulfil a technological purpose referring to the information stored on a ledger and to the ability to enforce defined conditions (Groschopf et al. 2021a). Some companies include (snowballing) clauses in their contracts that suppliers need to include the buyer's requirements in their supplier contracts (i.e. the buyer's sub-suppliers). Dependent suppliers, lacking the option to deny specific elements of the terms and conditions, are forced to accept regardless of their ability to fulfil them, while powerful independent suppliers can force their customers (i.e. the buyer) to accept their standard terms and conditions. Adapting terms and conditions specifically to suppliers or groups of suppliers is a possible, but uncommon, practice. Costs for the development, improvement and maintenance of these approaches and instruments are limited, and usually part of the conventional negotiations between buyers and suppliers.

A.1.7 Risk sharing

The sharing of work in supply chains goes along with sharing of risks. Buyers are incentivised to use – or abuse – power asymmetries with suppliers to limit their own risks by allocating it to other supply chain actors (Eckerd and Girth 2017). Risk considerations address conventionally commercial matters, such as sales success or demand stability, but also supply risks, among many others. The main economic risk is the uncertainty of actual demand and thus revenues from sales that are required to cover prior investments and fixed costs. Suppliers can be requested to invest into product development, certifications, or into setting up the business relationship. If suppliers are not reimbursed by their customer for these investments, they depend on revenues – and thus the commercial success of their customer. Scale effects are

broadly considered in contracts, defining price reductions if the actual order volume exceeds the target defined in the contract; but often does not define price increases if customers actual order volume remains below – shifting business risks to suppliers. More short-term demand fluctuation risks concern the efficient use of production or transportation capacity. Short lead times and deviations from order plans give buyers increased flexibility while increasing efforts for suppliers. These practices generally increase uncertainty and economic pressure on suppliers. Costs for the development, improvement and maintenance of these approaches and instruments seem to vary depending on the practices deployed.

A.1.8 Supplier performance response

Performance targets defined in supplier contracts are enacted when buyers control actual performance and respond to deviations (Gonzalez-Padron 2016). Conventional responses typically incentivise suppliers for meeting or exceeding targets or penalise them for falling below or violating targets (Porteous et al. 2015). Such incentives can be monetary like a bonus, rewards, price premiums, or an increased reimbursement for an investment, or non-monetary like recommendation, awards, increase of business, creation of a strategic business partnership or extending the duration of the business partnership. Accordingly, penalties can also be monetary like fines, reduced prices, or a lowered reimbursement for an investment, or non-monetary like a decrease in order volume or contract duration, the establishment of a second source, or bad publicity. When companies take a longer-term perspective in their supplier relationships, the response to lack of performance can also be supplier development (see below). Suppliers' experience of the effects of their lack of performance to their buyer relationship determines how serious they take these requirements (Hajmohammad et al. 2021). If not meeting the targets has no commercial consequences, the supplier may assume that the buyer does not really care. Reports from suppliers in developing or industrialising countries give the impression that buyers predominantly take action when a supplier causes a real threat to them, in this case terminate the supplier relationship – while ignoring most other performance deviations. Costs for the development, improvement and maintenance of these approaches and instruments are considerable, since performance information needs to be linked to commercial processes.

A.1.9 Supplier or sub-supplier development for sustainability

When suppliers or sub-suppliers are identified as lacking capabilities required to operate at or beyond a threshold level, buyers can help them in closing these gaps with specific development (Tran et al. 2021; Jia et al. 2023). Supplier development means that buyers, possessing internally the capabilities required by the supplier, identify the exact capability needs, provide the required knowledge and assist in applying these new resources (Marttinen et al. 2023). Buyers may have dedicated organisational entities for supplier development, providing educational material or sending dedicated staff, or may delegate the task to their respective experts who consequently shift their engagement from internal operations to the selected suppliers. Organisational entities for supplier development are quite common among large companies, yet their role is often focused on improving quality or resilience or on reducing production cost, and their business model is based on creating cost savings for suppliers that are shared with the buyer to cover the buyers investments into the supplier (Benton Jr. et al. 2020). Suppliers tend to experience that higher levels of sustainability generate only moderate financial benefits that don't herald the investment – often out of a limited budget. When buyers decide to cover the cost for the development of the supplier, the challenge for the buyer is how to safeguard this

investment against the potential benefit to other customers of the supplier – in particular avoiding freeriding for competitors of the buyer. Usually, contractual clauses are used that grant a time of exclusive use for the investing buyer, yet sustainability often requires scale effects that run against limiting use (Wagner and Bode 2014). Still, costs for the development, improvement and maintenance of these approaches and instruments appear limited.

A.1.10 Crafting of supply chains

Some "born sustainables" (i.e. start-ups that have sustainability as a key aspect of their mission and vision) consider the supply chain as one of their unique features, have selected every single supplier and sub-supplier in their supply chain based on specific requirements – ranging from conventional elements to similarity in values, norms, or practices – and speak of their supply chain as the company's family (e.g. Läderach, Icebreaker). The similarity in values, norms, and practices suggests that, from their shared perspective, no major sustainability issues exist. In such a setting all supply chain actors share the same goals and motivations, and have a common interest to find solutions that are economically fair among them. The experienced win-win is a safeguard against freeriding or attacks by competitors. This approach reduces supply chain risks as well as supplier monitoring and development efforts to a minimum, allowing the investment of these savings into their sustainability practices (Allal-Chérif et al. 2023). A few examples exist where the brand of the final good is co-owned by the different key actors of the supply chain (e.g. ChobaChoba). The co-ownership of the brand causes all owners to protect credibility in the brand's values and its compliance with these values, using a governance system that is built on aligned self-interest. Costs for the development, improvement and maintenance of these approaches and instruments appear reasonable considering its impact on the company and its business model.

