TEXTE
73/2025

Final report

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

Recommendations for selected incentive mechanisms

by:
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This project would not have been possible without valuable and faithful inputs from various interviewees, workshop participants and the distinguished project advisory board. We would like to express our gratitude for their contributions

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

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 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. 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 environmental and human rights risks: cotton-readymade garments; tin – tin solder; natural rubber – car tyres; coffee – coffee for consumption; iron ore – quality steel for automotive industry. It aims to provide guidance to business and policy makers to facilitate the practical implementation of effective environmental upgrade measures along these global supply chains and to allocate the distribution of the resulting cost and benefits more equitably.

This final report consolidates the research from previous project phases and highlights four promising incentive mechanisms for more equitable, cost-benefit distribution of environmental upgrades in global supply chains: price premiums, pay-per-performance contracts, collaborative financing of supplier investments in environmental upgrades, and offtake agreements. It discusses each instrument's key aspects, design requirements for effective cost-benefit sharing, necessary actions for creating supportive framework conditions, and the roles of various stakeholders in mainstreaming these instruments. The aim: to help industry actors and external stakeholders promote equitable cost-benefit distribution and effective environmental upgrades in global supply chains.

Kurzbeschreibung: Kostenverteilungs- und Anreizmechanismen für Umwelt- und Klimaschutz und Ressourcenschonung entlang globaler Lieferketten

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 – Konfektionsware, Zinn – Lötzinn, Naturkautschuk / Autoreifen, Kaffee – Konsumkaffee, Eisenerz – Qualitätsstahl für die Automobilindustrie. Das Projekt soll Unternehmen und politischen Entscheidungsträger*innen als Orientierungshilfe dienen, um die praktische Umsetzung wirksamer Umweltschutzmaßnahmen entlang der globalen Lieferketten zu erleichtern die daraus resultierenden Kosten und Nutzen gleichmäßiger zu verteilen.

Dieser Abschlussbericht fasst die Ergebnisse aus den vorherigen Projektphasen zusammen und hebt vier vielversprechende Anreizmechanismen für eine verbesserte Kosten-Nutzen-Verteilung bei der Umsetzung von Umweltverbesserungsmaßnahmen in globalen Lieferketten vor: Preisprämien, leistungsabhängige Verträge, die gemeinschaftliche Finanzierung von Investitionen der Lieferant*innen für verbesserten Umweltschutz, sowie Abnahmevereinbarungen. Er erörtert die wesentlichen Aspekte jedes Instruments, die Gestaltungsanforderungen für eine verbesserte Kosten-Nutzen-Verteilung, notwendige Maßnahmen zur Schaffung unterstützender Rahmenbedingungen, sowie die Rollen und Aufgaben verschiedener Anspruchsgruppen bei der Verankerung dieser Instrumente. Dies soll Akteur*innen aus den jeweiligen Branchen sowie externe Anspruchsgruppen dabei unterstützen, eine bessere Kosten-Nutzenverteilung und eine wirkungsvollere Umsetzung von Klima- und Umweltschutzmaßnahmen in globalen Lieferketten zu fördern.

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Abbreviation	Explanation
BMUV	German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety and Consumer Protection
B2B	Business-to-Business
CBAM	Carbon Border Adjustment Mechanism
CBS	Climate Bonds Standard
CSDDD	European Corporate Sustainability Due Diligence Directive
DFI	Development Finance Institutions
DR-EAF	Direct Reduction and Electric Arc Furnace
ESG	Environmental, Social, and Governance
ETS	Emissions Trading System
EU	European Union
EUDR	EU Regulation on Deforestation-free Products
EUR	Euro
FSC	Forest Stewardship Council
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
Higg FEM	Higg Facility Environmental Module
HREDD	Human Rights and Environmental Due Diligence
IFC	International Finance Corporation
IoT	Internet of Things
ISO	International Organisation for Standardisation
KPI	Key Performance Indicators
MDB	Multilateral Development Banks
MSI	Multi-stakeholder Initiative
NGO	Non-governmental Organisation
QASP	Quality Assurance Surveillance Plan
RCP	Responsible Contracting Project
RPP	Responsible purchasing practices
SAQ	Supplier Self-assessment Questionnaire
SLL	Sustainability-linked Loans
SME	Small and Medium-sized Enterprises

Abbreviation	Explanation
SOW	Statement of Work
SSCM	Sustainable Supply Chain Management
TCLP	The Chancery Lane Project
UN	United Nations
VSS	Voluntary Sustainability Standards

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 help businesses and policy makers to facilitate the practical implementation of effective environmental measures along global supply chains and to allocate the distribution of the resulting costs and benefits more equitably.

The project targets global supply chains in sectors crucial to the German economy that also have significant potential for adverse environmental and human rights impacts. The project analysed five supply chains from raw material to end product:

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

After an introduction on the background and objectives of the report, **Chapter 2** summarises the research conducted for the previous phases of this project.

The **first phase** aimed to provide a comprehensive understanding of the current structure and organisation of the selected supply chains, the dominant actors as well as the concentration and manifestation of power along the supply chain, the main environmental impacts, and the institutional barriers and (dis)incentives for environmental protection, information sharing and cost-benefit distribution that supply chain actors have to deal with. The results indicate that, in most of the supply chains, power is predominantly exercised by buyers downstream. Except for the iron ore-steel supply chain, these downstream actors are typically larger corporations. There are exceptions, such as composite factories in the textile industry that have managed to gain power through scale by integrating several steps of the supply chain. However, generally, weaker suppliers like smallholder farmers or small and medium-sized enterprises and manufacturers are disadvantaged in a competitive environment where scale is a crucial factor shaping power dynamics. In this context, profits are frequently distributed unevenly, favouring certain actors who also have the power to enhance their position relative to suppliers. The respective sectors address environmental impacts, which occur across all five supply chains, to differing extents. While voluntary sustainability programmes, organisations and tools exist in all five sectors, they are more developed in the cotton and coffee supply chains. Generally, more ambitious environmental upgrade activities and the sharing of costs and benefits between different supply chain actors can only be observed when profits allow for it, or when public scrutiny and legislation leave actors with no other choice. The detailed results of the research project's first phase are published in Strasser et al. (2024).

On this basis, the **second phase** of the project provided an overview of current sustainable supply chain management (SSCM) approaches and instruments initiated and offered by various supply chain actors or stakeholders. It also highlights key contextual factors and outlines different strategies for using sustainable supply chain instruments for environmental upgrades. The strategies considered include a coercive strategy, where sustainability requirements are

imposed on business partners through the threat or application of penalties, and a collaborative strategy, which is based on cooperation among supply chain partners. Subsequently, the supply chain-specific analysis provides an overview of the main environmental hotspots observed in the respective supply chains and analyses the status quo of SSCM approaches and instruments that are applied by supply chain actors to mitigate negative environmental impacts. The findings show that while a broad range of SSCM approaches exists, established approaches predominantly follow a coercive strategy, often leading to the ineffective implementation of sustainability measures because compliance is prioritised over effectiveness and costs and benefits are unevenly distributed between the actors in the supply chain. Emerging and new SSCM approaches are shifting towards more proactive, collaborative buyer-supplier relationships, promoting shared responsibility for sustainability outcomes. Nevertheless, more balanced power relations between buyers and suppliers, where buyers have limited ability to impose demands (like in the iron ore-steel industry), do not automatically lead to more cooperative approaches and better sharing of the costs and benefits of improved environmental performance, but often rather to uncoordinated strategies or a general lack of initiatives. The detailed results of the research project's second phase are published in Grüning et al. (2024).

The **third phase** of the project focused on translating these findings into sector-specific roadmaps for the cotton-garment, coffee, tin and the iron ore-steel supply chains. These roadmaps incorporate a mix of SSCM approaches and instruments to incentivise environmental and climate protection measures at suppliers and to contribute to a more equitable distribution of costs and benefits of environmental measures along these supply chains. Each roadmap includes a description of an environmental target, effective SSCM approaches and instruments, key actors for their implementation, the necessary framework conditions, and a discussion of the interaction of the instruments. Each roadmap consists of a mix of buyer-initiated, third-party, and supply chain-collective approaches. The findings suggest that collaboration among stakeholders across all supply chains is key. Whether through collective initiatives like water stewardship programmes in the cotton-garment supply chain or extensive stakeholder collaboration in the coffee sector, the roadmaps emphasise the importance of joint efforts in achieving improved environmental performance, while acknowledging that multi-stakeholder collaboration is time-consuming and may slow progress. Enhanced data management and traceability systems are a common theme, underscoring the critical role of accurate data and transparency in tracking progress and ensuring accountability. Training and capacity-building programmes are also integral components across the roadmaps, reflecting the need to equip all supply chain actors with the knowledge and skills necessary to implement practices for improved environmental performance effectively. The roadmaps also indicate that certain instruments like responsible purchasing practices, environmental performance clauses, price premiums, offtake agreements, green and collaborative financing, and capacity building and training, are recommended for all four supply chains. The detailed results of the research project's third phase are published in Grüning et al. (2025).

Chapter 3 of this report synthesises the overall project findings by highlighting four selected incentive mechanisms that have proven to be promising for more equitable distribution of costs and benefits, to support the effective implementation of environmental upgrade activities and passing on of information in global supply chains. The chapter illustrates the potential design of each mechanism, describes the necessary framework conditions for their effective implementation along the supply chain, and provides examples of those mechanisms already applied in selected supply chains. It also outlines the role of different stakeholder groups in mainstreaming the respective mechanism.

The first mechanism, **price premiums**, involves financial bonuses offered to suppliers meeting specific sustainability criteria. This approach is designed to incentivise suppliers to adopt environmentally friendly practices, providing them with additional income above standard market prices. The effectiveness of price premiums lies in its ability to motivate suppliers to invest in sustainable practices, particularly in sectors with high environmental impacts. However, the feasibility of implementing price premiums varies across markets and materials, influenced by factors such as buyer willingness to pay and market demand for sustainable products. The design of price premiums must consider long-term sustainability goals and business strategies, ensuring that the financial incentives align with broader environmental objectives.

The second mechanism, **pay-per-performance contracts**, links compensation to specific environmental outcomes, promoting efficiency and effectiveness by aligning financial interests with improved environmental performance. In the textile and fashion industry, few companies use these contracts to evaluate supplier performance and allocate business based on environmental performance, or overall sustainability, criteria. This approach motivates suppliers to meet environmental targets and helps companies manage risks and enhance their sustainability credentials. However, widespread adoption of pay-per-performance contracts is mainly hindered by market fragmentation and differing stakeholder priorities, such as price versus environmental performance. Addressing systemic barriers, like power imbalance in the supply chain, requires greater collaboration to align on long-term goals and mainstream this mechanism.

The third mechanism, **collaborative financing** through reverse factoring, is a financial incentive where suppliers receive early payments based on their environmental performance, leveraging the buyer's creditworthiness. This mechanism supports supplier investments in sustainability by reducing financial risks. Price premiums can be integrated with collaborative financing to further incentivise suppliers, creating a feedback loop that encourages high environmental standards. This dual mechanism addresses imbalances in benefit-sharing across supply chains, ensuring that gains from sustainable practices are more equitably distributed. As the long-term economic viability of such mechanisms remains uncertain, there is a need for tailored approaches that are able to address the complexities of different supply chains and market dynamics.

The fourth mechanism, **offtake agreements**, involves contracts that secure the purchase of future production, offering suppliers revenue certainty and encouraging investment in environmental upgrades. By guaranteeing demand for products from suppliers that meet certain environmental criteria, these agreements make suppliers more attractive to financiers. They can be combined with pay-per-performance contracts to enhance accountability and drive environmental improvements. Offtake agreements use pricing models that equitably distribute risks between suppliers and buyers, ensuring mutual benefits. Their widespread adoption requires support from stakeholders and policies that enhance their viability, promoting sustainable practices across global supply chains.

Chapter 4 provides a synthesis of the findings with a particular focus on the interconnectedness and interactions of the discussed incentive mechanisms. By exploring incentive mechanisms beyond current practice, the report aims to support industry actors, regulators, financial institutions, and others in promoting a more equitable distribution of costs and benefits, thereby enhancing the effective implementation of environmental upgrade activities and passing on of information in global supply chains.

Zusammenfassung

Das Forschungsprojekt „Kostenallokation und Anreizmechanismen für Umwelt-, Klimaschutz und Ressourcenschonung entlang globaler Lieferketten", beauftragt vom Umweltbundesamt, untersucht (Des-)Anreize und Barrieren für die Implementierung von Umweltmaßnahmen sowie den Informationsaustausch zwischen verschiedenen Akteur*innen entlang ausgewählter globaler Lieferketten. Ziel des Projektes ist es, Unternehmen und politischen Entscheidungsträger*innen sowie verschiedenen weiteren Akteur*innen eine Hilfestellung für die praktischen Umsetzung effektiver Umweltschutzmaßnahmen entlang globaler Lieferketten zu geben und die daraus resultierenden Kosten und Nutzen besser zu verteilen.

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

- Baumwolle und die Herstellung von Baumwoll-Konfektionsware
- Kaffee für Einzelhandel und Verbrauchermarken
- Eisenerz und Qualitätsstahl für die Automobilindustrie
- Zinn und Lötzinn für die Herstellung von Elektronik
- Naturkautschuk für Autoreifen

Nach einer Einführung in den Hintergrund und die Ziele des Berichts fasst **Kapitel 2** die Forschungsergebnisse der vorherigen Projektphasen zusammen. Die **erste Phase** zielte darauf ab, ein umfassendes Verständnis der aktuellen Struktur und Organisation der ausgewählten Lieferketten, der dominierenden Akteur*innen sowie der Konzentration und Manifestation von Macht entlang der Lieferkette, der wichtigsten Umweltauswirkungen und der institutionellen Barrieren und (Fehl-)Anreize für Umweltschutz, Informationsaustausch und eine verbesserte Kosten-Nutzen-Verteilung, mit denen die Akteur*innen der Lieferkette konfrontiert sind, zu gewinnen. Die Ergebnisse zeigen, dass in den meisten Lieferketten die Macht überwiegend von Käufer*innen am Ende der Lieferkette ausgeübt wird. Mit Ausnahme der Eisenerz-Stahl-Lieferkette sind diese nachgelagerten Akteur*innen typischerweise größere Unternehmen. Es gibt zudem Ausnahmen, wie beispielsweise Fabriken mit mehrstufigen Textilproduktionsverfahren, die durch die Integration mehrerer Schritte der Lieferkette ihre Verhandlungsmacht gegenüber nachgelagerten Akteur*innen vergrößern konnten. In der Regel sind jedoch schwächere Lieferant*innen wie Kleinbäuer*innen oder Fabriken kleinerer und mittlerer Größe in einem wettbewerbsintensiven Umfeld benachteiligt, in dem Skalierung die Machtverhältnisse bestimmt. In diesem Kontext werden Gewinne häufig ungleich verteilt, und zwar zugunsten bestimmter Akteur*innen, die auch die Macht haben, ihre Position gegenüber den Lieferant*innen zu verbessern. Die jeweiligen Branchen gehen die Umweltauswirkungen, die in allen fünf Lieferketten auftreten, in unterschiedlichem Maße an. Während freiwillige Nachhaltigkeitsprogramme sowie Nachhaltigkeitsinitiativen und entsprechende Lieferkettenmanagementinstrumente in allen Branchen existieren, sind sie in den Baumwoll- und Kaffeelieferketten bereits weiterentwickelt. Im Allgemeinen können ehrgeizigere Umweltverbesserungsmaßnahmen und eine verbesserte Verteilung von Kosten und Nutzen zwischen den entsprechenden Akteur*innen der Lieferkette nur beobachtet werden, wenn die Gewinne dies zulassen oder wenn öffentlicher Druck und die Gesetzgebung den Akteur*innen

keine andere Wahl lassen. Die detaillierten Ergebnisse der ersten Phase des Forschungsprojekts wurden in Strasser et al. 2024 veröffentlicht.

Auf dieser Grundlage wurde in der **zweiten Projektphase** einen Überblick über aktuelle Ansätze und Instrumente des nachhaltigen Lieferkettenmanagements, die von verschiedenen Akteur*innen oder Interessengruppen der Lieferkette initiiert und angeboten werden, erarbeitet. Sie hebt wichtige Kontextfaktoren hervor und skizziert unterschiedliche Strategien für die Nutzung nachhaltiger Lieferketteninstrumente zur ökologischen Aufwertung. Zu den in Betracht gezogenen Strategien gehören eine Zwangsstrategie, bei der Nachhaltigkeitsanforderungen durch die Androhung oder Anwendung von Strafen gegenüber Geschäftspartner*innen durchgesetzt werden, und eine kollaborative Strategie, die auf der Zusammenarbeit zwischen den Partner*innen in der Lieferkette beruht. Anschließend bietet die lieferkettenspezifische Analyse einen Überblick über die wichtigsten Umwelthotspots in den jeweiligen Lieferketten und analysiert den Status quo von Ansätzen und Instrumenten des nachhaltigen Lieferkettenmanagements, die von den Akteur*innen der Lieferkette zur Minderung negativer Umweltauswirkungen angewendet werden. Die Ergebnisse zeigen, dass es zwar eine breite Palette von nachhaltigen Lieferkettenmanagement-Ansätzen gibt, etablierte Ansätze jedoch überwiegend einer Zwangsstrategie folgen, was häufig zur ineffektiven Umsetzung von Nachhaltigkeitsmaßnahmen führt, da die Einhaltung von Vorschriften über die Effektivität gestellt wird und Kosten und Nutzen ungleichmäßig zwischen den Akteur*innen in der Lieferkette verteilt sind. Neue nachhaltige Lieferkettenmanagementansätze verlagern sich hin zu proaktiveren, kollaborativen Beziehungen zwischen einkaufenden und zuliefernden Unternehmen, die die gemeinsame Verantwortung für eine bessere Umweltleistung fördern sollen. Dennoch führen ausgewogenere Machtverhältnisse zwischen einkaufenden und zuliefernden Unternehmen, bei denen die einkaufenden Unternehmen nur begrenzt Forderungen stellen können (wie in der Eisenerz-Stahl-Industrie), nicht automatisch zu kooperativeren Ansätzen und einer besseren Verteilung der Kosten und Nutzen bei der Umsetzung von Umweltleistungen, sondern oft eher zu unkoordinierten Strategien oder generell fehlenden Nachhaltigkeitsinitiativen. Die detaillierten Ergebnisse der zweiten Phase des Forschungsprojekts wurden in Grüning et al. (2024) veröffentlicht.