A.1.11 Design for sustainability

The decisions taken during research and development of a new product or service have major consequences for the subsequent production, distribution, use and after-use. Design for sustainability has become a key approach to ensure that sustainability considerations and limitations are taken into account in these early stages, potentially eliminating problematic processes or materials (Rocha et al. 2019). Key is the inclusion of sustainability experts early in the development stage to ensure that engineers are aware of potential implications and have knowledge about the alternatives, or may be given order to develop own solutions. Costs for the development, improvement and maintenance of these approaches and instruments appear limited, focused on structures and incentives.

A.1.12 Further approaches and instruments

In addition to the above approaches and instrument, many others exist. An important instrument is the established make-or-buy decision process for companies to determine whether a specific activity should be run internally under the full control (and responsibility) of the company or be sourced from an external supplier – or further upstream – who controls the process and is responsible for related sustainability issues. The academic literature has provided examples that many companies used outsourcing to get rid of some of the company's sustainability challenges (Berry et al. 2021) and argued that companies are held responsible for their upstream supply chains (Hartmann and Moeller 2014). Business modelling is another

instrument from strategic management that helps to identify and position specific practices and activities. The inclusion of social or environmental criteria is challenging, but not new, to strategic management. The balanced scorecard is a widely adopted tool that gives sustainability goals and performance indicators the important role needed to enable comprehensive management decisions (Hansen and Schaltegger 2016). Another approach at the senior management level is lobbying both in the political (legislative) and in the governmental/administrative (executive) spheres – both to limit a company's involvement or liability and to increase regulative pressures on the companies in the countries where the sustainability issues actually occur.

A.2 Buyer-collective voluntary approaches and instruments

Buyer-collective approaches and instruments serve both the company itself and the entire sector, and are voluntary. They are developed and used by the members of the respective collective and in partial dependence on one another (Peters et al. 2011). In many sectors, buyers have established specific organisations (so called voluntary sector initiatives or "initiatives", e.g. AIM Progress, Together for Sustainability and many others), usually associated with their respective industry associations. They exist because buyers joined forces to develop, improve and maintain approaches and instruments – without legal obligation from public policy (Barnett and King 2008). Some of these approaches and instruments may have been built on individual company experiences, but their use and results are always a joint effort of the collective's members. The decision may be the result of internal or external (except law) pressures or the shared conviction about a business opportunity. The efforts for their development, improvement and maintenance are covered by the collective, and not individual buyers.

A.2.1 Sustainability-related exchange and interest representation in voluntary sector initiatives

Buyers that are active in similar markets often share the same sustainability challenges and external pressures. As long as the related activities can be considered pre-competitive, joining forces is a powerful approach that recommends addressing specific issues jointly among several buyers (considering of course the framework of competition law) and, if required, further stakeholders (Carlos Marques et al. 2023). Sharing of insights enables the participants to achieve a more comprehensive understanding of issues and explore a wider range of potential responses or solutions. The collective approach makes it more attractive to third parties to engage and thus develop out-of-the-box solutions. Initiatives that represent the interests of numerous companies, which in turn represent a relevant share of a sector, are also better placed to connect with regulators to make better use of public regulation or address issues that concern practices or situations that are not supplier-specific but of concern for an entire region or nation. Agreement on specific solutions across an industry can be an important foundation for entrepreneurial action that helps in its realisation – both in buyer but also in supplier economies. Scale effects are also beneficial in the further development of sustainability reporting practices where initiatives – as well as associations of initiatives – play a major role. Engaging with the broader public is another area for collective action. Initiatives organise events for various stakeholders, and in particular media, to inform about sustainability issues, the specific challenges, and how these are addressed – contributing to an objective and comprehensive public conversation. Costs for the development, improvement and maintenance of these

approaches and instruments are usually covered by the initiatives, which are funded by membership fees.

A.2.2 Voluntary sustainability standards

Buyers active in the same sector appear to have high similarities in their supply chains, sourcing the same or relatively similar goods or services often from the same suppliers and sub-suppliers, which means they face the same sustainability issues and challenges. Such similarities make the case for collective action – to limit company-individual expenses, benefit from the advantages of scale effects, and ensure a level playing field in the respective sector. As most suppliers serve a broad range of customers (often direct competitors), differences in customer requirements quickly result in high levels of heterogeneity and complexity – up to the point of mutual exclusion of buyer specific requirements for the same suppliers. The agreement among the members of an initiative on common sustainability requirements, frequently referred to as voluntary sustainability standards (Dietz et al. 2021), substituted the idea of market differentiation with the objective to establish global rules in the business (Erwin 2011). Conversations on an industry level ease multi-stakeholder dialogue since the efforts invested by the externals are multiplied into the entire sector (Ashwin et al. 2020). However, this standardisation of sustainability requirements has been identified as regionally different (Husted et al. 2016) with the result that for the same industry buyers from different world regions specify different requirements – and suppliers have the choice to either give preference to buyers of a specific world region, or to bear a doubling or tripling of their efforts if they want to be able to serve customers in different world regions. Costs for the development, improvement and maintenance of these approaches and instruments are usually covered by the initiatives, which are funded by membership fees.