Die **dritte Projektphase** konzentrierte sich darauf, diese Erkenntnisse in sektorspezifische Roadmaps für die Lieferketten von Baumwollbekleidung, Kaffee, Zinn und Eisenerz-Stahl zu übersetzen. Diese Roadmaps beruhen auf einem „smart mix" an nachhaltigen Lieferkettenmanagementansätzen und -instrumenten, um bei Zulieferern Anreize für Umwelt- und Klimaschutzmaßnahmen zu schaffen und zu einer ausgeglicheneren Verteilung der Kosten und Nutzen dieser Maßnahmen entlang der Lieferketten beizutragen. Jede Roadmap enthält ein unternehmens- und lieferkettenspezifisches Umweltziel, effektive nachhaltige Lieferkettenmanagementansätze und -instrumente, die wichtigsten Akteur*innen für deren Umsetzung, die notwendigen Rahmenbedingungen und eine Einordnung der Kombinationsfähigkeit der Instrumente. Jede Roadmap besteht aus einer Mischung von Lieferkettenansätzen, die von einkaufenden Unternehmen initiiert, von unabhängigen Dritten angeboten oder in kollektiven Zusammenhängen vorangetrieben werden, in die auch Lieferant*innen und andere Akteur*innen stärker involviert sind. Die Erkenntnisse deuten darauf hin, dass in allen Lieferketten die Zusammenarbeit zwischen den Interessengruppen entscheidend ist. Ob durch kollektive Initiativen wie Wasserbewirtschaftungsprogramme in der Baumwollbekleidungs-Lieferkette oder umfassende Zusammenarbeit verschiedener Interessengruppen im Kaffeesektor - die Roadmaps betonen die Bedeutung gemeinsamer Anstrengungen zur Verbesserung der Umweltleistung, wobei anerkannt wird, dass die Zusammenarbeit mit mehreren Interessengruppen zeitaufwändig ist und den Fortschritt verlangsamen kann. Verbesserte Datenmanagement- und Rückverfolgbarkeitssysteme ist ein

allen Lieferketten inhärentes Thema und unterstreicht die entscheidende Rolle der Verfügbarkeit genauer Daten und Transparenz bei der Fortschrittsprüfung und der Sicherstellung der Rechenschaftspflicht. Schulungs- und Kapazitätsentwicklungsprogramme sind ebenfalls integrale Bestandteile der Roadmaps und spiegeln die Notwendigkeit wider, alle Akteur*innen der Lieferkette mit dem Wissen und den Fähigkeiten auszustatten, die erforderlich sind, um Praktiken für eine verbesserte Umweltleistung effektiv umzusetzen. Die Roadmaps weisen auch darauf hin, dass bestimmte Instrumente wie verantwortungsvolle Einkaufspraktiken, Umweltleistungsklauseln, Preisprämien, Abnahmevereinbarungen, grüne und gemeinschaftliche Finanzierung sowie Kapazitätsentwicklung und Schulung für alle vier Lieferketten empfohlen werden. Die detaillierten Ergebnisse der dritten Phase des Forschungsprojekts wurden in Grüning et al. (2025) veröffentlicht.

Kapitel 3 dieses Berichts fasst die Gesamtergebnisse des Projekts zusammen, indem es vier ausgewählte Anreizmechanismen hervorhebt, die sich als vielversprechend für eine verbesserte Verteilung der Kosten und Nutzen erwiesen haben, um eine wirkungsvolle Umsetzung von Umweltverbesserungsmaßnahmen und die Weitergabe von Informationen in globalen Lieferketten zu unterstützen. Das Kapitel veranschaulicht das potenzielle Design jedes Mechanismus, beschreibt die notwendigen Rahmenbedingungen für deren effektive Umsetzung entlang der Lieferkette und bietet Beispiele für die Anreize, die bereits in ausgewählten Lieferketten angewendet werden. Es skizziert auch die mögliche Rolle verschiedener Interessengruppen bei der Etablierung des jeweiligen Mechanismus.

Der erste Mechanismus, **Preisprämien**, beschreibt finanzielle Boni, die an Lieferant*innen vergeben werden, die bestimmte Nachhaltigkeitskriterien erfüllen. Dieser Ansatz soll Lieferant*innen dazu anregen, umweltfreundliche Praktiken zu übernehmen, indem er ihnen zusätzliches Einkommen über den Standardmarktpreisen hinaus bietet. Die Wirksamkeit von Preisprämien liegt in ihrer Fähigkeit, Lieferant*innen zu motivieren, in nachhaltige Praktiken zu investieren, insbesondere in Sektoren mit signifikanten Umweltauswirkungen. Die Umsetzbarkeit von Preisprämien variiert jedoch je nach Markt und Rohstoff und ist beeinflusst durch Faktoren wie die Zahlungsbereitschaft der Käufer*innen und die Marktnachfrage nach nachhaltigen Produkten. Das Design von Preisprämien muss langfristige Nachhaltigkeitsziele und Geschäftsstrategien berücksichtigen, um sicherzustellen, dass die finanziellen Anreize mit umfassenden Umweltzielen übereinstimmen.

Der zweite Mechanismus, **leistungsabhängige Verträge**, verknüpft die Vergütung von Geschäftspartner*innen mit spezifischen Umweltergebnissen und fördert Effizienz und Effektivität, indem finanzielle Interessen mit einer verbesserten Umweltleistung in Einklang gebracht werden. In der Textil- und Modeindustrie nutzen aktuell bereits einige wenige Unternehmen diese Verträge, um die Leistung ihrer Lieferant*innen zu bewerten und Aufträge basierend auf Umweltleistungs- oder allgemeinen Nachhaltigkeitskriterien zu vergeben. Dieser Ansatz soll Lieferant*innen dazu motivieren, Umweltziele zu erreichen, und Unternehmen dabei helfen, Risiken zu managen und ihre Nachhaltigkeitsbilanz zu verbessern. Die weitverbreitete Einführung von leistungsabhängigen Verträgen wird jedoch hauptsächlich durch Marktfragmentierung und unterschiedliche Prioritäten der Interessengruppen, wie Preis versus Umweltleistung, behindert. Die Bewältigung systemischer Barrieren, wie des Machtungleichgewichts in der Lieferkette, erfordert eine stärkere Zusammenarbeit zwischen den relevanten Akteur*innen, um sich auf langfristige Ziele abzustimmen und den Mechanismus breit zu etablieren.

Der dritte Mechanismus, die **gemeinschaftliche Finanzierung** durch Reverse Factoring, ist ein finanzieller Anreiz, bei dem Lieferant*innen vorzeitige Zahlungen basierend auf ihrer Umweltleistung erhalten, wobei die Kreditwürdigkeit des einkaufenden Unternehmens genutzt

wird. Dieser Mechanismus unterstützt Investitionen der Lieferant*innen in Nachhaltigkeit, indem er die finanzielle Risiken dieser Maßnahmen reduziert. Ansätze der gemeinschaftlichen Finanzierung können mit Preisprämien kombiniert werden, um Lieferant*innen weiter zu motivieren und einen Rückkopplungsmechanismus zu erzeugen, der hohe Umweltstandards fördert. Dieser duale Mechanismus behandelt Ungleichgewichte in der Kosten- Nutzen - Verteilung entlang der Lieferketten und stellt sicher, dass Gewinne aus nachhaltigen Praktiken gleichmäßiger verteilt werden. Da die langfristige wirtschaftliche Tragfähigkeit solcher Mechanismen ungewiss bleibt, besteht Bedarf an maßgeschneiderten Ansätzen, die in der Lage sind, die Komplexität verschiedener Lieferketten und Marktdynamiken zu bewältigen.

Der vierte Mechanismus, **Abnahmevereinbarungen**, beschreibt Verträge, die die Beauftragung zukünftiger Produktionen sichern, den Lieferant*innen Einnahmesicherheit bieten und Investitionen in Umweltverbesserungen fördern. Indem sie die Nachfrage nach Produkten von Zulieferern garantieren, die bestimmte Umweltkriterien erfüllen, machen diese Vereinbarungen Lieferant*innen attraktiver für Finanzinstitute. Sie können mit leistungsabhängigen Verträgen kombiniert werden, um die Rechenschaftspflicht zu erhöhen und Umweltverbesserungen voranzutreiben. Abnahmevereinbarungen nutzen Preisgestaltungsmodelle, die Risiken zwischen zuliefernden und einkaufenden Unternehmen gleichmäßiger verteilen und gegenseitige Vorteile gewährleisten. Ihre breite Einführung erfordert Unterstützung von verschiedenen Interessengruppen und Strategien, die ihre Tragfähigkeit erhöhen, um nachhaltige Praktiken in globalen Lieferketten zu fördern.

Kapitel 4 schließlich bietet eine Synthese der Ergebnisse des dritten Kapitels mit besonderem Fokus auf die Wechselwirkungen der hier diskutierten Anreizmechanismen. Durch die Erforschung von Anreizmechanismen über die aktuelle Praxis hinaus zielt der Bericht darauf ab, Akteur*innen der Industrie, Regulierungsbehörden, Finanzinstitutionen und andere dabei zu unterstützen, eine ausgeglichenere Verteilung von Kosten und Nutzen zu fördern und so die effektive Umsetzung von Umweltverbesserungsmaßnahmen und die Weitergabe von Informationen in globalen Lieferketten zu verbessern.

1 Background and objectives

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 upgrade activities as well as the exchange of information between different actors along selected global supply chains. The report addresses the issue that the implementation of environmental upgrade activities is often accompanied by significant costs (both financially and in terms of resources and expenditure). Observations from the research already conducted in the project confirm that these costs are often unevenly distributed among the actors involved in the setting of global supply chains - the costs are often higher for the less powerful and financially weak suppliers, while the benefits from the implementation of environmental protection measures (e.g. improved reputation) are focused to a greater extent on more powerful and financially stronger, larger purchasing companies. This can hinder the effective implementation of environmental and climate protection as well as cooperation between supply chain actors. For this reason, the report is intended to provide guidance to businesses and policy makers to facilitate the practical implementation of environmental upgrade activities along global supply chains and to improve the distribution of cost and benefits in the process.

The project focuses on global supply chains from raw material to the end product that represent key sectors of the German economy with a high potential for adverse environmental impacts. We analyse the following five supply chains:

- 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

Building on the findings of the previous research conducted as part of the project (see Chapter 2 for more information), the final phase of the project and this final report will synthesise the overall project findings by highlighting four selected incentive mechanisms that appear most promising to more equitably distribute costs and benefits and support the effective implementation of environmental upgrade activities in global supply chains. The four incentive mechanisms were chosen based on a qualitative assessment of all materials collected throughout the project implementation – consisting of extensive literature review, workshops and interviews with practitioners and various industry experts. They were mentioned repeatedly as being the most promising approaches to improving environmental upgrades, cost benefit sharing and cooperation between different stakeholders along global supply chains. Some are already in use, while most are not yet used or still in pilot phases in the analysed supply chains. Chapter 3 of this report describes each incentive mechanism's intended effects as well as its (potential) design for effectiveness and provides recommendations on the framework conditions necessary for mainstreaming. The recommendations cover the role that (German and European) companies, sponsors of certification and auditing systems, sector and multi-stakeholder initiatives (MSIs), other intermediaries like stock exchanges, banks, financial institutions and governments and international organisations would need to play and the actions they need to take in order to effectively implement each incentive mechanism. Where

applicable, the chapter will provide examples of applications for each incentive mechanism that can already be observed in the raw material specific supply chains analysed in the course of the project.

By considering incentive mechanisms that go beyond current practice, the report aims to support actors from within the industries under consideration as well as those who regulate, finance or otherwise support these sectors in furthering an equitable distribution of costs and benefits, supporting the effective implementation of environmental upgrade activities along global supply chains.

2 Overview of the objectives and main findings of the research project

The research project took place in different phases focusing on specific aspects of the overall research question; these aspects are interlinked and build on each other in terms of content and methodology. The objectives and most important results of the individual phases are summarised in the following sections.

2.1 Analysis of the cotton, tin, natural rubber, coffee and iron ore supply chains

The first phase of the research project and the associated interim report (Strasser et al. 2024) aim to establish a comprehensive understanding of the current structure and organisation of the selected supply chains. It introduces the relevance of globalised production and trade and their impact on the environment as well as a brief review of the management and economic literature and its corresponding sub-disciplines related to the governance of sustainability in global supply chains. Against that backdrop, five commodity-specific supply chain profiles are presented, which provide an overview of the market structure of each raw material/commodity, the dominant actors, the concentration and manifestation of power along the supply chains and possible future trends and developments in the sector. In addition, the supply chain profiles provide initial insights into the environmental hotspots of the supply chains and key protection measures that are used in the respective industries today. Lastly, they describe the prevalent institutional barriers and (dis)incentives for environmental protection.

Due to variations in power structures and dynamics, differing roles of international markets and pricing mechanisms, and different levels of progress in addressing environmental impacts, it can be assumed that there are different barriers to environmental upgrades and opportunities for costs and benefit sharing in the different commodity-specific supply chains. This was taken into account when selecting the five focal supply chains in order to obtain as good an overview as possible of the different types and structures of supply chains. This is intended to enable the knowledge gained in the project to be transferred to supply chains for other commodities in the future. Methodologically, the first interim report is based on a qualitative analysis of relevant studies, reports, databases and online tools as well as interviews with industry experts to profit from insider perspectives. To make results comparable, supply chains are assigned to different categories – a process guided by the typology of Gereffi et al. (2005) on the structures of supply chains and the various forms of exercising power.[1]

The results of this initial research phase show that, in the majority of the supply chains analysed, power is exercised by buyers at the downstream end of the supply chain. This distribution of power often disadvantages suppliers operating in business environments that are characterised by a large number of smaller actors, such as smallholder farmers in the coffee, cotton and rubber supply chains and artisanal and small-scale miners in the tin supply chain. While the cotton-garment, natural rubber-tyre and coffee supply chains often still rely on supplies from smallholder farmers – who have very limited ability to influence their position and advocate for their needs, fair prices, etc. – the iron ore-steel supply chain is dominated at the upstream end by large multinational mining corporations, who are in a much better position to negotiate their

[1] The typology of Gereffi et al. 2005 distinguishes between the five global value chain governance types: “market”, “modular”, “relational”, “captive” and “hierarchy”. They types depend, among others, on the complexity of the transactions, the ability to codify transactions, the capabilities in the supply-base and the degree of explicit coordination and power asymmetry between actors of the supply chain - with a market representing the lowest and a hierarchy the highest power asymmetry.

standing vis-à-vis steel producers and the automotive industry. The degree to which downstream actors exert power over other actors in the supply chain also depends to some extent on the commodity in question, with consumer-facing commodities (such as coffee and cotton) facing more public scrutiny, leading to more advanced sustainability initiatives than for industrial commodities (such as natural rubber, tin and iron ore), which tend to be less visible to end consumers.

Significant environmental impacts occur along all five supply chains. These are currently being addressed to varying degrees by the respective sectors. In all industries, voluntary sustainability programmes, organisations and tools exist that aim to address some of the environmental hotspot topics. While they are more developed in the cotton and coffee supply chains (e.g. in relation to the production of organic products), they are either not considered at all in the metals supply chains or are still in their infancy. One important reason for the implementation of corresponding measures, especially in the less progressive supply chains, are government regulations that oblige companies to implement decarbonisation strategies, for example. The natural rubber supply chain presents a special case, as its upstream segment is characterised by similar smallholder structures to those of the cotton and coffee supply chains but is associated with a lower visibility of the products. This means that although environmental protection initiatives are emerging in the supply chain, they still cover only a small segment of the market.

Overall, the comparative analysis of the five supply chains shows that in a competitive setting, where actors try to stabilise and improve their own position, scale is one of the key factors shaping power dynamics. Weaker actors that are not organised are often historically and structurally disadvantaged, dependent on intermediaries to sell their products and are subject to international price setting mechanisms that are difficult to control. As sellers are interested in raising sales prices and buyers in lowering purchase prices, actors generally tend to disengage from practices that lead to lower profitability, such as environmental upgrade activities. In this situation, profits often accrue in a very unbalanced manner; some actors profit at the expense of others while at the same time having the power to further improve their position by pressuring suppliers into unfair contracts. With regard to environmental upgrades, buyers who are more powerful are able to demand certain standards (e.g. certificates) while shifting the costs for the necessary changes (e.g. purchase of new technical equipment) to the supplier at the threat of ending the contract. This can be described by the concept of cascading compliance. Currently, more ambitious environmental upgrade activities and the sharing of costs and benefits between different supply chain actors can only be observed when profits allow for it, or when public scrutiny and legislation leave actors with no other choice.

By analysing existing power relations, pricing mechanisms and other market dynamics, the first research phase and corresponding interim report provide the starting point for identifying instruments and approaches that can help to improve the sharing of costs and benefits for implementing environmental upgrade measures and exchanging environmental data, thereby promoting environmental and climate protection in the global supply chain as a whole.

2.2 Business approaches and instruments to sustainable supply chain management

The second phase of the research project explores and catalogues the diverse approaches and instruments employed by companies to foster environmental and climate protection within their supply chains. It provides a general overview of the many approaches and instruments that are available to companies today and that are initiated and offered by various stakeholders to achieve a wide range of objectives. The corresponding interim report (Grüning et al. 2024) also

outlines the context in which buyers and suppliers operate and their business relationships, focussing on key contextual factors such as industry specifics, skills, power dynamics, dependencies, and geographical distance. In addition to the intentions and objectives of each company, these contextual factors play a significant role in shaping companies' decisions to utilise individual sustainable supply chain management (SSCM) instruments and approaches. The report describes two overarching strategies, which companies apply to get their business partners to implement sustainability requirements or standards. Some companies focus 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 more collaborative setting, buyers and suppliers optimise beyond the boundaries of their respective organisations on shared objectives, considering the effects on the other parties involved.

Building on this, supply chain-specific analyses were conducted. These provide an overview of the main environmental hotspots observed in each of the five raw material-specific value chains and important SSCM approaches and instruments, which are already applied by the supply chain actors. For this purpose, the analysis differentiates between approaches and instruments initiated by individual buyers or suppliers (buyer-individual or supplier-individual voluntary), those implemented in a collective setting (buyer-collective, supplier-collective or supply-chain collective voluntary), those offered by third parties (profit-focused or impact focused third-party offered voluntary) and those initiated by governments (fourth-party enabled voluntary, fourth-party enforced compulsory). In addition, the report evaluates the existing SSCM approaches and instruments with regards to their contribution to a more equitable distribution of costs and benefits that potentially triggers environmental upgrades 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 research 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.

In the cotton-garment supply chain, a focus on buyer-individual voluntary approaches was observed. While collaborative business models are increasing and are most advanced in this supply chain due to the sector's history of public scrutiny, instruments aimed at reducing power imbalances are still mostly applied in specific partnership-based cases. There is a rather clear divide between established approaches, such as supplier audits, product certifications and codes of conduct, which are often coercive in nature and primarily benefit buyers, and emerging and niche approaches including smart contracts, joint audits and price premiums, which demonstrate more collaborative practices but are not yet applied at a large scale. In the tin-solder supply chain, while there is recognition of the need for greater environmental sustainability, actors are mostly concerned with the financial implications of SSCM approaches and instruments. The sector uses a mix of approaches, but most established instruments such as smelter lists, audits and sustainability criteria in purchasing policies are characterised by buyers imposing demands that create financial obligations for suppliers. More cooperative emerging and niche approaches such as mining cooperatives and traceability tools are being piloted but are much less prevalent than in the cotton industry. While the natural rubber-tyre supply chain is starting to address environmental issues primarily due to legislative pressures, efforts to implement SSCM instruments and approaches for environmental sustainability are still in their inception phase. Activities are being dominated by a few frontrunners, which are targeting specific suppliers or focusing on certain product lines. Some non-financial incentives can be observed, but financial instruments supporting smallholders and contributing to the sharing of costs are rare. Generally, only a few instruments are used, and many remain in the emerging phase, including supplier training and technical advice, supplier cooperatives and codes of

conduct. In the coffee sector, large buyers have developed initiatives aimed at enhancing sustainability along the supply chain, although most of them remain voluntary. Established instruments in coffee supply chains include both penalty (e.g. supplier audits, codes of conduct) and incentive mechanisms (e.g. direct sourcing, sustainable supply chain finance and product certifications), mostly providing advantages for buyers. The circumstances are close to those in the cotton supply chain and the sector appears to be more advanced than the natural rubber industry. However, innovative instruments that focus on a distribution of costs and benefits are still considered niche and although farmer cooperatives aim to enhance the bargaining power of upstream actors vis-à-vis buyers, power imbalances determine the adoption of approaches. In the iron ore-steel supply chain, buyers tend to have less influence over their suppliers than in other supply chains, resulting in separate individual approaches at all levels of the supply chain (initiated by automotive companies, steel companies and mining companies). Some more collaborative approaches such as offtake agreements, collaborative financing and joint standards for environmental data sharing are also emerging, particularly where there is a need to act due to mandatory legislation (e.g. decarbonisation strategies) and investment in emerging clean technologies (e.g. hydrogen-based "green" steel production). However, innovative instruments are still in the piloting phase and environmental issues other than greenhouse gas (GHG) emissions are being largely neglected. As in the tin supply chain, there are generally few established SSCM approaches, but emerging ones tend to be more collaborative.

The findings show that there is a broad range of SSCM approaches, instruments and initiatives across supply chains that aim to address negative environmental impacts. Importantly though, established approaches mostly follow a coercive strategy in which sustainability requirements are forced upon business partners through the threat or implementation of penalties. This reflects the power dynamics identified in the first interim report of the project (Strasser et al. 2024) and results in a setting where the benefits of implementing environmental upgrade measures primarily accrue to buyers. In addition, such coercive strategies often lead to an ineffective implementation of sustainability measures because compliance is prioritised over effectiveness and costs and benefits are unevenly distributed between the actors in the supply chain. Many of these SSCM approaches and instruments follow a logic of risk mitigation and cost avoidance for buyers, with many initiatives being buyer-driven, often resulting in cascading compliance. In addition, the costs incurred by buyers through many of the existing buyer-driven sustainability initiatives are generally rather low, as some of the costs incurred are priced in by suppliers and/or the costs of providing information and raising public awareness, for example, are often shared with other buyers in industry initiatives. In settings with more balanced power relations between suppliers and buyers, such as the iron ore-steel sector, buyers have less leeway to simply impose their demands on suppliers without offsetting costs or sharing benefits of improved environmental performances.

Emerging and new approaches to 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. Fair Wear Foundation, Responsible Contracting Project – RCP, The Chancery Lane Project – TCLP), coffee (e.g. Global Coffee Platform), natural rubber (Global Platform for Sustainable Natural Rubber), iron ore-steel and tin (e.g. Responsible Minerals Initiative) supply chains. Some sector-agnostic approaches such as RCP or TLCP attempt to address power imbalances by incorporating responsible business practices based on human rights and environmental due diligence (HREDD) (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.

2.3 Roadmaps for the implementation of sustainable supply chain management approaches and instruments

The third phase of the project focuses on translating the findings of the previous research into four practical roadmaps presented in the corresponding interim report (Grüning et al. 2025). The roadmaps include a mix of SSCM approaches and instruments for the effective implementation of environmental and climate protection measures and a more equitable distribution of costs and benefits of environmental measures along the cotton-garment, coffee, iron ore-steel and tin-solder supply chains[2].

The roadmaps should provide businesses and policy actors with guidance regarding the following questions:

- How can more cooperative and incentive-based sustainable SSCM approaches and instruments be introduced that help achieve a specific environmental upgrade target?
- Which activities have to be implemented by which actors in which time horizon and under which regulatory and market framework conditions in order to achieve the environmental upgrade target?
- Where do we recognise dependencies between different SSCM approaches and instruments and which key measures can be identified to enable effective implementation?

The roadmaps are based on the results of previous research conducted as part of the project and a series of interviews and workshops with practitioners and industry experts (including business associations, international organisations, MSIs, civil society, certification and standard organisations, and other intermediaries). Two roadmaps (cotton-garment and iron ore-steel) were each developed in close collaboration with a focal company from the sector.

Each roadmap includes a specific environmental upgrade target, a description of the SSCM approaches and instruments contained in the roadmap and key stakeholders necessary for their implementation, their interaction and the necessary framework conditions. The approaches and instruments contained in the roadmaps are each assigned to different categories, depending on whether an instrument is initiated by an individual company (usually buyer-initiated), at the level of a collective supply chain (supply chain-collective initiated) or by a third party (third party-initiated).

The **roadmap for the cotton-garment supply chain** describes the possible interplay of different SSCM approaches and instruments for improved water management, chemical management and wastewater treatment. To this end, the roadmap includes measures initiated by the buyer which, when combined, may increase effectiveness: codes of conduct and environmental performance clauses, process certifications, offtake agreements, responsible purchasing practices (RPP), improved supplier/factory communication, training and capacity building, environmental performance platforms, green financing and direct sourcing/ vertical

[2] For the implementation of the third phase, it was decided in close cooperation with the German Environment Agency to focus the analysis on only four supply chains and to exclude natural rubber tyres. This decision was made to enable the necessary in-depth investigation of the supply chains in close cooperation with a focal company or in dialogue with various stakeholders through interviews and workshops. The decision not to investigate the natural rubber tyre supply chain further also reflects the observation that key characteristics of the supply chain are very similar to the coffee supply chain, such as the prevalence of labour-intensive harvesting by smallholders of the commodity, the power dynamics that are largely skewed in favour of downstream buyers, and the (expected) strong influence of the EU Regulation on Deforestation-free Products (EUDR) on the transparency, traceability and sustainability performance of various actors along the supply chain (for more details, see Strasser et al. 2024, section 3.3). By focusing the analysis on the supply chains of cotton-garment, coffee, iron ore-steel and tin supply chains, the interim report aims to cover the broadest possible spectrum of different supply chain and market structures.

supply chain integration. These are supplemented by the supply chain-collective initiated water stewardship programme and policymaking/lobbying.

The **roadmap for the coffee supply chain** focuses on addressing deforestation. The roadmap features third party-initiated audit and certification processes, supply chain-collective initiated extensive stakeholder collaboration, enhanced data management and traceability systems, and educational training programmes for farmers, as well as the buyer-initiated responsible contracting and price premiums.

The **roadmap for the iron ore-steel sector** describes a possible combination of measures to significantly reduce GHG emissions at all stages of the supply chain. It covers the buyer-initiated SSCM approaches and instruments supplier development, climate-aligned clauses in supplier code of conducts and contracts and supplier performance monitoring, as well as the supply chain-collective initiated approaches harmonised carbon accounting framework, enhanced data verification and traceability systems, joint research and development projects and third-party verification and cross recognition.

The **roadmap for the tin-solder supply chain** is also aimed at the reduction of GHG emissions. To this end, it proposes a combination of the third-party initiated approaches audits and certifications and green loans, the supply chain-collective initiated instruments harmonised GHG emission accounting framework, transparency tool for the reporting of verified information, capacity building and training programmes for suppliers and enhanced data management and traceability systems and the buyer-initiated incentive measures price premiums and collaborative financing.

The SSCM instruments and approaches suggested in each of the roadmaps provide a comprehensive framework for improving environmental performance across different supply chains. Some instruments can be recommended across all four supply chains, such as RPP, environmental performance clauses, price premiums, offtake agreements, green and collaborative financing, and capacity building and training.

- RPP can align purchasing decisions with environmental targets, promoting sustainable practices through fair partnerships between business partners, fair payment terms and sustainable costing, among others. Originally designed for the textile and fashion industries, RPP can be adapted for other sectors like consumer electronics and agriculture.
- Incorporating environmental performance clauses in contracts ensures suppliers meet environmental standards, potentially linked to incentives such as bonuses of preferred supplier status. Rising regulatory pressures make these clauses increasingly important, even if their effectiveness varies from sector to sector, as they use formal contracts to varying degrees.
- By offering financial incentives for improved environmental performance, price premiums encourage suppliers to adopt sustainable measures. While currently underutilised, they hold significant potential to trigger environmental upgrades across supply chains if they are further promoted through pressure from consumers and civil society.
- Offtake agreements provide financial stability for suppliers to invest in, such as new sustainable technologies, for example, while also ensuring a stable supply of sustainably produced materials or products for buyers. They can regulate the payment of price premiums and facilitate access to third-party funding, thereby supporting the achievement of environmental targets if they are linked to specific environmental performance metrics.

- Green financing programmes and collaborative financing schemes (including green loans, funding form international organisations etc.) provide financial resources and incentives for suppliers to invest in sustainable practices. While being relevant for all four supply chains, financial institutions struggle to make green funds available at scale. However, emerging collaborative efforts can support the mainstreaming of such approaches, particularly in complex supply chains like cotton-garment or the production of innovative new products, such as "'green steel".
- Essential for all supply chains, capacity building and training initiatives equip suppliers with the skills to implement sustainable practices, optimise processes and support them in accessing premium markets. MSIs play a crucial role in facilitating knowledge exchange and supporting pilot projects to drive systemic change.

These observations of the most promising approaches and instruments also informed the selection of the four incentive mechanisms presented in Chapter 3 of this report.

3 Recommendations for mainstreaming incentive-based sustainable supply chain management instruments

The following sections present four selected incentive mechanisms; throughout the course of the research project, they have been identified as the most promising approaches to improving environmental upgrades, cost benefit sharing and cooperation between different stakeholders along global supply chain, even if not all of them are used (at scale) in all of the analysed supply chains (as of yet). They were chosen based on a qualitative assessment of all materials collected throughout the project implementation – consisting of an extensive literature review, workshops and interviews with practitioners and various industry experts. Most of the incentive mechanisms described below are still in a pilot phase and need to be mainstreamed through collective effort. Each of the following chapters thus describes the respective incentive mechanism's intended effects as well as its (potential) design for effectiveness and provides recommendations on the framework conditions necessary for the incentive to be mainstreamed. The recommendations cover the role that (German and European) companies, sponsors of certification and auditing systems, sector initiatives and MSIs, other intermediaries like stock exchanges, banks, financial institutions as well as governments and international organisations would need to play and the actions they need to take in order to effectively implement each incentive mechanism. Where possible/applicable, the chapters will provide examples of applications for each incentive mechanism that can already be observed in the raw material specific supply chains analysed in the course of the project.

3.1 Incentive mechanism 1: Price premiums

Price premiums, as understood in this report, are financial bonuses offered to suppliers or producers for meeting certain sustainability criteria or implementing environmentally friendly practices. They represent an additional amount paid above the standard market price for goods or services that meet specific sustainability standards. The implementation of price premiums to promote environmental sustainability in global supply chains represents a complex, but potentially transformative, approach. They can be implemented via a supply chain-wide scheme (e.g. Fairtade) or in bilateral contracts between buyers and suppliers. In both cases, the effectiveness of this approach depends on careful calibration to balance incentivising sustainable practices while maintaining economic viability across the supply chain.

In recent years, price premiums for improved environmental performance have been increasingly introduced across different commodity supply chains, for example in metals (e.g. aluminium, steel, copper), materials (e.g. food-grade plastic, high-quality recycled plastic), and other commodities, such as coffee, chocolate, cotton (Azevedo et al. 2022; WEF 2023b).

How can price premiums support improved cost benefit-sharing and efficient implementation of environmental upgrade activities along global supply chains?

One of the needs for price premiums arises from the current paradigm in procurement, where buyers often focus on continually reducing purchasing prices. This approach has led suppliers, particularly in developing and industrialising countries, to prioritise price leadership as their primary strategy for maintaining business relationships (Labowitz and Baumann-Pauly 2015). However, this focus on cost reduction can come at the expense of environmental sustainability. Recent research by Kuwornu et al. (2023) emphasises that sustainable supply chain practices often require significant investments, which hint on the importance for suppliers to receive financial incentives in order to make those investments. The price premiums can serve as an effective motivator for suppliers to adopt more sustainable practices, particularly in industries

with high environmental impacts. It is important to note that the feasibility and extent of price premium schemes can vary significantly across different markets and materials (WEF 2023b). The factors that influence the effectiveness of price premiums as a sustainable supply chain management instrument include, among others, buyer opinions on product quality (through their willingness to pay or demand for sustainable products as an example), influences of sellers on product quality (brand name and investment in brand name), and influences of markets on product quality (e.g. different markets with different cultures, product standards) (Rao and Monroe 1996; Azevedo et al. 2022).

How to design effective price premiums for enhanced environmental performance and improved cost-benefit sharing in global supply chains?

As stated above, price premiums need to be carefully designed to offer suppliers and sub-suppliers incentives for environmental improvements but while remaining economically viable. Some key considerations when it comes to designing a supply chain-wide price premium scheme and/or bilateral Business-to-Business (B2B) schemes are:

- **Defining relevant stage(s) of the supply chain and the specific environmental criteria**: A crucial first step in setting up a price premium scheme, whether for supply chain-wide or bilateral B2B contexts, is to define the environmental issues and related supply chain stages to be addressed with the funds raised by the premium. Developing new environmental standards or using existing ones is a necessary precondition. Certification and traceability systems as well as platforms for data exchange may be a necessary precondition, especially when setting up a supply chain-wide price premium scheme.

- **Cost of implementation**: In both supply chain-wide and bilateral B2B setups, the price premium should, at minimum, cover the additional costs incurred by suppliers to implement and maintain improved environmental practices. This includes investments in new technologies, training, and potentially higher operational costs associated with environmental management. Moreover, the premium should provide a financial incentive that makes the investment in environmental practices not just feasible, but also attractive. On the other hand, the price premium must be set at such a level that the competitiveness of buying companies is maintained in the market or, in different terms, that consumers are willing to pay for more environmentally friendly products. This requires an understanding of how increased costs at the supply level translate to final product pricing and market positioning (see "market responses" and the green steel example below).

- **Market responses**: The design process must also take into account the broader market response to price premiums. Taking the steel industry as an example, manufacturers show a willingness to pay a premium of ~30% for green steel produced by Stegra (formerly: H2 Green Steel (H2GS)). This premium is justified by the relatively small impact on production cost (around 1%) for end-products of Stegra's clients (manufacturers, such as Adient, BE Group, Bilstein Group, BMW, Electrolux, Ingka/IKEA), while enabling them to reduce their overall production emissions by up to 40% – a compelling value proposition made possible by Stegra's claim to reduce steel production emissions by up to 95% (Keating 2024). The price premiums differ by sector and products. For instance, a study of the Spanish coffee market in 2021 (Merbah and Benito-Hernández 2023) found that Rainforest Alliance and other organic certifications commanded significant price premiums of 28.51% and 25.50% respectively, compared to regular coffee. Green aluminium (biofuel aluminium) was 30-50% higher than aluminium produced using coal as a fuel. Green logistics (using biofuel blends) receive 40% higher prices compared to fuel oil (WEF 2023b). Market research is essential to understand the price sensitivity of different customer segments and their willingness to pay

for sustainable products. This information can help in setting price premiums that the market can bear while still driving sustainable practices.