A.2.3 Collective sustainability performance monitoring with shared audit systems

Suppliers need to be able to address their many customers' need for information on their sustainability performance in an efficient way. Voluntary sustainability standards, defining a common code of conduct in an industry, allow suppliers to receive standardised sustainability performance reports from audits that are relevant to all their customers of this industry (Caro et al. 2018; Ha et al. 2023). Most initiatives are well aware of this efficiency benefit and have established their own supplier auditing systems for their industry, consisting of a standard measurement instrument (usually a list of standards to be checked), a process and a process owner for the assessment, the actor running the assessment, the conditions for the assessment (e.g. the kind of announcement or the regularity of the audit), ownership of the audit results, or the bearer of the audit costs (e.g. the BSCI system by Amfori, see (Hofstetter and Müller 2013). The efficiency effect of these auditing systems, if adhered to by most initiative members, allows suppliers to focus on one audit for an entire market by sharing with all of their customers of the same industry – instead of many buyer-specific audits. This limits the auditing efforts to one audit per sector and industry. The intended sharing of audit results to any actual or potential customer of a buyer market prevents buyers from bearing the audit costs, since the audit is just as available to competitors who did not pay for the audit results they receive. It is common practice that suppliers pay the cost for the supplier audits, and need to either accept reduced profitability or price these costs into their product or service prices. Despite the fact that such commercial relationships between the auditor and the supplier have been criticised as a source for incorrect or biased results, this practice is the default (Chen et al. 2020b). It also seems to be well aligned with the intent of buyers to keep sustainability budgets low. Most initiatives use

services provided by third parties for auditing or their audit database. Costs for the development, improvement and maintenance of these approaches and instruments are usually covered by the initiatives, which are funded by membership fees.

A.2.4 Collective supplier or sub-supplier development for sustainability

For non-critical suppliers that may also supply competitors, buyers prefer to bundle efforts in collective supplier development to reduce individual costs, involve more stakeholders and counter potential freeriding, but also to make the request to suppliers for development more powerful, since it comes from a larger number of their customers i.e. more significant share of their sales (Liu et al. 2018). Some initiatives engage in supplier development by addressing the needs to suppliers and offering educational material. Some offer their own development services, relying on third parties that may be recommended or even authorised by the initiative. For sub-suppliers – with whom buyers have no contractual relationship – and in particular for large numbers of small scale sub-suppliers (e.g. smallholders), joint approaches are essential to realise changes (Nelson and Phillips 2018). Costs for the development, improvement and maintenance of these approaches and instruments are usually covered by the initiatives, which are funded by membership fees, and can also be complemented by investments from service providers (e.g. consultants offering their services to suppliers).

A.2.5 Grievance and remedy structure

The need to enable suppliers and sub-suppliers to interact with buyers, considering the deep-rooted limitations in supply chain transparency, requires collective industry solutions. Workers in supplier or sub-supplier companies need to be enabled to complain about practices that impact them negatively – in a broader sense, also including negative impacts to their social or natural environment. Since workers may not be able to address their concerns to their own management, their company's customers or the downstream supply chain, shared approaches can take up the information on an industry level and initiate adequate formalised responses to ensure corrective action is taken (Harrison and Wielga 2023). This concerns both grievance and whistleblowing. Collective approaches can also be used to deal with reparation claims or remedy for past events (e.g. accidents or prior abuse of workers) when the respective sustainability issue concerns a number of buyers (Donaghey and Reinecke 2018). These structures can involve various organisations, including government organisations. Costs for the development, improvement and maintenance of these approaches and instruments are usually covered by the initiatives, which are funded by membership fees.

A.3 Supplier-individual voluntary approaches and instruments

Supplier-individual approaches and instruments serve the respective company itself (internal use) and are voluntary. They exist because suppliers decided to develop, improve and maintain them, without obligation from public policy. The decision may be the result of internal or external (except law) pressures – in particular the demand of their customers to comply with their requirements (Foerstl et al. 2015; Chen et al. 2023) – or the conviction about a business opportunity – e.g. to reduce costs for input factors (Gholami et al. 2021) or to increase sales prices - or the needs for environmental protection – e.g. to secure soil fertility for agriculture (White 2020) – or social development – e.g. to improve labour productivity (Amrutha and Geetha 2020). The efforts for their development and maintenance are covered by the respective

supplier. Similar to Chapter 2, this chapter excludes the large number of approaches and tools available to improve operations – from behavioural changes to reduce waste to technological changes to substitute specific materials or processes – of which many are highly context-specific.

Since suppliers are also buyers for the goods and services they need for their operations, the approaches and instruments outlined in Chapter 2 apply to their own procurement and supply chain management. The following adds further ones for the role of suppliers. Costs for the development, improvement and maintenance of these approaches and instruments are usually covered by the supplier themselves.

A.3.1 Sustainability-related structures and responsibilities

Responding to customer (i.e. buyer) demand or pressures from various external actors to better control social and environmental aspects in their operations and supply chain also requires suppliers to establish adequate structure and responsibilities (Omar et al. 2022) – as outlined in Chapter 2. For suppliers, this relates also to establishing "organisational fit" with customers (Shou et al. 2018), i.e. organisational structures mirroring the roles, mandates or business processes of their customers , but also to the need to improve sustainability in their upstream supply chain (Grimm et al. 2014). Due to the absence of globally standardised structures, suppliers need to select one over others or establish several simultaneous structures, harming efficiency.