- **Long-term perspective**: When designing price premiums, longer-term benefits from implementing environmental improvement measures should be considered, whether for supply chain-wide or bilateral B2B setups. The relationship between investment and benefit can be understood in terms of time horizons. In the short-term, the costs associated with implementing improved technologies, new processes, and systems may be substantial. However, in the long term, the benefits of adopting environmental practices – such as improved resource efficiency, enhanced brand reputation, and reduced regulatory risks – may offset these initial investments (Ogunbukola 2024). Therefore, premium schemes need to be designed collaboratively between buyers and suppliers to ensure they appropriately address both necessary short-term capital expenditures and longer-term operational expenditures as well as the arising benefits from improved production techniques.
- **Collaborative approach**: Effective design of price premiums often requires engagement with various stakeholders under a collaborative approach to create an equitable and effective premium programme (Grüning et al. 2024). Suppliers can provide insight into the real costs of implementing environmental upgrading measures. Customers can offer perspectives on their willingness to pay for sustainable products. For supply chain-wide schemes, the collaboration should extend to include consumer groups, non-governmental organisations (NGOs) and government bodies to ensure the premium structure is widely accepted and effective across the entire supply chain. In both setups, industry associations and sustainability experts can contribute knowledge on best practices and emerging trends.
- **Adaptive mechanisms**: Given the dynamic nature of markets and sustainability challenges, it is crucial to build adaptive mechanisms into the premium structure. Regular reviews and adjustments based on market conditions, technological advancements, and evolving environmental standards can ensure that the premium remains effective and economically viable over time. In a bilateral B2B setup, this might involve regular renegotiations and flexible terms that allow for adjustments based on changing market conditions or technological improvements. In supply chain-wide schemes, adaptive mechanisms might include periodic reviews of the entire premium structure, involving all stakeholders in the supply chain to ensure continued effectiveness and fairness.
- **Multi-tier implementation and hybrid approach**: Bilateral price premium agreements between buyers and suppliers may have limited impact on environmental issues in lower tiers of the supply chain. To enhance their effectiveness, buyers should consider multi-tier agreements, including improved transparency, and capacity building for lower-tier suppliers. Additionally, it is crucial to distinguish between price premiums and pay-for-performance models. While price premiums offer pre-set incentives to meet certain sustainability criteria, pay-for-performance models directly reward measurable outcomes. A hybrid approach combining both elements could provide a more comprehensive solution, ensuring that sustainability efforts reach all levels of the supply chain and drive tangible environmental improvements. Clear performance indicators, regular audits, and advanced traceability technologies are essential for verifying and maximising the impact of these initiatives across complex supply chains.
- **Data verification and traceability systems**: Once the price premiums are in place, verifying that (sub-)suppliers comply with the criteria for price premiums is essential for maintaining the credibility of the scheme. Fostering collaboration across different tiers of the

supply chain is key. This involves creating mechanisms for communication and cooperation between buyers and suppliers (primary and sub-suppliers). Means of collaboration can be joint training sessions, shared reporting platforms, or collaborative problem-solving initiatives to address sustainability challenges that span multiple tiers of the supply chain. A comprehensive approach combining various instruments/methods ensures accuracy, reliability, and continuous improvement, while cost efficiency needs to be carefully considered. These include:

- Utilising publicly available supplier information can streamline the assessment process. Both buyers and suppliers should register relevant data on reputable environmental performance platforms, which provide standardised, verified data across various environmental performance criteria, reducing duplication of effort. For additional or industry-specific details, targeted supplier self-assessment questionnaires (SAQs) serve as an effective screening tool and guide more in-depth verification efforts, such as audits. These SAQs should be tailored to each (sub-)supplier, covering all relevant criteria to qualify price premiums, and be updated regularly. Integrating SAQ responses with other verification methods is crucial to inform and focus third-party audits or on-site inspections.

- Robust data verification and traceability systems ensure that sustainability claims are accurate and premiums are rightly allocated. They enhance transparency in pricing, addressing a key barrier to equitable sharing of costs and benefits along the supply chain (Strasser et al. 2024; Grüning et al. 2024). They reduce uncertainty, which positively influences both price premium acceptance and purchasing decisions (Choe et al. 2009). The participation of both suppliers and buyers with their distinctive roles is needed to implement those systems. Supply chain actors can implement data management solutions to improve transparency and facilitate audit processes. Digital platforms, if designed in a user-friendly way so that both suppliers and buyers are able to enter inputs as well as access and analyse data, can facilitate easy tracking of performance over time. Some modern technologies, such as blockchain, might be applied as they can create real-time and secure records of data (Strasser et al. 2024). The integration of Internet of Things (IoT) devices can further automate data collection, reducing the risk of human error or manipulation. Continuous monitoring systems play a vital role in providing real-time insights into supplier performance, allowing for dynamic adjustment of price premiums based on actual sustainability achievements and enabling fairer price premium calculations.

- Verification processes to ensure comprehensive supply chain oversight should extend beyond tier 1 supplier. In a bilateral B2B setup, a multi-tiered approach can be used, encouraging direct suppliers to implement similar verification processes with their own suppliers. Joint audits that involve multiple tiers of the supply chain can provide a more holistic view of environmental performance and providing training and resources to lower-tier suppliers can help build capacity for effective monitoring and reporting. In the case of a supply chain-wide price premium scheme, common platforms for data sharing and common verification and monitoring schemes can be even more effective as they can reduce redundancy, lower costs, and increase transparency for all parties involved. Capacity building can be carried out centrally by the institution governing the price premium scheme.

- Complementing these methods with gathering information through engagement can further enhance the robustness of the verification system. On-site visits allow for

thorough assessments of supplier facilities, including document reviews and employee interviews. Engaging with local communities, NGOs, and government agencies in the verification process adds additional layers of credibility and comprehensiveness to the assessment.

While these design considerations provide the foundation for effective price premium schemes, successful implementation requires coordinated action and clear responsibilities across different stakeholder levels, particularly focusing on two key dimensions of execution:

- **At the buyer level**: Buyers can take a lead in implementing price premium schemes as a means of responsible sourcing by establishing a strong internal framework. This begins with setting clear environmental policies and targets that are well-defined and integrated into the overall business strategy. These targets should be specific, measurable, and aligned with broader industry and societal goals, e.g. reducing GHG emissions in line with the Paris Agreement or the climate neutrality goal of the European Union (EU). Then, comprehensive strategies that integrate premiums into sourcing practices with clear criteria for calculation and disbursement, incorporating a collaborative approach can be developed. Cross-departmental collaboration is crucial, particularly among the management board and sustainability, procurement, and finance departments. This ensures that incentives and decision-making processes are aligned across the organisation, preventing siloed approaches that could undermine the effectiveness of price premium initiatives. Buyers should also demonstrate a long-term commitment to environmental initiatives, with involvement of top management to ensure environmental improvement is prioritised and resources are adequately allocated for environmental performance efforts, including price premium initiatives. They can collaborate with others in the same industry and with civil society or governments to establish supply chain- or sector-wide price premium schemes including common methodologies for calculating and verifying premiums, considering competition law requirements. It should be highlighted that the development of a robust market for green products is crucial for the success of price premiums, whether through cultivating niche consumer segments or leveraging government initiatives, such as via public procurement, policy and regulation development (Xue et al. 2021; WEF 2023b; Chen et al. 2024; Schnitzer 2024)
- **At the (sub-)supplier level**: Effective implementation of price premiums requires significant engagement and collaboration among suppliers at different tiers. Targeted capacity building (e.g. training, technical assistance) helps suppliers understand the price premium schemes and implement the environmental standards that qualify them for premium payment. (Sub-)suppliers must document and provide evidence of their compliance with premium-qualifying criteria and cooperate with verification processes. The additional cost for accurate data collection and reporting by suppliers must be recorded and considered as a part of price premiums. Clear communication, transparent guidelines and performance metrics that suppliers need to meet to qualify for premiums are crucial.

How to create supportive framework conditions that allow for the effective implementation and mainstreaming of price premium mechanisms?

To make price premiums widely adopted and effective, it is essential to establish the necessary framework conditions and involve other actors:

- **Providers of Voluntary Sustainability Standards (VSS)**: To increase the mainstreaming of price premiums, providers of VSS can integrate the instrument into their frameworks. One example is the Fairtrade price premium scheme (Fairtrade International 2024c). Generally,

VSS can be designed by the private sector either as company-led standards and codes of conduct (such as Starbuck C.A.F.E. Practices), group of private firms (such as Global GAP), NGOs (such as Fairtrade, Rainforest Alliance), public sector (such as USDA Organic), or MSI (such as Forest Stewardship Council – FSC) (UNCTAD 2020). However, VSS targeting product certifications are often seen as suitable for using price premiums, as they enhance consumer recognition and trust, enable market differentiation, increase perceived value, and provide access to niche markets where consumers are willing to pay more for products that align with their values and meet specific sustainability criteria.

There are possibilities to incorporate price premium mechanisms into those standards by identifying and rewarding compliance with predefined key environmental criteria that can be linked to financial incentives rather than variable performance levels. Key environmental criteria can include, for example, GHG emission reduction, water conservation, or energy efficiency. This means establishing fixed premium payments for meeting the certification requirements, distinct from pay-for-performance schemes where payments vary based on achieved performance improvements. In order to mainstream price premiums in VSS, comprehensive guidance is required. This should include detailed methodologies for calculating premiums based on fulfilling environmental criteria, protocols for verifying compliance, and best practices for implementation across diverse supply chains. VSS should include explicit requirements and mechanisms for premium distribution, ensuring that the financial benefits reach the supply chain actors who bear the costs and responsibilities of implementing and maintaining the environmental standards. Another possibility is to establish mutual recognition agreements between certification schemes, taking into account that many schemes are often overlapping, to reduce audit overload and streamline premium systems. This might enable suppliers certified under one system to have relevant aspects recognised by others without additional auditing.

- **Sponsors of certification and auditing systems**: Certification and auditing bodies play a crucial role in developing robust methodologies for assessing conformity with environmental criteria linked to price premiums. The investment in technology and training to enhance auditing efficiency, effectiveness and capability is important for assessing complex environmental impacts. The combination of robust methodologies and advanced auditing techniques creates a strong foundation for credible and effective price premium systems.

  Regular audits (either company or third-party audits) and certifications can be used as a foundation of the verification process of price premiums. These assessments, especially third-party ones, can provide credible validation of supplier claims and practices (Strasser et al. 2024). Audits could be conducted annually or bi-annually, with the possibility of unannounced spot checks. These audits may be aligned with recognised certifications like International Organisation for Standardisation's (ISO) norm ISO 14001 for environmental management systems, or industry-specific standards (e.g. the Tin Code (ITA 2024)), ensuring that they feed into continuous improvement plans.

- **Sector initiatives, MSIs, business associations and chambers of commerce**: These organisations can create enabling framework conditions for price premiums. These can include, for example, fostering collaboration and standardisation across industries, developing common sustainability criteria and verification systems, promoting standards to address key environmental issues (Reinecke et al. 2012), facilitating knowledge sharing and capacity building, particularly benefiting smaller actors (Soundararajan 2023). By leveraging their collective influence, they can advocate for supportive policies and regulations (Lambin

and Thorlakson 2018). In particular for smallholders, collective actions in farmer cooperatives can lead to better market access and negotiation power (Fischer and Qaim 2014; Grüning et al. 2024).

MSIs play a vital role in creating industry-wide momentum for sustainability efforts (Grüning et al. 2025). They contribute to developing industry-wide sustainability standards and benchmarks, providing frameworks for price premium systems that ensure consistency and comparability between different companies' efforts. MSIs also facilitate knowledge sharing by creating platforms for the exchange of best practices and lessons learned in implementing price premiums and accelerate the adoption of these effective strategies. In addition, they develop enforcement mechanisms and help solve label and certification issues (Searcy 2017). By bringing together diverse stakeholders, including companies, NGOs, and government representatives, MSIs can create a more holistic and widely accepted approach to sustainability, one that supports the mainstreaming of price premium initiatives.

MSIs are also essential in facilitating dialogue between different actors to align on price premium structures and verification methods through dialogue forums or working groups (Grüning et al. 2025). They can also act as incubators or platforms for setting up price premium schemes and facilitators to ensure widespread adoption throughout supply chains. These initiatives should address key issues such as fair premium distribution across the supply chain, and cost distribution for sustainable practices and investment. Through their facilitation role, sector initiatives can build consensus, drive the development of more effective and widely accepted premium systems, and accelerate adoption by ensuring widespread sharing of effective strategies.

- **Financial institutions**: Although price premiums can be considered a financial incentive for suppliers to implement environmental measures, additional financing can be necessary to help overcome cost barriers. This can include, for example, capital intensive investments in new technologies or production processes, which often hinder the adoption of more sustainable practices (Ogunbukola 2024). Mechanisms like green financial products, green loans or sustainability-linked loans (SLL), play a crucial role in supporting and incentivising sustainable practices in supply chains. Through other mechanisms such as short-term loans, which can be made available as "bridge financing", supply chain finance programmes, and specialised credit lines, financial institutions can provide the necessary capital for businesses to overcome the (initial) cost barriers. Financial institutions can also develop financial products that support and incentivise businesses adhering to specific VSS with price premium components. Examples include specialised loan products, e.g. at the portfolio level, offering preferential rates to suppliers and buyers implementing verified premium schemes, or investment funds focusing on companies active in supply chain-wide VSS with price premium schemes.

  In this way, financial institutions play a significant role in creating an enabling environment for price premium schemes. Their efforts help to meet growing investor demands for sustainable options (Belloni et al. 2020; OECD 2024), align with regulatory expectations (Berensmann and Lindenberg 2016; Zhang et al. 2024), open new revenue streams, and contribute to the institutions' reputational value. Innovative approaches like SLL, which tie interest rates to specific environmental targets, which can also be linked to premium systems, can help overcome financial barriers to implementation.

- **Governments and international organisations**: Governments and international organisations can also take various measures to create a supportive policy environment for

price premiums (Grüning et al. 2024; Grüning et al. 2025). This includes creating markets for environmentally friendly products, for example through giving preferential treatment in public procurement for products with credible eco-labels that use price premiums or by raising awareness about environmental issues in the global supply chains of products-. International organisations might provide support in harmonising these policies across countries, creating a consistent global environment for implementing price premiums. This policy framework can leverage governmental influence to drive widespread adoption of premium systems. The funding of research and pilot projects that demonstrate the effectiveness of price premium systems need to be allocated as these studies can examine both the environmental impacts and economic effects on different supply chain actors, testing various premium structures and implementation approaches across different contexts.

- **Civil society organisations**: Civil society organisations, including a diverse range of independent, not-for-profit entities – from community-based groups, indigenous peoples' movements and labour unions to professional bodies like think tanks – play a crucial role in providing independent scrutiny and raising awareness about sustainability issues. Engaging with these organisations allows suppliers and buyers to leverage their independent assessments of environmental performance claims and impacts, significantly enhancing the credibility of price premium systems. These third-party evaluations can help validate company efforts and identify areas for improvement. By fostering a more informed and engaged consumer base through their activities (such as public campaigns, educational programmes, and research publication), civil society can help create the market conditions necessary for price premium systems to thrive.

Price premiums in the coffee supply chain

As of August 2023, the minimum price for unwashed Arabica beans was $1.40 per pound (0.453 kg), and it was set at a minimum price of $1.80 per pound by Fairtrade International. The same was applied for natural Robusta with an increase of $0.19, from $1.01 to $1.20 per pound. These increased prices are equivalent to 19% and 29% for Fairtrade-certified Robusta and Arabica coffee, respectively (Fairtrade International 2023) in responding to the intensifying impacts of climate change and price volatility that are severely affecting coffee producers worldwide. These increased prices act as a safety net for farmers (Carlan 2024). For Fairtrade coffee, buyers pay either the Fairtrade Minimum Price or the market price, whichever is higher, plus a Fairtrade premium. Organic coffee receives an additional organic differential on top of the price and premium (Fairtrade International 2024b). This system has provided price stability for farmers, with the Fairtrade Minimum Price exceeding the benchmark New York C price by 53% for the duration from 2011 to 2022 (Fairtrade International 2024a). The premium is paid to farmer cooperatives who democratically decide how to invest it in their businesses and communities, thereby supporting sustainable practices and improving livelihoods (Fairtrade International 2024d). This structured approach demonstrates how price premiums can be systematically implemented to benefit producers and enhance overall supply chain sustainability.

3.2 Incentive mechanism 2: Pay-per-performance contracts

Pay-per-performance, also known as performance-based contracting or outcome-based payment, is a financial model in which compensation is tied to the results, i.e. payments are made based on the achievement of specific, measurable outcomes rather than on the inputs used to achieve those outcomes. This approach is often used to incentivise efficiency and

effectiveness, as it aligns the financial interests of the service provider with the desired outcomes of the service (NIGP and CIPS 2012; Adtance 2023).

Performance-based contracts are commonly found in the service sector and in industries where outcomes can be clearly defined and measured, and where there is a strong incentive for both parties to optimise performance (e.g. marketing). In the manufacturing sector, pay-per-performance contracts are particularly common in industries where the focus is on innovation, quality, and efficiency. Industries such as the automotive, the aerospace and defence, or the consumer goods industry (e.g. electronics, apparel) often involve complex supply chains and require precise performance metrics. In the automotive industry, performance-based contracts often include specific metrics for suppliers. These might include quality standards, delivery times, and defect rates. Suppliers are rewarded for meeting or exceeding these metrics (e.g. keeping a certain defect rate below a specified threshold), which helps automotive manufacturers maintain high standards in their supply chain (Schram 2010; Schaefers et al. 2021). As the automotive and electronics industries increasingly move towards more service-oriented business models (e.g. mobility-as-a-service, phone-as-a-service), performance-based contracts ned to be adapted to include metrics related to service quality, customer satisfaction, operational efficiency, and increasingly sustainability. In the aerospace industry, performance-based contracts for aircraft maintenance have become increasingly popular (General Services Administration 2024). The US Government uses such contracts in military contexts to focus on outcomes rather than specific tasks (Jackson et al. 2024).

According to Nyden (2024), performance-based contracts consist of five elements:

- **Statement of Work (SOW)**: Performance work statements or SOWs detail the goods or services to be delivered. To complete the delivery, the supplier needs to satisfy all outlined requirements.
- **Quality Assurance Surveillance Plan (QASP)**: The QASP outlines the methods the purchasing company will use to monitor and assess the contractor's performance. This includes performance metrics, monitoring techniques (e.g. inspections, audits, sampling, testing, surveys), and documentation and reporting to ensure the supplier meets the standards set in the SOW.
- **Performance-based metrics**: Performance-based metrics are meant to verify that the supplier's work aligns with the requirements and ensure that these measures are reasonable and attainable. Environmental performance metrics such as energy consumption, carbon emissions, waste reduction and recycling, and sustainable use of raw materials could be included in a QASP.
- **Contractual incentives or dis-incentives**: Incentives can include bonuses for outstanding performance, while penalties such as liquidated damages (i.e. pre-determined financial penalties specified in a contract that are imposed when one party fails to meet certain contractual obligations) or service level credits may be applied for subpar performance. (Service level credits are financial or service-based compensations provided by the supplier to the client when agreed-upon service levels are not met, meaning that service improvements or additional services can be provided at no extra cost).
- **Pricing model**: A pricing model determines how the work is priced, e.g. through a lump sum or direct cost pass-through, and can have a positive or negative impact on the supplier's performance.

The development of performance-based contracts often requires a lengthy process of trust-building between a company and its contractor (Schram 2010). This relationship typically begins with standard contracts, where the contractor is paid based on the time spent and materials used. Over time, as the parties work together and develop mutual understanding and trust, they may become more open to exploring performance-based arrangements. However, Schram observes that even when both parties are ready to implement performance-based elements, contracts rarely shift entirely to this model. Instead, they often adopt a hybrid approach that combines two key components (Schram 2010):

- A traditional section that outlines specific work to be completed, along with conventional payment terms. This might include fixed prices, maximum price caps, or turnkey arrangements.
- A performance-based section that defines additional work or objectives, tied to a system of financial incentives and penalties based on the contractor's performance.

This hybrid model allows both parties to benefit from the stability of traditional contracting while also incorporating performance-based incentives to achieve better outcomes.

How can pay-per-performance contracts support improved cost benefit sharing and efficient implementation of environmental upgrading activities along global supply chains?

Pay-per-performance contracts can be a tool to support improved cost-benefit sharing and environmental performance in global supply chains in various ways, as outlined below:

- **Environmental performance clauses:** Environmental performance contracts can include clauses that link supplier performance to pricing. Performance can be measured by quality (e.g. percentage of rework, quality defects), efficiency (e.g. garments produced per hour, energy per unit of production, material waste) or specific environmental metrics like water usage, GHG emissions, and recycling rate, among others. These clauses, when included in contracts with direct suppliers, can help incentivise environmental performance across all supplier tiers. This approach addresses the operational difficulty of sharing information throughout complex global supply chains (Aupècle et al. 2024). The RCP and TCLP have tried to develop contracts and clauses to incentivise better environmental performance. While the RCP focuses primarily on integrating human rights and environmental considerations into contracting practices, it supports performance-based contracts as a means to ensure compliance with these standards. The RCP emphasises a shared allocation of risks and responsibilities (shared responsibility) and encourages joint commitments to HREDD, rather than placing guarantees solely on suppliers, which in the past has led suppliers to "cut corners" and compromise on sustainability (RCP 2023; Dadush et al. 2023; Pietropaoli et al. 2023). TCLP is dedicated to developing contracts and clauses that address climate change and sustainability. Although it does not specifically focus on performance-based contracts, TCLP creates climate-aligned clauses that can be integrated into various contracts, including performance-based ones. These clauses often include incentives for reducing GHG emissions and meeting environmental objectives.
- **Environmental results obligation:** Performance-based contracts include an obligation for the service provider or supplier to achieve specific environmental results. The price clause is directly linked to these outcomes, creating a strong incentive for improved environmental performance (Aupècle et al. 2024).
- **Consumer preferences and willingness to pay:** Studies have shown that environmentally aware consumers show a preference for and greater willingness to pay for "eco-friendly",

"green" or low-carbon products (Laroche et al. 2001; Lee 2011; Khan et al. 2024; Wang et al. 2024). Depending on the sector, companies could leverage this willingness to implement a premium with their suppliers (see 3.1) and pass that on to retail prices. Fashion brands and retailers are already sourcing sustainable and organic materials or from certified facilities, for which some pay their suppliers a premium. Justifying the premium to consumers will lead to higher retail prices if they identify with the topic (Khan et al. 2024). Similarly, manufacturers might receive bonuses for meeting or exceeding other targets in terms of quality, quantity or environmental performance indicators (e.g. improved energy efficiency, reduced water consumption). As we learned through previous research (cf. in particular Grüning et al. 2025), certain impact areas, such as wastewater and chemical use, have received less public attention and therefore brands/retailers have not yet set more ambitious targets in this area.

- **Optimal contract design:** Research has been conducted on optimal contract design for carbon emission reduction in green supply chains. These contracts can define the degree of a product's sustainability in terms of carbon emission reduction per unit of product, aligning supplier incentives with environmental targets. Wang et al. (2024) highlight the Agricultural Bank of China, which has implemented a new policy that acknowledges the environmental achievements of companies and allows their environmentally friendly products to be used as collateral for loans (Wang et al. 2024). According to Ecovadis and affectio mutandi (2019), contractual imbalances that make only one party responsible must be avoided. Instead, suppliers need to be enabled to fulfil contractual requirements by buyers incentivising cooperation through financial bonuses, preferred supplier programmes or long-term contract commitments and factoring in sustainability cost.
- **Traceability and transparency:** Pay-per-performance contracts can also be used to incentivise better traceability in supply chains. The United Nations (UN) Global Compact has developed guides like the "Guide to Traceability" to assist companies in developing more sustainable supply chain practices, which can be incorporated into these contracts (UN Global Compact 2014). This includes companies outlining what information must be tracked at each stage of the supply chain. Performance- or more specifically emission-based revenue models with a premium/penalty-oriented mechanism require digital technologies (e.g. blockchain) to provide the production-related parameters, composition of the product, or origin of primary/secondary materials, to name a few (Saccani et al. 2024). These technologies enable the creation of an unalterable record of a transaction or process, increasing trust, transparency and efficiency. The data provided by blockchain or similar technology can be used to provide secure information to financial institutions about the environmental performance of the companies involved along the supply chain (Bancilhon et al. 2018). Companies also need to provide training to suppliers to demonstrate how these technologies work effectively and fulfil traceability requirements.

By tying financial incentives directly to improved environmental outcomes, performance-based contracts can drive sustainable practices throughout the supply chain, from direct suppliers to multiple tiers of sub-suppliers. However, their effectiveness depends on thorough design, clear performance metrics, and robust monitoring and enforcement mechanisms.

How to design effective pay-per-performance contracts for enhanced environmental performance and improved cost-benefit sharing in global supply chains?

There are different ways a pay-per-performance mechanism in contracting can improve the environmental outcome.

- **Setting clear targets**: The first step is for buyers and suppliers to collaboratively define clear, measurable targets that need to be achieved and include them in the contract (TCLP 2024). These targets should be aligned with the overall goals of the project or initiative. In the textile and fashion industry, for example, clear targets could include reducing carbon emissions, minimising production waste, improving product quality, or reducing the use of water and chemicals in textile processing. Targets can be set either individually by the buyer or in collective initiatives (e.g. sustainability initiatives, MSIs) and reward suppliers for instance with financial bonuses, preferred supplier status, or long-term contract commitments for achieving those targets.
- **Measurement and verification**: Establishing a robust system for measuring and verifying the achievement of these targets is crucial. This often involves setting up baseline data and using third-party verification to ensure accuracy and transparency. As indicated above, performance metrics could include specific targets for energy efficiency, waste reduction and the percentage of sustainable or organic materials used, among others. Regular data collection supported by internal and external audits is necessary to verify whether these targets are being met. Buyers can monitor their suppliers' performance through environmental performance platforms where other stakeholders also have access to, and report progress for accountability (Pietropaoli et al. 2023; TCLP 2024).
- **Payment structure**: Payments are structured in a way that they are released upon the achievement of predefined milestones, targets or outcomes. This can include bonuses or a preferred supplier status for exceeding targets or penalties for underperformance (Baker 1992; Payscale 2021). Smart contracts could be used to automate and execute payments, where the agreed-upon conditions between buyers and suppliers are encoded directly into the contract's programming logic (Bancilhon et al. 2018).
- **Incentives for innovation and efficiency**: By focusing on outcomes rather than processes, service providers are encouraged to find innovative and efficient ways to achieve the desired results (Baker 1992; Essig et al. 2016). Contracts can be designed to incentivise suppliers to innovate, such as developing new sustainable materials or adopting more resource efficient production techniques. This not only improves environmental performance but can also lead to cost savings and competitive advantages.
- **Collaboratively balancing costs and benefits:** Designing pay-per-performance contracts should be done collaboratively to ensure that both the benefits (e.g. better information provision to consumers, safer and more environmentally friendly production practices) and the potential costs (e.g. increased economic costs for firms and consumers) associated with varying levels of stringency in meeting regulatory requirements are considered. Where significant investment is required (e.g. environmentally friendly technology, traceability technology), buyers can link financial support for strategic suppliers to long-term contractual commitments, thereby reducing the cost burden.

How to create supportive framework conditions that allow for the effective implementation and mainstreaming of pay-per-performance mechanisms?

Global supply chains are complex, and challenges need to be addressed systemically with other stakeholders like local governments, MSIs or financial institutions to reduce the environmental impact and improve cost-benefit allocation. Pay-per-performance is not yet widely used as an incentive for improving environmental performance in supply chains. To mainstream its use, a range of stakeholders need to take action, beyond individual buyers and suppliers:

- **Sector initiatives, MSIs, business associations and chambers of commerce**:
  - **Standardisation and best practices:** Sector initiatives and MSIs contribute to standardisation and best practices by developing and promoting industry-specific standards for pay-per-performance contracts, ensuring consistency and reliability across the supply chain. Initiatives like Cascale (formerly known as Sustainable Apparel Coalition) or the Partnership for Sustainable Textiles already have created guidelines in the past that define metrics related to environmental performance (e.g. Key Performance Indicators (KPIs) on wastewater/chemicals, circular economy, decarbonisation). Business associations can compile and disseminate best practices, helping their members understand how to implement environmental performance-based contracts effectively.
  - **Facilitating collaboration:** MSIs can collaboratively develop frameworks for pay-per-performance mechanisms drawing on the wealth of knowledge of their members to effectively address common challenges and align incentives across the supply chain. Business associations and chambers of commerce and industry can facilitate networking opportunities for businesses to collaborate on sustainability initiatives, thereby fostering partnerships that lead to shared resources and innovative solutions (Chambers of Commerce 2024).
  - **Capacity building and training:** Business associations and chambers of commerce and industry can offer training programmes and workshops to educate members about the benefits and implementation of pay-per-performance contracts. They can also provide resources, for instance in collaboration with international organisations, for building the necessary skills to design and manage these contracts effectively.
  - **Policy advocacy and support:** By advocating for supportive policies and regulations, sector initiatives and business associations can help create an enabling environment for pay-per-performance contracts. They can lobby for incentives or subsidies that encourage sustainable practices linked to performance metrics. MSIs could influence policy by demonstrating the effectiveness of pay-per-performance models through pilot projects and case studies.
  - **Monitoring and evaluation:** MSIs can establish monitoring and evaluation systems to assess the impact of pay-per-performance contracts on supply chain sustainability and efficiency. Sector initiatives can develop indicators and metrics to measure performance outcomes and ensure accountability.
  - **Networking and knowledge sharing:** By hosting conferences, forums, and networking events, sector initiatives, MSIs, chambers, and business associations can facilitate the exchange of ideas and experiences among their members and relevant industry players, promoting the adoption of pay-per-performance contracts.
- **Financial institutions:**
  - **Providing green financing and incentives**: Financial institutions, such as multilateral development banks (MDB), investment banks, development finance institutions (DFI) or central banks, can facilitate pay-per-performance mechanisms by offering loans and market bonds with favourable terms through commercial banks to suppliers that meet specific environmental performance criteria in line with those required in pay-per-performance contracts with their buyers. MDBs like the World Bank/International

Finance Corporation (IFC), Asian Development Bank and African Development Bank finance large-scale environmental upgrading projects that enhance environmental performance in supply chains (World Bank 2020). They also provide technical assistance to develop policies that promote sustainable business practices, creating an enabling environment for suppliers to comply with pay-per-performance contracts. This assistance ensures that suppliers have the guidance needed to align their operations with the performance criteria. Investment banks can issue green bonds to raise capital for companies to invest in environmental projects (Laurent 2023), while DFIs and government funds increasingly use results-based financing to reward verified sustainability improvements, particularly in climate-related areas (Anderson et al. 2019).

- **Developing performance-based financial products**: Commercial banks can offer green loans or SLL with favourable interest rates to companies that meet specific environmental performance targets (IFC 2022). These loans adjust interest rates based on the borrower's performance against pre-defined targets, linking financial terms to environmental outcomes (Edunjobi 2024). While funders may incur higher costs to monitor and verify the successful achievement of targets that lead to payments, these products incentivise environmental investments (Anderson et al. 2019). However, smaller suppliers may feel tied ("locked in") to a buyer or market if their customers directly or indirectly assume a significant share of the financing (Bancilhon et al. 2018).
- **Enhancing risk management and insurance**: Providing tools and services to assess and mitigate environmental risks in supply chains enables companies to make informed decisions and invest in environmental practices. Smart contracts, operating on blockchain technology, enhance the efficiency, transparency, and trust in pay-pay-per-performance contract by ensuring that the terms (e.g. payments) are executed only when specific environmental criteria are met. Additionally, insurance products that cover environmental risks can reduce the financial burden on companies (Desalegn 2023).
- **Enhancing transparency and reporting**: Established frameworks and standards for green financing, such as the Green Bond Principles or the Climate Bonds Standard (CBS), provide clear criteria for what qualifies as a green project, ensuring that funds are allocated to genuinely environmentally friendly initiatives (Laurent 2023). Financial institutions are typically required to provide regular (often annual) reports on the use of proceeds from green financing instruments and on the environmental impact of the projects funded. Their reports give account of how the funds are used, the environmental performance improvements achieved, and any deviations from the original plans, thereby providing transparency. CBS requires an external review to confirm that the bond meets the criteria set out in the standard (Climate Bonds Initiative 2024).

► **Sponsors of certification and auditing systems, standard setters:**

- **Developing environmental standards and metrics:** Standard-setting organisations can establish clear and specific environmental performance metrics tailored to each supply chain. For example, in the coffee supply chain, standards might include metrics for sustainable farming practices and water usage. These standards can serve as benchmarks for pay-per-performance schemes, ensuring that all participants have a clear understanding of what constitutes improved environmental performance.
- **Facilitating certification programmes:** Certification systems provide a structured framework to verify compliance with environmental standards, establishing clear

environmental performance benchmarks that companies must meet to qualify for performance-based incentives. This ensures that pay-per-performance models align with recognised environmental criteria, promoting consistency and credibility among relevant stakeholders. Pay-per-performance schemes benefit more from process standards because they focus on achieving specific performance outcomes over time. Process standards, such as ISO 14001 (Environmental Management System), emphasise continuous improvement and the implementation of systematic procedures to enhance environmental performance. This focus on ongoing improvement and management processes makes them well-suited for pay-per-performance schemes, which reward achieving or exceeding specific environmental performance metrics.

- **Implementing robust monitoring and/or auditing systems:** Monitoring and auditing systems are essential for verifying compliance and ensuring transparency in the implementation of pay-per-performance schemes. Regular and independent audits can assess whether companies are achieving the environmental targets set out in their agreements. For example, Cascale's Higg Facility Environmental Module (Higg FEM) is used to assess the environmental performance of textile manufacturing facilities in certain areas, such as water use, chemical use, energy use, carbon emissions, and waste management. It provides a standardised approach to evaluating and reporting environmental performance, which can be accessed on an integrated online platform and used by multiple brands (Cascale 2024; Worldly 2024). In doing so, data is made available to a larger group of companies in different positions of the supply chain, which could be replicated for other supply chains.

► **Governments and international organisations:**

- **Regulatory framework and guidance:** Due diligence regulations, particularly those focused on HREDD (e.g. the European Corporate Sustainability Due Diligence Directive – CSDDD), facilitate the use of pay-per-performance schemes. These regulations create a framework that encourages companies to demand greater accountability and data transparency from themselves and their (sub-)suppliers regarding HREDD performance. This regulatory pressure in consumer markets not only drives improvements in HREDD practices but also supports the implementation of pay-per-performance schemes by aligning financial incentives with compliance and performance targets. In turn, pay-per-performance schemes can help companies meet these due diligence requirements by fostering improvements in supply chain conditions, thereby enhancing HREDD over the medium and long term (The Remedy Project and adelphi consult 2024).

- **Facilitating public-private partnership**: Public-private partnerships involve businesses (buyers, suppliers), governments and NGOs collaborating to fund large-scale sustainability projects, thereby amplifying impact and sharing financial risks. Programmes like the Deutsche Investitions- und Entwicklungsgesellschaft's develoPPP support companies that aim to operate sustainably in developing and emerging countries by piloting innovative technologies and raising supply chain standards (develoPPP 2024). These programmes could set up matching funds for private sector investments in environmental-friendly technologies and practices that are tied to specific performance metrics outlined in contracts between buyers and suppliers. Additionally, they can offer technical expertise to help companies design effective performance-based contracts with environmental criteria, including setting appropriate metrics, monitoring mechanisms, and incentive structures. Risk sharing mechanisms

provided by such programmes can provide guarantees to mitigate risks associated with new environmental practices, leading companies to set more ambitious environmental targets in their contracts.

- **Provision of guidance material:** Governments and international organisations can play a crucial role by developing comprehensive guidelines and manuals on pay-per-performance approaches. These materials could include detailed templates and toolkits that assist in establishing performance-based agreements, offering clear guidance through the contracting process. To enhance their utility, these resources can be supplemented by advisory services (e.g. help desk) that provide tailored support to individual companies or specific industries to ensure that the contracts are aligned with sector-specific challenges and opportunities. Additionally, sector-specific best practices can be compiled and shared, highlighting successful implementations and innovative solutions within different industries. This could involve organising workshops or webinars that bring together industry leaders to discuss and disseminate effective strategies, fostering learning and collaboration across sectors. With the EU tightening regulations on companies operating within the EU to address social, environmental, and ethical issues in global supply chains, GIZ collaborated with the RCP and TCLP to develop model contract clauses aimed at enhancing sustainability and responsibility in contractual agreements which can also be designed with pay-per-performance elements (Lee and Rammohan 2017; GIZ and IDH 2024; RCP 2024). TCLP provides a framework for integrating HREDD into buyer-supplier contracts, emphasising the importance of legal innovation to address climate and environmental challenges. On the basis of model contract clauses that integrate HREDD performance indicators into the contract and create incentives (e.g. price premium, early payment) for compliance with and improvement of environmental performance standards, the companies ensure that legal due diligence obligations are fulfilled (TCLP 2024). Following the HREDD approach, companies determine the consequences for suppliers failing to meet the targets and can terminate the contract as a last resort.