A.3.2 Business modelling

The sustainability-related changes buyers require from suppliers can have major cost implications that make the respective supplier unprofitable – potentially even drive it towards bankruptcy - or put current setups into question (Gielens et al. 2018). Suppliers in developing countries complain that some criteria used by buyers in their sustainability performance monitoring (e.g. auditing) enforce specific solutions that are of limited help in their specific context – making the problem worse instead of supporting a solution (Rubio-Jovel 2023). Suppliers have options for selecting their customers, yet need to understand the ones that are more beneficial for them. Imagining changes to and the related impacts on a company's grown (established) business model and finding the optimum solution can be assisted by business modelling (Bocken et al. 2019). To understand their options, companies can evaluate alternative business models by investigating the factors that change due to external developments or by altering the factors they can change to adapt and that have a sufficiently high impact on profitability and cashflow they can find a viable alternative. Since this process requires both specific capacity and skills, business case modelling is less used by suppliers and sub-suppliers in developing and industrialising countries.

A.3.3 Active feedback structures

Many sustainability requirements aim to reduce energy use or pollution, or improve the situation of workers or external stakeholders (including the natural environment). To ensure the goals of these sustainability requirements are met, feedback from those experiencing the sustainability issues is important. Receiving feedback on what works or not and why allows better understanding the problems as well as adaptation and optimisation of corrective action. Typical approaches are environmental management systems or the use of continuous improvement processes (Darnall et al. 2008).

A.4 Supplier-collective voluntary approaches and instruments

Supplier-collective approaches and instruments – to some extent similar to Section A.2 – serve both the company itself and the entire sector, and are voluntary. They were developed and are used by the members of the respective collective. In some sectors, suppliers have established specific organisations (so called voluntary sector initiatives), at times associated with their respective industry associations. Some of these approaches and instruments may have been built on company individual experiences, but their use and results are always a joint effort of the collective's members. The efforts for their development, further progression and maintenance are covered by the collective, and not suppliers individually.

Since suppliers are also buyers for the goods and services they need for their operations, the approaches and instruments outlined in A.2 apply. The following adds further ones for the role of suppliers.

A.4.1 Certifying organisations

Some suppliers have joined forces in addressing certain sustainability issues, agreed on specified rules or practices to realise sustainability goals, and market their goods with a specific label (Blackman and Rivera 2011; Bennett 2022). Prominent examples are Rainforest Alliance or Demeter for the agricultural sector. By establishing dedicated organisations to establish and guarantee member compliance with specific behaviours or performance thresholds, these organisations provide reliable justification for the suppliers to prove their added value to their stakeholders – in particular customers (Ciliberti et al. 2009). Similar to the voluntary sector initiatives on the final goods level, these certifying organisations maintain a set of rules that are mandatory for all members, provide members help to achieve the ability to follow these rules, a control systems that reliably check members' compliance with the organisation's rules, a correction system with assistance and penalties to ensure members correct their practices if found non-compliant, and promotional activities to make members' stakeholders aware of and appreciate the contributions of the certifying organisation and its members – to increase the perceived value and eventually enable higher price premiums in the sales price.

A.4.2 Supplier cooperatives

When many smaller suppliers in developing or industrialising countries face similar challenges or demands, the establishment of cooperatives can be a useful approach for them to address their needs that often relate to sustainability issues (Verhofstadt and Maertens 2014; Candemir et al. 2021). Cooperatives allow members to share fixed costs or investments, and increase supplier power in negotiations with buyers. They can also generate the critical mass needed to change or add economic activity – like the first processing steps for crude material that allows the trading of higher-value processed goods instead of cheap bulk commodities. Cooperatives can establish and provide members services to which they would otherwise have little access, such as logistics, access to financial services or social security. Cooperatives often enjoy wide public attention, which allows the members of the cooperative to better voice their needs and interests in the political processes.

A.5 Supply chain-collective voluntary approaches and instruments

Supply chain-collective approaches and instruments are developed and used by numerous actors from all relevant steps (or tier levels) in the supply chain and in dependence from one another. They serve both the company itself and the entire supply chain, and are voluntary. These approaches can range from informal conversations that include various supply chain actors to established organisations that structure such talks but also support their members and communicate with external stakeholders. Examples include the Marine Stewardship Council or the Electronic Industry Citizenship Coalition (today part of the Responsible Business Alliance). It appears that these approaches and instruments are often initiated by the leaderships of some companies and specific individuals (Peters et al. 2011), but their use and results are always a joint effort of the collective's members that considers the needs and context of the many parties involved along the supply chain. The decision may be the result of internal or external (except law) pressures or the shared conviction about a business opportunity. The efforts for their development, further progression and maintenance are covered by the collective, and not buyers individually.

A.5.1 Coordination of interests and context

Supply chain-collective approaches tend to apply an integrative, collaborative approach to coordination that considers the interests and context of the various actors in multi-tier supply chains. They seem to have gained momentum when supply chain actors experienced strong contextual limitations to establishing sustainability practices – often when behaviour of a specific tier level undermines the activities of the rest of the supply chain (Alexander 2022). Conversations among the various actors in a supply chain allow addressing and resolving contextual elements by better considering the peculiarities of the different steps before and after a specific actor. Inspired by the Total Quality Management approach, the consideration of prior and succeeding steps enables systemic optimisations and to challenge and change "unspoken rules" in supply chains. Supply chain-collective approaches also help in identifying practices that are a major barrier to realising sustainability objectives, and put both pressure on as well as offer help or seek joint solutions for those parties who apply and try to keep these practices.

A.5.2 Supply chain tracing

Supply chain-collective approaches engage with a variety of actors (buyers, suppliers and sub-suppliers) along the many tier levels of a supply chain. This broad coverage of actors provides a rare opportunity to exchange data, and eventually establish tracking and tracing solutions up- and downstream along supply chains that link consumption with trading and production where sustainability issues occur. Software firms can be embedded to materialise on this opportunity by establishing supply chain tracing apps. In Canada, the app This Fish! allowed restaurants to provide their guests with ample data about the fish on their plate: when and where the fish was caught by which fishermen on which vessel, as well as many further processing, trading and logistics steps until it reached their host. Such third parties (see chapter A.5) run data management systems that provide a unique identification for each raw material unit for which status information is collected throughout the supply chain. This results in a digital log book per individual raw material unit that allows information about the time, route, actors involved or other status information. This information may be restricted to members of the organisation or be open to the public to either check the history of the procured product or products in general. A wide range of supply chain tracing systems exists (Li et al. 2017), varying in data quality and

granularity – which primarily depends on access to the involved supply chain actors. Since in many cases sub-supplier identity is not shared, the tracing systems cover at least those supply chain parts they have access to data (Wowak et al. 2016).

A.5.3 Chains of custody

In the context of sustainable supply chains, a chain of custody is a "process by which inputs and outputs and associated information are transferred, monitored and controlled as they move through each step in the relevant supply chain" (ISO 22095:2020). The chain of custody models specified in ISO 22095:2020 range from identity preservation, where physical goods are kept separated from other goods along the entire supply chain, to book and claim (or also called certificate trading), where the administrative record flow is separated from the actual physical flow of material. When the use of sustainability practices creates a physical value-added in comparison to conventionally produced goods and mixing them would deter these specific benefits, physical separation of the differently produced goods is justified. However, the additional logistics efforts needed for the separation of material flows are both costly and generate increased environmental impact.

A.6 Third-party offered voluntary profit-focused approaches and instruments

Third-party offered approaches and instruments are commercial services offered to supply chain actors, and are voluntary. Third parties (or providers) are private or public organisations that pursue commercial motives of profit generation by creating value for their users or customers. The providers of these approaches and instruments invested into the development, offering and promotion of their services and usually hold the intellectual property what allows them to charge for their services. A vast number of different consulting services exists that contribute to the approaches and instruments described above. Also, a vast offer exists for education and training – both off- and online. This section introduces unique approaches and instruments offered by third parties.

A.6.1 Supply chain mapping

The request for supply chain transparency has triggered the development of different offers responding to different questions or requirements on the level of detail. One group of service providers, focused on primary data, uses a voluntary approach asking their client's suppliers to disclose the identity of their suppliers (sub-supplier), then contacts these companies and asks them to disclose the identity of their suppliers, and so on. The contacted companies are also requested to inform them about changes in supplier or customer relationships, as well as provide sustainability performance data or audit results. Within this group of service providers, some also include data from logistics service providers or by reverse engineering of products while others add a verification step. With increasing length and breadth of the supply chain, at high frequency of supplier substitutions, or when companies consider the knowledge of their suppliers' identity as crucial, this approach faces limitations (Grimm et al. 2016). Another group of service providers, focused on secondary data, maps supply chains based on economic trade data and by taking into account additional information from their customers and other sources – leading to more generic maps (Schmidt et al. 2022). Natural-sciences-based service providers, focused on the physical structures of materials, offer DNA-based tracing that allows identifying

the origin of organic or crude materials – but does not provide information about any processing steps (Migone and Howlett 2013).

A.6.2 Supply chain tracing and blockchain

Tools for supply chain tracing collect and store data on e.g. time, place, actor or production slots for items of groups of items. The coverage of such tools may be limited to within a company or span from raw materials to distribution or use and cover specific materials or the entire product, primarily depending on the willingness as well as on the ability of the supply chain actors to disclose information. Data collection and storage can be automated, and data security can be enhanced by the use of digital ledger technologies applied in blockchain solutions for supply chains (Saberi et al. 2019; Bager et al. 2022; Khan et al. 2022).

A.6.3 Digital product passports

IT-service providers offer increasingly sophisticated solutions (beyond supply chain tracing) to store individual product information about material contents, suppliers and sub-suppliers, production technologies or processes – creating so-called "digital twins" of a product. Digital twins require procurement and operations data as well as information from supply chain mapping and tracing. The product-level transparency enables buyers to address their supply chains with the respective parties with more detail (Langley et al. 2023).

A.6.4 Third-party supplier auditing and reporting

The strong pressures on companies (suppliers) to provide credible information about their sustainability performance – from buyers or other stakeholders – has led to an overwhelming range of commercial auditing services by local, regional and global firms (Short et al. 2016). Some auditing firms offer a variety of different audits, catering to the high heterogeneity among stakeholder interests and trends per sector (Hannibal and Kauppi 2019). Some auditing firms maintain accreditation from sector initiatives that allow them to audit for these initiatives based on their respective code of conduct, standards, measurement model, and auditing scheme. Initiatives can withdraw the accreditation in case an auditing firm does not comply with their rules or issues incorrect auditing reports (Dogui et al. 2014). A few firms use their own measurement model and auditing scheme, sell their auditing services predominantly to suppliers (and less to buyers who require their suppliers to be audited), store audit results in their own database, and sell information or reports to buyers – or make these available to subscribers or members.