- **Monitoring and reporting systems:** Governments can enhance the companies' ability to track supplier compliance with environmental performance criteria by developing standardised monitoring and reporting systems. By providing or funding platforms and tools, such as those exemplified by the ForestGuard project of the "Export Initiative Environmental Protection" by the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety and Consumer Protection (BMUV), governments can facilitate efficient compliance tracking and reduce the burden on individual companies. ForestGuard aims to create a blockchain-based open-source software solution to ensure deforestation-free supply chains (Export Initiative Environmental Protection n.d.).

Pay-per-performance in the textile and fashion supply chain

The textile and fashion industry provides an example of performance-based contracts.

- H&M has implemented a Sustainable Impact Partnership Programme (SIPP), which assesses the sustainability performance of their suppliers (H&M Group 2024b). Suppliers are assessed on their compliance with sustainability standards using tools like the Higg FEM. The results of these evaluations influence the business volume that H&M allocates to each supplier, effectively linking supplier performance to sustainability criteria. Suppliers that perform well according to these criteria are rewarded with increased orders, while those that do not meet the standards may see a reduction in business.

- H&M also works closely with some of their suppliers to ensure they set and work towards carbon reduction targets. Suppliers are required to create and submit plans detailing how they will meet these targets, which are then reviewed by H&M's sustainability team (H&M Group 2024a).
- It is important to note that H&M, like many other brands and retailers, takes a risk-based approach to monitoring the sustainability performance of its suppliers. In particular, smaller factories with less than 25 employees and factories with little business that do not have the resources to bear the costs of Higg modules and verification are only required to meet the minimum requirement assessment (H&M Group 2024a; H&M Group 2024b).

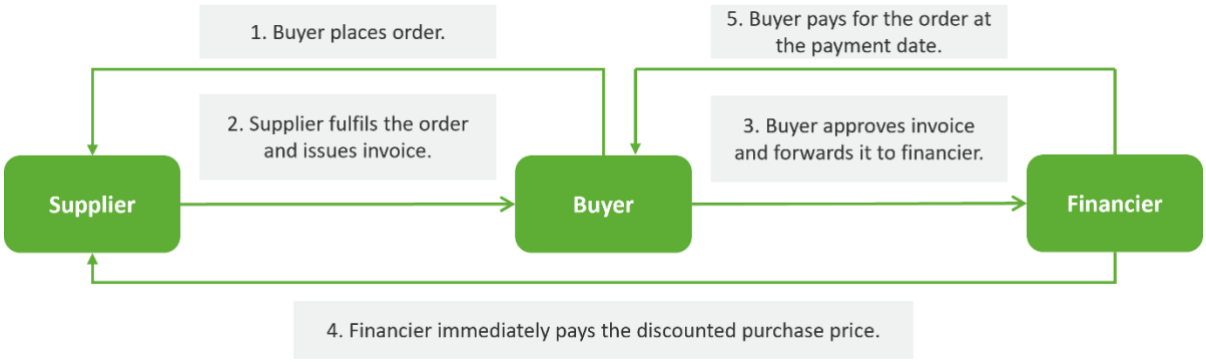
3.3 Incentive mechanism 3: Collaborative financing of supplier investments in environmental upgrades

Securing sufficient funding to implement environmental upgrades project remains a challenge, particularly for small and medium-sized (SME) suppliers. The large upfront costs and long-term nature of investments make them less attractive to traditional financial institutions (Bai et al. 2024). The issue of insufficient short-term returns on sustainability programmes can, in particular, deter SME suppliers from engaging in related practices (Jia et al. 2020). To overcome this financial bottleneck, there is a need to explore other models of financing schemes and mechanisms between supply chain actors, foster public-private partnerships, and encourage collaboration among different stakeholder groups such as governments, businesses, financial institutions, and non-profit organisations (Bai et al. 2024).

Collaborative financing refers to a broad range of financing models that pool resources from various stakeholders. Unlike traditional financing, where funds are provided by a single entity or a group of investors, collaborative financing democratises the investment process and aligns the interests of a diverse group of stakeholders. Collaborative financing can include reverse factoring programmes, cost-sharing via co-financing, joint investments, green loans, or a combination thereof. Additionally, it encompasses methods such as crowdfunding, peer-to-peer lending, and syndicate investing (FasterCapital 2024a). Collaborative financing plays a role, by involving strategic alignment of goals among various stakeholder groups, including suppliers, buyers, governments, and financial institutions, to foster systemic change. This model leverages shared capital, costs and risks to address large-scale social, economic, and environmental challenges effectively (Spicer and Robinson 2023).

Reverse factoring is a form of collaborative supply chain finance, which involves three distinct stakeholders as shown in Figure 1. Initiated by large buyers, these programmes involve financial institutions providing suppliers with early payment for accounts receivables at a financing cost based on the buyer's credit risk. This improves suppliers' working capital and reduces financing costs due to the buyer's better creditworthiness. Reverse factoring also mitigates risks associated with asymmetric information and improves supply chain efficiency (Jia et al. 2020; Moraux et al. 2023).

Figure 1: Reverse factoring programme scheme



Source: own illustration (adelphi research gGmbH) based on information from LBBW (2024)

In the case of reverse factoring for sustainable supply chain financing, suppliers are evaluated on their adherence to social and environmental standards, with customised factoring plans offered based on these evaluations. Suppliers with higher scores are rewarded with better financing terms (Zhan et al. 2018; Patel 2022). This financing mechanism is also known as green reverse factoring (arara.io 2022).

According to Zhan et al. (2018), the components and financing terms of reverse factoring programmes and mechanisms include:

- **Payment ratio** (or payment percentage): Proportion of the accounts receivable that the financier agrees to finance.
- **Payment term**: This is the timeframe within which the bank makes payments to the supplier.
- **Interest Rate**: The cost of borrowing under the reverse factoring arrangement.

How can collaborative financing through reverse factoring support improved cost benefit-sharing and efficient implementation of environmental upgrade activities along global supply chains?

Reverse factoring addresses cash-flow challenges faced by suppliers, who may struggle with accounts receivables that constrain their liquidity and, as a result, impede their ability to invest in environmental upgrades. By improving liquidity through facilitating timely payments, reverse factoring reduces financial risks of suppliers and enables them to access needed cashflow for investing in sustainable initiatives (Zhan et al. 2018). The risk is transferred to the buyer with a better credit rating, which lowers the probability of default and reduces capital return hurdles (IFC 2014). This is especially beneficial for SMEs, which frequently have limited access to working capital. Additionally, the large buyer gains from having financially healthier suppliers (WEF 2023a). By linking reverse factoring terms to environmental performance metrics, suppliers are incentivised to adopt sustainable practices, to benefit from lower interest rates or faster access to funds (Zhan et al. 2018).

One aspect of benefit-sharing in the case of reverse factoring is deferred payment, which allows buyers to delay payment for goods, alleviating the immediate financial burden. This arrangement enables buyers to order more (green) products than they could with immediate payment, spreading the financial load over time. As a result, buyers can increase order quantities, benefiting from economies of scale such as bulk purchase discounts, which in turn boosts profits. For the suppliers, larger orders facilitate more efficient production runs, reduce per-unit costs, and optimise logistics. Additionally, collaborative efforts between suppliers and buyers have been shown to increase firm valuation for both parties (Zhan et al. 2018).

While (green) reverse factoring may not directly enhance cost-sharing by itself, it can achieve this when integrated with other financial instruments and mechanisms. For instance, combining reverse factoring with such mechanisms as cost-sharing can increase its effectiveness in promoting environmental upgrades (Moraux et al. 2023). Similarly, it can be paired with financial instruments and mechanisms like price premiums (see Section 3.1) or offtake agreements (see Section 3.4) to further enhance its impact. For suppliers to actively engage and invest into environmental upgrades or improved performance, they need to see clear and immediate financial benefits; otherwise, such efforts are often viewed as an unnecessary and burdensome expense (Jia et al. 2020). Offering price premiums for sustainably produced goods or services can serve as such incentive for suppliers, helping them recover their investments. These measures address the imbalance where buyers often reap greater benefits, such as increased sales growth (Dai et al. 2021), ensuring a more equitable sharing of the financial gains across the supply chain.

Reverse factoring in and of itself is one of the most adopted and studied supply chain financing solutions (Medina et al. 2023). However, there are few studies examining the role of reverse factoring, the merits of financing solutions, or their integration with mechanisms like cost-sharing contracts to enhance suppliers' sustainability and supply chain financial performance (Moraux et al. 2023). Moreover, the field of green supply chain finance itself is still in its infancy (Deng et al. 2021). Continued research and application of these financing solutions can support advancing sustainable supply chain practices and achieving broader environmental goals.

How to design effective collaborative financing incentive mechanisms through reverse factoring for the implementation of environmental upgrades and improved cost-benefit sharing in global supply chains?

There are different ways a reverse factoring mechanism can improve supplier access to finance and support the environmental outcome:

- **Alignment of stakeholder goals**: The buyer seeks to enhance sustainability in their supply chain by aligning its initiatives with broader environmental goals. Suppliers, integral to the buyer's value chain, aim to improve their environmental performance and secure working capital through receivables anticipation, thus aligning their operational targets with the buyer's sustainability initiatives. Financiers are interested in expanding their portfolios with green assets, aligning their financial targets with sustainable investment principles (arara.io 2022).

- **Financing terms**: According to Zhan et al. (2018) mathematical models which analyse how financing terms should be structured to optimise outcomes show that a well-crafted reverse factoring contract can benefit the buyer, the supplier and the bank providing the reverse factoring financing service. A well-designed reverse factoring mechanism offers a collaborative opportunity for buyers and banks to adjust key financing terms:

  - **Payment ratio**: When the bank commits to financing a higher ratio of the accounts receivable, the financing cost for reverse financing is relatively low. This incentivises suppliers to invest more in environmental upgrades, which in turn leads to increased order quantities from retailers.
  - **Payment term**: An earlier payment term accelerates the supplier's capital turnover, motivating them to enhance sustainability efforts. Under the reverse factoring model, retailers incur no capital costs, which helps increase order quantities. If the bank pays a larger percentage of the total purchase cost or within an earlier term, both retailer and supplier profits increase, further motivating sustainability investments.

- **Evaluation of supplier's environmental performance**: The environmental performance of suppliers can be evaluated by either the buyer or the financier. This assessment often involves utilising environmental, social, and governance (ESG) ratings to gauge adherence to various sustainability metrics. Additionally, objective KPIs (e.g. carbon emission reductions and energy efficiency improvements), along with ratings or certifications, can be used to evaluate sustainability. These assessments enable financiers to offer tailored financing structures. Based on these evaluations, financiers provide individually customised factoring plans, with suppliers achieving higher scores receiving more favourable financing terms, such as lower interest rates or earlier payment options (Zhan et al. 2018; Patel 2022).
- **Invoice standardisation and approval**: Integrating invoice standardisation into the operational processes of reverse factoring ensures uniformity in data formats, facilitating smoother transactions and evaluations. Standardised invoices streamline the financing process, enhancing efficiency and accuracy in assessing receivables. Additionally, it significantly reduces operational costs for supply chain financing programmes, as all suppliers adhere to a single invoice format (IFC 2014).
- **Digital platforms**: Digital platforms simplify the financing application process and enhance accessibility for all stakeholders. These platforms connect buyers, suppliers, and financiers by allowing the upload of all relevant information, such as invoices, ensuring that necessary data is readily available to all parties involved (arara.io 2022). This centralised access reduces administrative burdens, accelerates decision-making, and enhances transparency across the supply chain. The speed of invoice approval is crucial for success, and digital platforms facilitate this process, especially when standardised invoices are used(IFC 2014). Additionally, it's important to streamline processes of relevant data collection to minimise the documentation burden on suppliers (Mascarenhas et al. 2022). For example, Nestlé's partnership with digital platform CRX Markets facilitated ESG financing for 84 suppliers, reducing their financing costs by 25-30% and highlighting the financial benefits of digital platforms (Patel 2022).
- **Legal considerations and frameworks**: Regulatory compliance, such as meeting environmental impact assessment requirements, safeguards project legitimacy while reducing risks for stakeholders. Clearly defined contracts establish the responsibilities and rights of all parties, with risk allocation mechanisms like insurance policies further enhancing project stability. Effective governance structures, including steering committees, ensure transparency and accountability, while dispute resolution frameworks help address conflicts efficiently. Additionally, conducting due diligence on partners and addressing cross-border legal issues in global supply chains are vital steps to ensure smooth collaboration (FasterCapital 2024b).

How to create supportive framework conditions that allow for the effective implementation and mainstreaming of collaborative financing through reverse factoring?

- **Sector initiatives, MSIs, business associations and chambers of commerce:** MSIs play a key role in advancing collaborative financing for environmental projects.
  - **Project identification:** By identifying large-scale environmental projects with significant potential for reducing negative or enhancing positive impacts, MSIs can develop investment concepts that engage relevant actors across the supply chain. These actors can participate in and benefit from such environmental projects.

- **Knowledge sharing and legal guidance:** MSIs also provide valuable guidance to companies in designing effective financing agreements by leveraging their expertise in sector-specific sustainability issues and standards. This ensures that collaborative financing efforts align with broader sustainability goals and regulatory requirements. By promoting cost-sharing and highlighting potential long-term cost reductions, MSIs can motivate stakeholders to invest in these environmental projects. For smaller suppliers who may lack access to pertinent information, MSIs, business associations and chambers of commerce may serve as central hubs for sharing knowledge about sustainable and green financing options. They can offer essential legal support, ensuring all suppliers have the necessary information and resources. Furthermore, they can facilitate the development of sustainability standards and frameworks (such as the "Harmonised GHG Accounting Framework" described in Grüning et al. 2025), which can be incorporated into collaborative financing agreements for monitoring purposes, tying financing to measurable environmental performance. MSIs and business associations may assist suppliers in negotiating collaborative financing agreements, helping them secure favourable terms and enhancing their participation in sustainable projects.
- **Promote green supply chain finance:** Additionally, MSIs, business associations, and chambers of commerce can promote green reverse factoring programmes by offering practical guidance that complements international standards, similar to their support for traditional factoring programmes. For instance, organisations such as the Bankers Association of Finance and Trade, the Euro Banking Association, and Factoring Chain International have developed the Standard Definitions for Supply Chain Finance as part of the Global Supply Chain Finance Forum. These definitions help establish a consistent understanding of supply chain finance (Castellano 2023). A similar approach for green collaborative supply chain finance ensures that all stakeholders have a common understanding and framework to operate within.

- **Financial institutions**: Institutions such as foundations, DFIs and MDBs can develop new and innovative green financial mechanisms (such as reverse factoring, cost-sharing contracts, price premiums and their interlinkages); these remain underexplored in the context of environmental upgrades. Drawing inspiration from frameworks that address just transitions and ESG investments, a comprehensive approach can be developed to encourage long-term investment in green assets (Beal et al. 2024), even when they initially offer lower returns. Evidence suggests that impact investors are willing to accept reduced financial returns in exchange for positive environmental and social impacts, highlighting the potential for lenders to offer favourable terms for green projects. This includes accepting longer pay-back periods and lower interest rates. Furthermore, institutional investors should prioritise transparency and standardisation in sustainability reporting, thereby enhancing trust and facilitating informed decision-making. By supporting clear reporting frameworks and researching innovative green financial instruments, stakeholders can overcome barriers to green finance adoption and accelerate the transition towards sustainable financial practices (Fu et al. 2023). Additionally, financial institutions can lead research efforts to identify sustainable finance gaps in supply chains and the necessary legal frameworks to support them, as demonstrated by the Asian Development Bank with Deep-Tier Supply Chain Finance (Mascarenhas et al. 2022).
- **Sponsors of certifications and auditing systems, standard setters:** Sponsors of certifications, auditing systems, and standard setters contribute to building trust, ensuring transparency, and providing comparative data for investors (and other stakeholders) and, as a result, reducing any data asymmetry. Examples of such standards include the Global

Reporting Initiative (GRI n.d.) or the European Sustainability Reporting Standards or the reporting standards of the International Sustainability Standards Board, which standardise ESG reporting, ensuring consistent and comparable disclosures that enhance accountability and help companies to communicate effectively with their stakeholders, align their strategies with stakeholder expectations and equip stakeholders (especially investors) with reliable data to evaluate sustainability performance and associated risks. Incorporating these standards into collaborative financing mechanisms, frameworks and digital tools ensures that stakeholders can effectively and reliably assess the environmental and social performance of companies and investment projects. Process certification systems, such as ISO 14001 (environmental management) and ISO 50001 (energy management), establish universally recognised benchmarks and methodologies to support environmental performance. These certifications reduce risks for investors by ensuring regulatory compliance, promoting resource efficiency, and enhancing transparency, all while boosting credibility of organisations seeking financing. Such certification systems provide a structured approach to measuring environmental performance, which can be used in green reverse factoring programmes or other green financing models. In such programmes, improved environmental performance, as supported by these certifications, can lead to more favourable payment terms. Third-party assessments based on these standards ensure that organisations are making genuine progress in their sustainability efforts, thereby enhancing their credibility and attractiveness to investors.

- **Governments and international organisations**: Governments and regulatory bodies can attract investments into environmental upgrades projects by fostering a political and business culture that is characterised by transparency, accountability, and sustainability. By establishing clear policies, regulatory frameworks which support green investments, and incentives, governments can create trust among stakeholders participating in green financing. Public-private partnerships, a key feature of collaborative governance, facilitate shared responsibilities and risks, thereby encouraging private-sector participation in sustainability initiatives (Bai et al. 2024). The following strategic measures can enhance green financing and promote the adoption of collaborative financing mechanisms through reverse factoring:

  - **Digital platforms**: As previously mentioned, digital platforms are essential for simplifying access to green finance for all stakeholders. Governments play a crucial role in creating an enabling framework for the development and adoption of these platforms. By learning from efforts to establish supportive environments for digital solutions in receivable finance, governments can similarly bolster the digital landscape for reverse factoring. This involves conducting thorough assessments of regulatory environments to identify specific needs and gaps, encouraging the use of regulatory technology and supervisory technology to enhance compliance and monitoring, and promoting the integration of digital reporting systems and data analytics to boost transparency and efficiency. Additionally, developing frameworks that balance data protection with information sharing is vital for effective data flow management and the digitalisation of financial operations (Castellano 2023).