A.6.5 Supply chain risk identification

Driven by interests in the financial sector to improve risk management, services have been established that identify and quantify the supply chain risks of companies – usually either investment objects or clients for financial services ranging from loans to insurances (Berkan et al. 2021). Some of these services monitor the risks per sector and world region based on different datasets and research. Other services collect and link information from a vast number of sources on risks, reported performance deviations, weather and climate etc. with company names or regional sectors. These services, that are often quick in spotting new issues but rather

weak on quantifying effects, become increasingly relevant to buyers. The economic model is often to sell subscriptions or memberships.

A.6.6 Supplier development

In the context of supplier audits, third parties (e.g. consulting companies) – some being associated with auditing firms or buyer sustainability initiatives (e.g. BSCI) – offer their commercial services to suppliers (or sub-suppliers) to help them improve specific performance deficits documented in the respective report (Blome et al. 2014; Jia et al. 2022). Such services are of particular relevance when suppliers face a reaudit on these critical factors. Third parties also offer educational or training services on a broad range of themes – from introductions to the context of the various audits to updates on new national or international government regulations, addressing technological skills but also management or administrative practices (Arraiz et al. 2013). These kinds of services are available also to groups of suppliers or cooperatives, allowing suppliers access to external capabilities at a lower (shared) cost. Some of these services are co-developed with, accredited by, and provided on behalf of a buyer initiative (see also Chapter A.2) or a large buyer; others resulted from public-private partnerships where governments actively engage in the development of new services that are of low commercial attractiveness to the private sector. Criticism of these commercial services concerns their price – potentially beyond the financial capabilities of small companies in developing or industrialising countries – or the focus of the service offering that primarily addresses risks that buyers are most concerned about (Liu et al. 2018).

A.6.7 Emission cap-and-trade and offset

The challenge in supply chains is the variation of emissions among the specific processing steps and the respective actors (emitters). The product footprint perspective aims to link the emissions at all steps or tier levels to the product – considering the challenges in supply chain transparency – (Dahlmann et al. 2023), putting the high emitters under pressure to reduce their emissions –by reducing their actual emissions (e.g. with technological means). The trading of emission certificates concerns in particular carbon and other greenhouse gases for which national governments regulate and enforce the terms and conditions (Zakeri et al. 2015). A supplier that emits above its allocated budget – and would otherwise face penalties for high emissions – can buy emission certificates from companies that emit below their allocated budget (and who can sell this positive gap) – referred to as cap-and-trade system (Xu et al. 2017). The price per unit is determined by market mechanisms based on the current supply and demand. The different trading platforms may define limitations on scope or conditions. Alternatively, a supplier can offset its emissions with investments into projects that claim to reduce carbon emissions. The organisations running the offsetting projects issue carbon credits to trading platforms where companies can buy “negative” carbon emissions to cover their gap (Yang et al. 2021). Major criticisms address the reliability of the actual carbon reduction realised by the offsetting projects as well as concerns about sociomateriality – the disconnection between local physical processes and administrative modelling – that fails in addressing the problem of local hotspots for exceptional environmental harm (Bansal and Knox-Hayes 2013).

A.6.8 Certificate trading in book and claim

The separation of physical goods in chains of custody (ISO22095:2020) is costly and can have a negative environmental impact caused by various additional logistics efforts required for the physical separation at every step in the supply chain. This questions its benefit and legitimate use for handling materials that do not differentiate physically between conventional or sustainable production practices. Certificate trading systems, following the book and claim model of chains of custody (ISO 22095:2020), disconnect the value-added by the use of sustainable business practices from the physical material. Certificate trading organisations run a system that issues a certificate per produced material unit to the materials' producer, who sells this material in the same quantity now as conventionally produced to local markets and offers the certificate to distant buyers. Buyers can purchase this certificate and the equivalent quantity of conventional material from local markets, with the combination of both allowing them to declare the sourced material as sustainable – according to the sustainability definition of the certificate trading organisation. Certificate trading organisations must ensure that any certificate is only valid for one equivalent unit of conventional material. Since the issuing of or multiple use of a certificate is like printing money, these systems have been subject to external attacks and fraud.

A.6.9 Certification of goods

Certification organisations promise that goods or service offered with their label reliably comply with their standards and objectives – examples include Fairtrade and Rainforest Alliance (Blackman and Rivera 2011). The labels are marketed based on their purpose and operationalised by requiring and enforcing or eliminating specific business practices or by requiring performance levels beyond a defined threshold. Certification organisations maintain their code of conduct and their measurement model, aligning between buyer requirements and companies' capabilities and context. They run their own system to monitor business conduct and performance of the companies they certify, and also offer consulting to companies that fail on specific criteria. Certifying organisations depend on the trust of buyers as well as suppliers into their value-added (Daugbjerg et al. 2014; Bennett 2022). For suppliers, being certified requires investments and in many cases higher operating costs, but offers the prospect of higher sales prices and more predictable customer demand. For buyers, buying certified goods or services means higher purchasing costs, but releases them from the need and efforts to control for sustainability issues in these supply chains. Major concerns include the cost of certification for suppliers in developing and industrialising countries, the heterogeneity of numerous labels per sector, differences in buyers' label preferences between world regions (limiting suppliers ability to sell to different parts of the world) (Montiel et al. 2019), the focus of criteria controlled by certification organisations versus public expectations (Torma and Thøgersen 2024), and the actual price premium (Meemken 2020).

A.6.10 Exchanges and trading platforms for sustainable commodities

A substantial share of commodities (e.g. raw materials) are traded on exchanges and trading platforms, instead of selling directly to buyers. For commodity producers (i.e. suppliers) to benefit from complying with sustainability standards, they either need to have direct customers with such requirements or need to be able to sell to traders that value this compliance. Under public pressure and with increasing demand for specific sustainability certified commodities, exchanges and trade platforms – such as the London Metal Exchange – have started covering

such goods (Bernards 2021). Increasing comparability between different certifications, labels and standards, and growing market volume of sustainably produced materials further support this development.

A.6.11 Green financial products

The financial industry's ESG-conscious financial products created a stock of dedicated capital available at favourable conditions that is limited to companies that exceed a specified threshold of sustainability criteria. The perspective of lowered cost of capital (Gonçalves et al. 2022) incentivises companies in need of external investments to adhere to stricter sustainability performance. Banks as well as insurances weigh sustainability criteria higher when evaluating risks of lenders. New business models for financial service providers emerged in developing countries, such as microfinance (Sim and Prabhu 2017) that provide loans to the most disadvantaged at reasonable conditions (Girabi and Mwakaje 2013) as well as FinTech solutions that facilitate access to capital in remote locations. Sustainable Supply Chain Finance describes a range of financial offers to suppliers and sub-suppliers by financial service providers (Jia et al. 2020), commonly drawing on the favourable credit rating of the powerful buyers (Gong et al. 2018), to support trade transactions considering the triple bottom line – with still-limited concrete examples reported in business practice.

A.7 Civil society-enabled voluntary impact-focused approaches and instruments

The civil society-enabled approaches and instruments are voluntary. These issue-motivated, impact-focused third parties pursue objectives that are based on the strong values and norms of their respective community. Traditionally strong organisations in civil society that relate to sustainability in supply chains are nature conservation organisations, human or labour rights organisations as well church organisations whose members share and are motivated by strong institutions and visions for the future. Some civil society approaches have aligned well with interests of economic actors, others have positioned themselves to oppose the predominant paradigms in business. More recently, the increasing practice of multi-stakeholder approaches brings various positions into the conversations.

A.7.1 Issue identification and public scrutiny

Identifying sustainability issues and bringing them to public attention are among the approaches and instruments deployed by civil society organisations. Watchdog organisations (e.g. Greenpeace), supervising the actions of actors in the society in the interest of the public, are often among the first to raise major sustainability issues in supply chains – often in distant parts of the world (Moosmayer and Davis 2016). Some watchdog organisations on trade and sustainability position themselves as the ones making people aware of major environmental or social issues, confronting them with a clearly communicated path in supply chains that link them (e.g. as consumer or shareholder) with these issues by the use of campaigns or media coverage. Watchdogs' understanding of such supply chain paths can be more detailed than the knowledge of the concerned companies who can benefit from these results. However, watchdogs may not sell this knowledge but provide it under the condition that the concerned companies take the necessary corrective action (Baur and Schmitz 2012). Other watchdog organisations monitor and analyse data from a different perspective and promote their findings, often with help of media, to the broad public but also to specific decision makers. Examples of well-known

instruments are product or consumption footprints. Watchdog organisations are usually funded by donations, and the funding strongly depends on the public perception of campaign relevance and quality.

A.7.2 Collaborative multi-stakeholder approaches

There are a wide range of national and global civil society organisations that not only communicate sustainability issues in supply chains but engage in the development of solutions – often with a focus on specific end-products, commodities, social (including human rights or labour rights) or environmental issues, or world regions (Peng et al. 2022a). Collaboration with the media is essential to some in order to promote the developed solutions and ongoing work. Some seek close collaboration with governments to drive regulatory changes. However, the integration of smallholders causes challenges (Brandi et al. 2015). Also, these organisations are mainly funded by donations, and need to justify to their funding community the value-added of their work.

A.7.3 Humanitarian aid

Rooted in the fight against diseases, hunger, or poverty in the world's hotspots, humanitarian aid organisations contribute to the activities on sustainability in supply chains with their long-time presence and relationships with local social structures. The organisation can help in reaching out to and engaging with local citizens, in particular to find solutions for social issues (Wang et al. 2021). Some of these organisations engage in education or training activities or help in developing alterative trade channels for disadvantaged smallholders. Some of these organisations are substantially funded by private foundations or are part of religious organisations.

A.7.4 Funding of sustainability development

Private foundations exist that have the purpose to help develop the local economy in developing or industrialising countries. While the main purpose is to make the local economy more productive and robust, the increasing sustainability requirements of buyers of some word regions make these considerations important parts in their portfolio of activities. This concerns funding provided to economic development projects but also the communication and the issues addressed in their public events (Camargo et al. 2023). Some of these organisations have a high impact on the discussions among business and political leaders in the respective countries.