  - **E-invoicing laws:** According to Zhan et al. (2018) when suppliers receive payments more quickly, they are more likely to invest in sustainability initiatives. Supportive laws for e-invoicing can facilitate this by standardising invoices, which accelerates the processing of transactions (IFC 2014). For example, in Chile, the mandatory use of e-invoicing has enhanced the development of factoring by providing greater security and speed compared to traditional paper invoicing (Castellano 2023).

- **Supporting research activities:** As previously noted, further research is essential to assess how green supply chain finance addresses environmental protection topics. Governments can support these efforts by providing research grants aimed at developing and evaluating strategies. These efforts could be aligned with the research activities performed by other stakeholder groups such as MSIs, business associations, chambers of commerce, and financial institutions. These research efforts could include comparative analyses of global green finance initiatives, as these can provide valuable insights into best practices and innovative approaches. By understanding these dynamics, stakeholders can better implement and support green finance solutions.

Collaborative financing in the textile and fashion supply chain

Apparel and footwear brand PUMA aims to reduce Scope 3 GHG emissions by 33% by 2030 (compared to 2017). To achieve this, PUMA leverages sustainable supply chain finance to help suppliers manage cash flow and incentivise sustainability improvements. The IFC, a World Bank subsidiary, helped reinterpret banking rules to support sustainability loans (Forbes 2024).

In cooperation with the IFC, PUMA launched a reverse factoring programme specifically aimed at promoting sustainability efforts among suppliers in emerging markets. PUMA evaluates supplier adherence to social and environmental standards, and the IFC offers individually customised factoring plans based on these evaluation scores. Higher scores lead to lower financing interest rates or earlier payments from the IFC (Zhan et al. 2018). This ESG-linked programme offers better financing terms to suppliers with higher sustainability ratings. Participation is voluntary, and suppliers are grouped into tiers based on performance (Forbes 2024).

Suppliers receive early payments for invoices with interests based on PUMA's credit. The use of the Infor NEXUS digital platform streamlines the process; this helps to reduce manual work when applying for loans by connecting all relevant actors such as buyers, suppliers, contract manufacturers, carriers, and banks. The platform provides an electronic record of supply chain activity, ensuring all parties to a transaction work from a single version of the truth, thereby reducing information asymmetry. Adoption of this programme surged during COVID-19, tripling supplier participation. By 2022, 30% of sourced products were financed through the program. (Forbes 2024).

3.4 Incentive mechanism 4: Offtake agreements

An offtake agreement is a legally binding agreement (e.g. a contract) between a supplier and a buyer to sell and purchase specific portions of the supplier's future production (Kumar 2022; Segal 2024; Senken 2024). Offtake agreements are typically signed before production begins, a new site is built, or a major investment is made, fixing terms and price of the transaction early on (Senken 2024).

Offtake agreements are common in project financing, especially in volatile markets like energy, mining, oil, natural resource and infrastructure development (cf. for example Gurch 2017; Hundt et al. 2021; Kumar 2022; Segal 2024), and are now also being explored as a tool in voluntary carbon markets. Here, buyers commit to purchasing carbon credits from a project once verified through "carbon offtake agreements" (Senken 2024; Carbon Market Institute 2024).

How can offtake agreements support improved cost benefit sharing and efficient implementation of environmental upgrade activities along global supply chains?

Offtake agreements can help distribute the costs of implementing environmental upgrade activities more equitably between buyers and suppliers in global supply chains. They can

incentivise businesses to invest in necessary improvements and help to secure additional funding from third parties like financial institutions and investors. Many environmental upgrades require significant initial investments, such as acquiring efficient technologies, purchasing responsibly produced raw materials, or altering production processes to reduce environmental impact. Research implemented within this project, involving various interviews with companies and industry experts from different supply chains reveals that suppliers often hesitate or are unable to make these investments due to uncertainties about product demand and pricing (cf. Chapter 2). Offtake agreements reduce these market risks, thereby stabilising supplier cash flow. Offtake agreements can enhance a project's or supplier's credit rating, addressing the challenge suppliers face in securing early-stage financing due to insufficient cash flow before production begins (Bonetti et al. 2010; Kumar 2022). According to the World Economic Forum, early-stage investment decisions depend heavily on demand (WEF 2024). Offtake agreements demonstrate customer interest in a project, product, or service, improving the likelihood of securing loans or credit early on (Segal 2024; Senken 2024; Tech for Net Zero 2024). They also benefit buyers by allowing them to secure goods or services at predetermined prices, providing protection against price fluctuations. This can be particularly beneficial if a certain product or service becomes popular in the future or a certain resource becomes scarce, causing demand to exceed supply (Segal 2024). The next section discusses how to design offtake agreements to support environmental upgrades in global supply chains and how different stakeholders can aid in their effective implementation.

How to design effective offtake agreements for the implementation of environmental upgrades and improved cost-benefit sharing in global supply chain?

Offtake agreements can be tailored to ensure the delivery of desired products or services while distributing risks more equitably between supplier and buyer. The exact structure of an offtake agreement depends on the specific application, business needs, and project details. Nevertheless, the most important factors and options that should be considered when designing and concluding an offtake agreement aimed at implementing certain environmental upgrade activities are briefly outlined here:

- **Price/pricing models**: Offtake agreements typically outline how prices for future products or services are calculated. Options include fixed prices, minimum prices with upward adjustments to a predetermined market price, inflation indexation (Tech for Net Zero 2024), or linking prices to a market index (if available for the specific product/service) with an environmental premium (cf. section 3.1). Offtake agreements may also specify quantities purchased at input costs plus a predetermined margin, potentially including price caps to protect buyers (WEF 2024). Price review mechanisms can be set at regular intervals or linked to predefined trigger events such as the establishment of a new widely accepted market price or index for a specific product or service (Green Hydrogen Organisation 2024). Less flexible/fixed pricing models pose higher risks for buyers but can be advantageous if demand for sustainably produced products (e.g. green hydrogen) increases or if the supplier gains new customers due to improved environmental performance, allowing buyers to secure products below new market prices.
- **Quantity/volume**: Offtake agreements can specify fixed quantities or a range of goods/services to be delivered or purchased. Another model that also affects the price structure of a purchase agreement is the take-or-pay approach, which frees buyers from the obligation to actually purchase a good/service in the future, but obliges them to compensate suppliers for any financial losses that may incur if goods/services are not purchased, such as paying a pre-agreed price or covering storage costs (Green Hydrogen Organisation 2024;

Tech for Net Zero 2024). This model provides suppliers with financial security, aiding in external debt financing, while buyers favour flexibility to adjust their purchasing behaviour to actual demand. Intermediate solutions like flexible take-or-pay or production thresholds can balance the interests of both parties (Green Hydrogen Organisation 2024; Tech for Net Zero 2024; WEF 2024).

- **Duration:** Offtake agreements include binding terms for contract duration. Although this is highly dependent on the specific project, product or service, various sources indicate that a minimum term of 10 years should be agreed to ensure long-term stability and return on investment (Tech for Net Zero 2024; WEF 2024). While short-term agreements can include extension options, they are less effective in demonstrating a supplier's creditworthiness (Tech for Net Zero 2024; WEF 2024).

- **Warranty/performance obligations and control mechanisms**: Offtake agreements should aim to enhance a supplier's environmental performance and include clear specifications and control mechanisms to ensure funds are used for environmental upgrade activities. While the specifics depend on the product or project involved, performance indicators might require suppliers to prove the use of certified sustainable raw materials or achieve process certifications like ISO14001 for efficiency improvements. Individual metrics can also be set for specific environmental goals, such as reducing water pollutants. Referencing internationally recognised standards or relevant national laws and regulations is advisable for consistency and recognition by other buyers (Green Hydrogen Organisation 2024; Tech for Net Zero 2024). To monitor progress over long terms, such as 10+ years, agreements should include information and communication obligations, like periodic reviews and audits by buyers or third parties. Established environmental platforms should be used for communication where possible. Agreements should also outline consequences for non-compliance, including potential early termination and associated fees (Segal 2024). A continuous improvement approach is preferred, encouraging parties to find solutions to meet environmental goals before dissolving the agreement.

- **Other possible conditions/elements**: Offtake agreements may include additional provisions such as technical specifications unrelated to sustainability, mandatory provision of additional evidence of creditworthiness by (one of) the parties (Green Hydrogen Organisation 2024), fixed delivery dates with buyer remedies, force majeure clauses, preferred dispute regimes, and other risk management rules (Tech for Net Zero 2024). Advanced models, like the tolling approach, involve the buyer supplying raw materials to the supplier in exchange for the final product, integrating supply chains more closely (Tech for Net Zero 2024). Parties might also form strategic partnerships or joint ventures to enhance risk sharing (WEF 2024).

How to create supportive framework conditions that allow for the effective implementation and mainstreaming of offtake agreements?

As described at the beginning of the chapter, offtake agreements have long been used in project financing but are not yet common as incentives for sustainability in supply chains.[3] To mainstream their use for environmental upgrades, various stakeholders need to take action, beyond individual buyers and suppliers:

- **Sector initiatives, MSIs, business associations and chambers of commerce**: Progressive and financially strong companies can join forces through sector initiatives to promote

[3] Cf. for example WEF (2024) for information regarding the scope of offtake agreements for green hydrogen.

sustainable products or technologies by collectively announcing offtake agreements. The World Economic Forum's "First Movers Coalition," with over 100 multinational corporations, exemplifies this by supporting emerging climate technologies like green hydrogen (WEF 2024). Such collaborations signal growing demand for eco-friendly products, encouraging other (less progressive) companies and financiers to invest. Sector initiatives and MSIs should encourage members to set clearly specified and verifiable sustainability targets for their supply chains. Companies with defined goals and mechanisms, like e.g. internal carbon pricing, are more likely to engage in offtake agreements, which can be counted as a measurable step on the way to achieving the environmental target (WEF 2024). Overall, MSIs or business associations should encourage their members to integrate sustainability considerations into operational decision-making and corporate strategic assessments (e.g. through the development of an internal carbon tax and climate scenario planning) (WEF 2024) – because the risks and benefits of an offtake agreement can only be properly weighed and future investments incentivised only if environmental issues play a role in a company's planning. Business associations and initiatives should also guide member companies on designing effective offtake agreements by leveraging their knowledge of sector-specific sustainability issues, emerging solutions, and relevant standards, laws and regulations. They can provide ongoing guidance on sustainability trends and supplier developments to help companies select suitable suppliers or projects to meet the company's sustainability target(s) for their supply chain. Within some MSIs, companies can also actively engage in the development of sector-, supply chain-, process or product-specific sustainability standards, which can then be incorporated into offtake agreements to monitor supplier performance. Associations and trade chambers should also assist suppliers in negotiating fair offtake agreements, enabling them to effectively use these contracts as security for loans and credits provided by third parties.

- **Financial institutions:** Offtake agreements enhance supplier creditworthiness, aiming to simplify access to early credit for environmental upgrade activities by appealing to financiers like banks and investors. For this to be effective, financial institutions must recognise offtake agreements as a reliable proof of market demand and adapt lending criteria accordingly. According to the World Economic Forum, financiers prioritise projects with a robust business case, characterised by a balanced distribution of risks. This concept, referred to as "bankability", involves sharing risks among suppliers, sponsors, buyers ("offtakers") and the government, supported by mechanisms such as credit guarantees and policy incentives" (WEF 2024). In order for buyers and suppliers to be able to meet the corresponding requirements, financiers should clearly communicate their requirements for "robust" offtake agreements, which can significantly improve the bankability of a project (e.g. in the form of guidelines) and align them with the realities of specific sectors and markets. To ensure that credits or loans based on offtake agreements really fund environmental upgrade activities, financiers should check that the sustainability metrics and monitoring systems concluded in these agreements are robust. Developing an overarching standard may be necessary for consistency. Determining the right pricing mechanism in an offtake agreement is crucial to a more equitable distribution of the risks, costs and benefits of an environmental upgrade project. To ensure that both negotiating parties have access to reference values when agreeing on an offtake agreement, freely accessible price indices from stock exchanges, independent price information or benchmarking services are needed for reference. For innovative green projects, products or services for which no such benchmarks are (yet) available, research by civil society organisations and academic institutes is needed to define appropriate environmental premiums in the agreements.

- **Sponsors of certification and auditing systems, standard setters**: Sponsors of certification systems and standard setters are crucial for implementing and mainstreaming offtake agreements. These agreements should include strict sustainability and control mechanisms to ensure investments are directed towards environmental upgrade activities. Referencing existing, third-party verified standards simplifies implementation and makes offtake agreements more accessible/transparent to other business actors, especially if the referenced certification is independent and credible (Green Hydrogen Organisation 2024). Uniform standards for sustainable products (for example a standard for "green steel") can also help companies in choosing suitable suppliers or projects for an offtake agreement that will fit their individual sustainability strategy/targets. Suppliers meeting recognised product or process standards offer a more attractive option than vague sustainability promises (Feldmann and Kennedy 2021). In addition, sponsors of certification systems can incentivise the implementation of offtake agreements in supply chains by introducing "sustainable purchasing/sourcing practices" criteria, which oblige companies that wish to be certified to support their suppliers in implementing sustainability activities.[4] This support could be evidenced by an offtake agreement for a supplier's environmental upgrade project.
- **Governments and international organisations**: When assessing a project's "bankability," financiers usually also look for government support in the form of credit guarantees or policy incentives, which further distribute the risks of a future investment between different actors (WEF 2024). Governments in buyer countries can promote offtake agreements for environmental upgrade activities by implementing policies such as green public procurement, carbon taxes, cap-and-trade programmes, strict environmental standards for certain production processes, services or products, funding for research and development programmes, tax breaks or subsidies for environmental upgrade activities. These measures can make eco-friendly products and processes more attractive to companies, thus also improving the attractiveness of early on offtake agreements (Feldmann and Kennedy 2021; WEF 2024). The formulation of clear environmental political targets for the future, such as the targets for the decarbonisation of the European industry as set out in the European Green Deal, can also incentivise companies to invest in sustainable projects and to secure access to sustainable products through offtake agreements (WEF 2024).

Offtake agreements in the iron ore-steel supply chain

One successful example of the use of offtake agreements to finance an environmental upgrades project is the financing of the construction of a large "green" iron and steel production plant by the Swedish start-up company Stegra (formerly: H2 Green Steel). Founded in 2020, Stegra plans to produce large amounts of "green" iron and steel via direct reduction and electric steelmaking (DR-EAF production route), for which it will also produce large amounts of renewable hydrogen (Stegra n.d.). Already in May 2022, Stegra announced that they had pre-sold over 1.5 million tonnes of their low-carbon "green" steel to customers in various industries (including steel service centres, producers of pipes and tubes, passenger vehicles and heavy commercial vehicles, whitegoods and construction products) via 5-to-7-year offtake agreements (Bhat and Salazar 2023; Keating 2024). According to the start-up, offtake agreements were mostly signed with ambitious customers who have "signed up for Science Based Targets covering not only scope 1 and 2 but also scope 3 emissions" and are willing to pay a premium for "green steel" (Stegra 2022). Reportedly, Stegra is selling its future "green" steel production via these offtake agreements at a premium of at least 20 % compared to traditional steel (Keating 2024). In January 2024, Stegra additionally announced

[4] See for example the responsible sourcing requirements included in the ResponsibleSteel standard, aimed to "help drive momentum for the creation of responsible supply chains" (ResponsibleSteel 2024).

that they were able to sign debt financing agreements for EUR 4.2 billion in project financing for the construction of their large scale steel and iron production site with various international banks (Stegra 2024), potentially indicating that the numerous offtake agreements have had a positive effect on the willingness of financial service providers to provide credit.

Stegra receives significant state aid for the construction of their plant: the company was awarded a EUR 250 million grant from the EU Innovation Fund (Stegra 2024). In addition, in June 2024, the European Commission approved support from the Swedish government for Stegra totalling EUR 265 million (EC 2024). One of the reasons given by the Commission for its decision was that the project could make a significant contribution to the decarbonisation of the steel industry and thus also support the achievement of various environmental policy goals set out in the EU Hydrogen Strategy, the European Green Deal and the Green Deal Industrial Plan (EC 2024).

The example of Stegra offers some lessons regarding factors that (can) support the mainstreaming of offtake agreements:

- Clear political regulations as a push factor: (European) steel manufacturers and their suppliers are forced by various regulations (including the EU Emissions Trading System (ETS) and Carbon Border Adjustment Mechanism (CBAM), cf. Grüning et al. 2025) to find solutions to significantly reduce carbon dioxide emissions in their supply chains – the future purchase of steel produced with green hydrogen seems to be a favourable and therefore attractive solution, also because traditional steel production might become increasingly expensive in the future.
- State aid as a pull factor: Projects that receive government support are particularly attractive for private investors, as this spreads some of the costs and risks across several shoulders and increases their credibility.