A.8 Government-enabled voluntary approaches and instruments

Government action can help motivate and develop, but also deter and limit, the effects on economy or society. This section focusses on enabling, i.e. the motivation and development. Government bodies involved in influencing sustainability in supply chains comprise global intergovernmental organisations, intergovernmental organisations of specific groups of nations, national governments, as well as local governments – all somehow relating to one another. The mandates and the power of these government bodies vary, as well as their resources and strategic objectives.

A.8.1 Policy development and advocacy

Global intergovernmental organisations – such as entities of the United Nations, the World Bank Group or the Word Trade Organisation – often host the establishment of global frameworks or guidelines for sustainable supply chain management, and advocate for global/international agreements that promote world-wide accepted sustainability standards and practices. Regional intergovernmental organisations – such as the European or the African Union – can engage in harmonising sustainability regulations and standards by formulating regional policies and initiatives and facilitating cross-border collaboration and knowledge-sharing on sustainable supply chain practices. National governments can establish national policies and programmes that incentivise or support sustainable practices in supply chains. With incentivising, governments put their attention on companies achieving the targeted ends, giving the supply chain actors maximum freedom in selecting the means to achieve these ends; while supporting activities promote specific means for companies to change their business practices.

A.8.2 Regulatory frameworks and standards

Global intergovernmental organisations can develop and disseminate international standards and guidelines for sustainable sourcing, production, and distribution. Regional intergovernmental organisations can help harmonising national regulations and standards across member states to facilitate compliance and reduce trade barriers. National governments can establish certification schemes and labelling programmes to identify sustainable products and services.

A.8.3 Financial incentives and support mechanisms

Global intergovernmental organisations can establish funds and financing mechanisms to support sustainable supply chain projects, especially in developing countries. Regional intergovernmental organisations can provide grants, loans, and technical assistance to support regional initiatives for sustainable supply chain management. National governments can offer tax incentives, subsidies, and grants to businesses that invest in sustainable technologies and practices. All of them can create public-private partnerships to co-finance sustainable supply chain projects. Governments of developed countries and their respective development agencies (like the German GIZ) are requested to invest into economic development of developing and industrialising nations (Cunha et al. 2021).

A.8.4 Capacity building and technical assistance

Global intergovernmental organisations can provide technical assistance, capacity building programmes and knowledge-sharing platforms to member states and private sector entities on implementing sustainability standards. National Governments can establish and fund scientific research programmes as well as training programmes and initiatives to enhance the capacity of businesses to implement more sustainable practices, and provide financial support for sustainability certification and training programmes. They foster dialogue or promote showcases to deepen understanding and give guidance (e.g. Supply Chain Atlas) as well as raise awareness in public and among business leaders. Several national governments provide funds to establish solid libraries for Life Cycle Analysis. The Ministry for Economic Development and its development agency GIZ engage with governments and in particular local businesses in

developing or industrialising but also with buyers in the home country. Services range from education and training to hands-on projects to develop and establish new business practices. The German Environment Agency commissions scientific research to provide latest knowledge to relevant environmental issues.

A.8.5 Public procurement policies

On the global level, the Agreement on Government Procurement of the World Trade Organisation (WTO GPA) (WTO 2020) serves as a guiding framework to public procurement, and is revised periodically. Regional Intergovernmental Organisations can either help the WTO GPA revisions to progress faster by spearheading with public procurement policies that prioritise sustainable products and services, or by quickly adopting the latest WTO GPA version. National Governments' duty is to translate the WTO GPA into national law and to specify sustainability criteria.

A.9 Government-enforced compulsory approaches and instruments

Government action also needs to be deterring and limiting to stop or avoid business practices that cause social or environmental harm. Regulation sets limits and defines rollout and law enforcement. Regulation also addresses scope and defines the boundaries for responsibility and liability. The structure of government organisations (see chapter A.6) applies also to mandatory approaches. Governments in industrialised countries are required to re-establish accountability of those that drive or benefit from practices in their supply chains that are past societal expectations or non-compliant with the law. Governments in developing or industrialising countries need to fill institutional voids, ensure law enforcement, and drive both social and economic development.

A.9.1 Incentives and penalties

Global intergovernmental organisations can establish incentive mechanisms, such as preferential trade agreements and tariff reductions, for countries that demonstrate progress in improving supply chain sustainability, and implement sanctions or trade restrictions against countries or businesses that fail to comply with international sustainability standards. National governments can offer financial incentives, tax breaks, and subsidies, or provide grants and subsidies to businesses that adopt sustainable practices and technologies, and impose taxes, tariffs, or carbon pricing schemes, or increase fees and charges on products and services with high environmental footprints. They further can establish reporting mechanisms for citizens and whistle-blowers to report violations of sustainability laws and regulations.

A.9.2 Legislation, regulatory enforcement and compliance

Global intergovernmental organisations can push for the development and implementation of international treaties, binding agreements or protocols that establish legal frameworks for regulating and enforcing sustainability in supply chains (e.g. international labour standards, the UN guidelines on business and human rights, or the OECD guidelines for multinational enterprises) and use international mechanisms for monitoring and enforcing compliance with sustainability standards, such as international courts or tribunals. National governments can enact new laws and regulations that mandate liability and compliance with sustainability

standards and reporting requirements (e.g. supply chain due diligence), conduct inspections and audits to ensure businesses adhere to environmental, labour, and human rights regulations and levy fines or penalties on cases of non-compliance. A further element is the introduction of public procurement policies that give preference to suppliers with proven sustainability credentials.