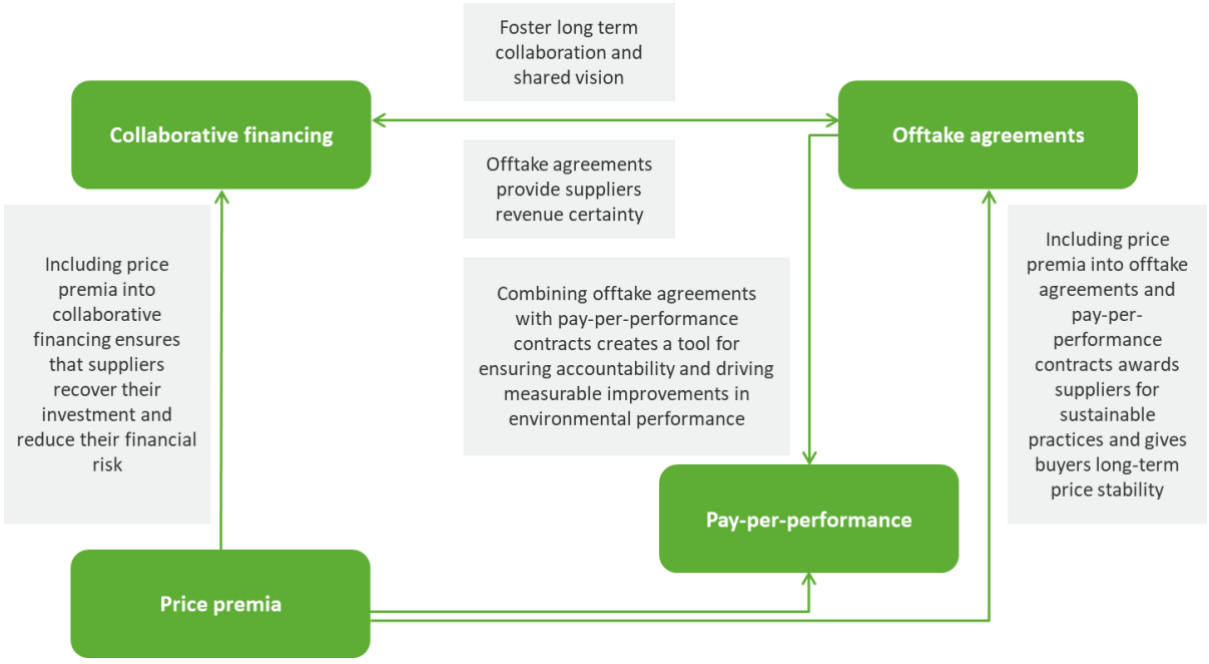
However, it should be emphasised that Stegra is one of the very first companies venturing into the production of renewable-hydrogen-based steelmaking as a potential breakthrough clean technology and is therefore attracting above-average attention (Chan and Vargas 2024). The “marketing advantage” (Keating 2024) that companies gain from such an offtake agreement should also not be underestimated, especially as the production at the Stegra plant and actual purchase of the “green” steel has not yet started. It can therefore not be assumed that offtake agreements will be similarly well received for green upgrading projects that are not focussed on financing future technologies but, for example, the reorganisation of existing processes for less visible/ad hoc efficiency improvements.

4 Synthesis and concluding remarks

This report briefly summarises the most important results of the research conducted as part of the project "Cost allocation and incentive mechanisms for environmental and climate protection and resource conservation along global supply chains" and provides recommendations for key stakeholders on selected incentive mechanisms that could contribute to driving environmental performance in the four supply chains coffee, cotton-garment, iron ore-steel, and tin:

- **Price premiums**: Financial incentives rewarding suppliers for environmentally friendly practices by paying above-market rates for environmentally improved products.
- **Pay-per-performance contracts**: Agreements tying compensation to measurable environmental outcomes, incentivising suppliers to meet defined environmental performance goals.
- **Collaborative financing through reverse factoring**: Financial incentives in which suppliers receive early payments based on their environmental performance, leveraging the buyer's creditworthiness.
- **Offtake agreements**: Long-term contracts that guarantee demand for products, often with pricing mechanisms tied to improved environmental performance.

Figure 2: Interconnectedness of incentive mechanisms



Source: own illustration (adelphi research gGmbH)

Figure 2 shows that the analysed incentive mechanisms price premiums, pay-per-performance, collaborative financing, and offtake agreements are interconnected – combining them can increase the effectiveness of the others. Offtake agreements typically establish how prices for future products or services are calculated, with options ranging from fixed prices to dynamic mechanisms like inflation indexation or linking prices to a market index with an environmental premium. **Integrating price premiums into offtake agreements or performance-based contracts** ensures suppliers are rewarded for sustainable practices while providing buyers with long-term price stability. Designing appropriate price mechanisms requires careful

consideration. While price indices or benchmarking services can guide negotiations, innovative products like "green hydrogen" or "green steel" may lack such references. Collaboration with research institutions or civil society, for example, is crucial to defining and justifying environmental premiums in these cases.

From a buyer's perspective, agreeing to pay a premium under an offtake agreement may initially seem costly, but offers strategic advantages. Securing long-term access to sustainable products, especially those likely to gain popularity and value over time, mitigates future price volatility. For example, investing in an offtake agreement for green steel now could provide a competitive edge as demand for sustainable materials rises and market prices climb. Thus, price premiums embedded within offtake agreements may balance short-term costs with long-term benefits, creating a win-win scenario for both buyers and suppliers.

Price premiums can play a crucial role in making collaborative financing viable by ensuring suppliers can recover their sustainability investments. Offering price premiums for sustainably produced goods or services incentivises suppliers to adopt green technologies while addressing imbalances in benefit-sharing across the supply chain. Buyers often reap greater financial rewards, such as enhanced sales growth and improved brand reputation, but price premiums help ensure that these gains are more equitably distributed and reach upstream actors. When thoughtfully implemented with a long-term perspective, price premiums can be a powerful tool for mainstreaming sustainable practices across global supply chains.

When combined with collaborative financing, price premiums further reduce financial risks for suppliers. This dual mechanism supports both the financing of sustainability measures and the long-term profitability of sustainable practices, creating a feedback loop that incentivises suppliers to maintain high environmental standards while ensuring buyers have access to sustainable products. However, one significant limitation is the potential for uneven distribution of benefits along the supply chain, particularly in ensuring that premiums reach the actors directly responsible for implementing sustainable practices. Additionally, the long-term economic viability of price premiums in various market conditions remains uncertain, highlighting the need for tailored approaches that consider the complexities of different supply chains and market dynamics.

Offtake agreements can complement collaborative financing by providing suppliers with long-term revenue certainty. These agreements guarantee demand for sustainably produced goods over a fixed period, offering suppliers the assurance that their investments in environmental upgrades will yield predictable returns. This certainty makes suppliers also more attractive to financial institutions, who consider offtake agreements as collateral for lending. Both collaborative financing and offtake agreements foster long-term collaboration and shared environmental goals between buyers and suppliers. Collaborative financing models encourage (co-)investment in sustainability projects (especially when combining with different collaborative finance mechanisms such as reverse factoring and cost-sharing), aligning diverse actors around a common vision. Similarly, offtake agreements reinforce these relationships by securing demand for sustainable products, ensuring that buyers and suppliers remain committed to shared goals over extended periods.

The integration of **offtake agreements with pay-per-performance contracts** creates a tool for ensuring accountability and driving measurable improvements in environmental performance. Offtake agreements often include performance obligations and control mechanisms to ensure that financial resources contribute directly to environmental upgrades. By combining these agreements with pay-per-performance contracts, suppliers can be incentivised to achieve specific environmental performance metrics as a precondition for contract activation. For

instance, an offtake agreement could require suppliers to meet certifications such as ISO14001 or demonstrate reductions in water pollutants to ensure the buyer's funds are used effectively. Regular reviews, audits, and communication obligations can further ensure transparency and accountability over the long term.

Pay-per-performance contracts are increasingly recognised for their potential to drive environmental upgrades by directly tying financial rewards to measurable environmental performance outcomes. These contracts are particularly prevalent in sectors where performance metrics are well-defined, such as automotive and aerospace. The success of these contracts hinges on several enabling factors. Certification systems and standard-setting organisations play an important role by providing benchmarks and frameworks that enhance transparency and accountability. Governments and international organisations can further support their adoption through clear environmental standards, financial incentives, and streamlined regulatory processes. Financial institutions also have a part to play, offering SLL and bonds with favourable terms for meeting environmental criteria, thereby encouraging suppliers to adopt greener practices. However, implementing pay-per-performance contracts in practice often requires a hybrid approach. While the traditional components of fixed pricing and payment terms ensure basic contractual stability, adding performance-based sections allows for financial incentives and penalties tied to environmental metrics. This approach necessitates a lengthy trust-building process between companies and contractors, as clear objectives, robust measurement systems, and supportive regulatory environments are essential for success. For example, H&M's Sustainable Impact Partnership Programme assesses supplier sustainability and links business volumes to performance. This initiative showcases how performance-based contracts can be leveraged to encourage suppliers to meet sustainability goals. Additionally, consumer willingness to pay more for eco-friendly products creates opportunities to design contracts that motivate suppliers to address less prominent issues, such as chemical management and wastewater treatment in the fashion industry.

While promising, the mechanisms described above remain underutilised on a large scale currently. Adoption has been slow due to various reasons, including market fragmentation, a lack of willingness to pay for products with better environmental performance and varying stakeholder priorities. Additionally, to mainstream these mechanisms different stakeholder groups such as buyers, suppliers, financial institutions, governments, and standard-setting organisations need to align on long-term goals and work collectively to overcome systemic barriers. Moreover, every supply chain is unique, requiring tailored approaches to design and implement these mechanisms in ways that fit specific conditions and meet the distinct needs of stakeholders.

To address these challenges and enhance the adoption of incentive mechanisms, further research is needed in several areas:

- Future research could explore how these incentive mechanisms can be tailored to the distinct conditions of various industries, geographies and market conditions. Case studies focusing on specific sectors, such as textiles, coffee, tin and iron ore-steel, are still rare, but would provide actionable insights into how to design context-specific solutions.
- While price premiums and collaborative financing offer potential benefits, their long-term economic viability under different market conditions remains uncertain. Research is needed to quantify the impacts of these mechanisms over time and identify strategies to ensure their financial sustainability. Additionally, green and sustainable supply chain finance appears to be an under-researched area overall but holds significant potential for driving

environmental upgrades. Exploring innovative financial models and their integration into sustainable supply chains could unlock new pathways for scaling these mechanisms.

- Integration with policy and regulatory frameworks: Understanding how policy support can facilitate the scaling of these mechanisms is crucial. Research should examine the role of government incentives, standardisation of environmental performance metrics, and international trade policies in creating enabling environments for these mechanisms.

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A Appendix

A.1 Participation of the Expert Advisory Board

As part of the project, an Expert Advisory Board consisting of different stakeholder groups was set up to accompany the project in a supportive capacity. The Expert Advisory Board was involved at key points of the project to provide general feedback and input on project implementation and interim results. It consisted of five representatives from companies (one practical expert for each of the commodity-specific supply chains analysed in this project), two representatives from a civil society organisation with a focus on environmental protection in supply chains, one representative from academia and one representative from an international organisation. One introductory and three subsequent meetings were held during the course of the project. The following table provides an overview of the months in which the meetings took place.

Meeting	Date
Introductory Meeting	May 2023
Meeting 1	June 2023
Meeting 2	November 2023
Meeting 3	April 2024

A.2 List of interviews and workshops conducted for the project

Supply chain	Stakeholder group	Type and date of contact	Contacted more than once[5]
Cotton	Company (trader)	Interview: April 2023	
Cotton	Civil society organisation	Interview: June 2023	x
Cotton	Industry insider (civil society organisation with connection to regional suppliers)	Interview: June 2023	
Cotton	Company (supplier)	Interview: April 2023	x
Cotton	Company (retailer)	Expert workshop 1: May 2024; expert workshop 2: July 2024; focal company	x
Cotton	Company (online retailer)	Interview: April 2023	

[5] With some of the interview partners listed, the project team had multiple exchanges: either in the form of several interviews, the participation of the person in interviews and expert workshops or roadmap consultations or also through written exchanges in combination with interviews, workshops and/or roadmap consultation exchanges. Written exchanges do not appear in the 'Type and date of contact' column but are also mentioned here.

Supply chain	Stakeholder group	Type and date of contact	Contacted more than once[5]
Cotton	Civil society organisation	Interview: April 2024; expert workshop 1: May 2024	x
Cotton	Company (buyer)	Interview: November 2023	
Cotton	Company (supplier)	Interview: November 2023; expert workshop 1: May 2023	x
Cotton	Development cooperation	Interview: July 2024	
Cotton	Company (brand)	Interview: February 2024	
Cotton	Intermediary (finance)	Expert workshop 1: May 2024; expert workshop 2: July 2024	x
Cotton	Company (retailer)	Expert workshop 1: May 2024	
Cotton	Intermediary	Expert workshop 1: May 2024; expert workshop 2: July 2024	x
Cotton	Multi-stakeholder initiative	Expert workshop 1: May 2024; expert workshop 2: July 2024	x
Cotton	Company (brand)	Expert workshop 1: May 2024	
Cotton	Company (certifying body)	Expert workshop 1: May 2024; expert workshop 2: July 2024	x
Cotton	Civil society organisation	Expert workshop 2: July 2024	
Cotton	Company (brand)	Expert workshop 2: July 2024	
Cotton	Industry association	Expert workshop 2: July 2024	
Cotton	Multi-stakeholder initiative	Expert workshop 2: July 2024	
Cotton	Consultancy	Expert workshop 2: July 2024	
Cotton	Industry association	Expert workshop 2: July 2024	

Supply chain	Stakeholder group	Type and date of contact	Contacted more than once[5]
Cotton	Civil society organisation	Expert workshop 2: July 2024	x
Cotton	Intermediary (service provider)	Expert workshop 2: July 2024	
Cotton	Company (brand)	Interview: May 2023	
Coffee	Company (brand)	Interview: May 2023	x
Coffee	Company (cultivation and processing)	Interview: May 2023	x
Coffee	Trading Group	Expert workshop 1: May 2024	
Coffee	Multi-stakeholder initiative	Expert workshop 1: May 2024	
Coffee	Civil society organisation	Expert workshop 1: May 2024	
Coffee	Civil society organisation	Expert workshop 1: May 2024	
Coffee	Multi-stakeholder initiative	Expert workshop 1: May 2024	
Coffee	Research Institution	Expert workshop 1: May 2024; roadmap consultation: September 2024	x
Coffee	Company (brand)	Expert workshop 1: May 2024; Expert workshop 2: June 2024; roadmap consultation: October 2024	x
Coffee	Company (brand)	Expert workshop 2: June 2024	x
Coffee	Civil society organisation	Expert workshop 2: June 2024	
Coffee	Company (brand)	Expert workshop 2: June 2024	
Coffee	Company (brand)	Expert workshop 2: June 2024	
Coffee	Company (brand)	Expert workshop 2: June 2024	x

Supply chain	Stakeholder group	Type and date of contact	Contacted more than once[5]
Coffee	Company (brand)	Expert workshop 2: June 2024; roadmap consultation: September 2024	x
Coffee	Company (brand)	Expert workshop 2: June 2024	x
Coffee	Civil society organisation	Roadmap consultation: September 2024	
Coffee	Company (brand)	Roadmap consultation: October 2024	x
Coffee	Company (brand)	Roadmap consultation: October 2024	x
Natural rubber	company (automotive producer)	Interview: June 2023	
Natural rubber	Multi-stakeholder organisation	Interview: May 2023	
Natural rubber	company (tyre producer)	Interview: June 2023	
Natural rubber	civil society organisation	Interview: June 2023	
Natural rubber	civil society organisation	Interview: June 2023	
Natural rubber	Provider of business sustainability ratings	Interview: March 2024	
Natural rubber	Multi-stakeholder initiative	Interview: November 2023	
Natural rubber	Multi-stakeholder initiative	Interview: November 2023	
Natural rubber	Civil society organisation	Interview: November 2023	
Tin	business insider (national authority)	Interview 1: June 2023; interview 2: December 2023	x
Tin	company (electronics producer)	Interview: July 2023	
Tin	Company (stock exchange)	Interview: June 2023	

Supply chain	Stakeholder group	Type and date of contact	Contacted more than once[5]
Tin	Association	Interview 1: November 2023; interview 2: June 2024; expert workshop 2: June 2024; roadmap review	x
Tin	Association	Interview 1: August 2024; interview 2: November 2024; roadmap review	x
Tin	Business insider (worked previously at industry association)	Interview: February 2024	
Tin	Company (smelter)	Interview: March 2024	
Tin	Business insider	Interview: January 2024	
Tin	Civil society organisation	Interview: February 2024	
Tin	Civil society organisation	Expert workshop 1: May 2024	
Tin	Company (solder producer)	Expert workshop 1: May 2024	
Tin	Company (steel and mining company)	Expert workshop 1: May 2024	
Tin	Association	Expert workshop 2: June 2024	
Tin	Company (tin recycler)	Expert workshop 2: June 2024	
Tin	Multi-stakeholder initiative	Expert workshop 2: June 2024	
Tin	Company (integrated mining - solder production)	Interview: September 2024	
Tin	Company (solder producer)	Interview 1: July 2023; interview 2: August 2024	x
Tin & iron ore/steel	Civil society organisation	Interview: July 2023	
Iron ore/steel	Sponsor of a sustainability assurance/certification system	Expert workshop 1: May 2024; expert workshop 2: June 2024	x

Supply chain	Stakeholder group	Type and date of contact	Contacted more than once[5]
Iron ore/steel	Company (steel producer)	Interview: July 2023	
Iron ore/steel	Civil society organisation	Interview: July 2023	
Iron ore/steel	Civil society organisation	Interview: June 2023	
Iron ore/steel	Company (miner)	Interview 1: July 2023; interview 2: November 2023; expert workshop 1: May 2024; expert workshop 2: June 2024; roadmap consultation workshop: September 2024	x
Iron ore/steel	Company (automotive producer)	Interview: July 2023	
Iron ore/steel	Business insider	Interview: July 2023; expert workshop 1: May 2024	x
Iron ore/steel	company (steel producer)	Interview: April 2024	
Iron ore/steel	Industry association	Interview: March 2024	
Iron ore/steel	Multi-stakeholder initiative	Expert workshop 1: May 2024; expert workshop 2: June 2024	x
Iron ore/steel	National authority	Expert workshop 1: May 2024	
Iron ore/steel	Company (electronics producer)	Expert workshop 1: May 2024	
Iron ore/steel	Company (rating company)	Expert workshop 1: May 2024	
Iron ore/steel	National authority	Expert workshop 1: May 2024	
Iron ore/steel	Industry association	Expert workshop 1: May 2024	
Iron ore/steel	Civil society organisation	Expert workshop 1: May 2024	
Iron ore/steel	International organisation	Expert workshop 2: June 2024	