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Regulatory Compliance in a Circular Economy: Analysing the 30-30-30 Strategy in the European Built Environment

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ABSTRACT

This study examines how upcoming European Union sustainability and bio-based material regulations affect non-EU exporting sectors, and how these sectors can adapt to remain competitive in the European market. Using a qualitative research design based on document analysis and comparative sector analysis, the study reviews European Union policy documents, academic literature, and institutional reports related to sustainability regulation, bio-based materials, circular economy, and international trade. Four export-oriented sectors are analyzed: construction materials, packaging, furniture, and textiles. The findings show that the effects of European sustainability regulation are uneven across sectors. Construction materials face the strongest regulatory pressure because they combine strict technical, safety, and durability requirements with growing sustainability expectations, while packaging faces strong pressure mainly through circular economy and material efficiency requirements. Furniture and textiles experience moderate to high pressure, primarily through traceability, responsible sourcing, and reporting obligations. The study identifies three categories of adaptation strategy available to non-EU exporters: technical adaptation (product testing, life cycle assessment, environmental product declarations, and digital product data), organizational adaptation (compliance systems, traceability, supplier data collection, and due diligence), and economic adaptation (budgeting for certification, investment in reporting systems, and strategic decisions on upgrading, partnering, or shifting markets). Exporters that successfully adapt are likely to retain or improve their competitive position, while those that partially comply or fail to comply risk declining competitiveness or exclusion from European value chains. The study concludes that European sustainability regulation functions not only as an environmental instrument but also as a market-shaping force, and recommends sector-specific, evidence-based policy support for non-EU exporters.

Keywords: European Union Sustainability Regulation, Bio-Based Materials, Circular Economy, Non-EU Exporters, Adaptation Strategy

INTRODUCTION

Climate change, biodiversity loss, and the depletion of non-renewable resources are among the most urgent challenges facing global economic and industrial systems today. The construction sector plays a central role in these challenges because of its heavy reliance on energy-intensive materials such as concrete and steel; within the European Union, the built environment accounts for approximately 36-40% of total CO2 emissions (European Commission, 2020), and the sector consumes over one-third of the Union's total energy (IEA, 2019), while nearly 75% of the current EU building stock remains energy-inefficient (Buildings Performance Institute Europe, 2021).

In response, the European Union introduced the European Green Deal, which aims to achieve climate neutrality by 2050 through deep decarbonization, biodiversity restoration, and a transition toward a circular economy. The European Commission identifies the construction sector as a high-impact transition sector because of its long material life cycles and large waste streams (European Commission, n.d.), and the European Environment Agency similarly highlights the sector's significant embedded emissions relative to other industries (EEA, n.d.). A core element of this strategy is the substitution of fossil-based materials with renewable, low-carbon alternatives, and bio-based materials have been positioned as strategic substitutes, particularly in construction, packaging, and manufacturing. In line with this ambition, the Netherlands has introduced its '30-30-30' construction strategy, which requires that by 2030 at least 30% of construction materials be bio-based, intended to reduce embedded carbon emissions and stimulate circular value chains.

While these policies are formulated at the European and national level, their implications extend far beyond EU borders. European construction and manufacturing sectors are deeply embedded in global supply chains, sourcing raw materials and finished products from non-EU countries. As European sustainability requirements tighten, the World Trade Organization (2022) notes that exporting countries face growing pressure to meet destination-market standards, while the OECD (2021) similarly observes that foreign producers must increasingly demonstrate compliance with EU requirements to maintain market access. This is particularly relevant for exporting countries such as Indonesia and Viet Nam, which supply a wide range of materials to the European market and possess abundant biomass residues, fibres, bamboo, wood products, and plantation-based materials (FAO, 2022) that the Asian Development Bank (2021) identifies as offering significant untapped potential for higher-value, sustainability-certified exports. At the same time, many exporting firms are not yet fully equipped with the certification systems or investment required to demonstrate compliance.

The transition is complicated by the fact that bio-based substitution is not universally applicable. Construction materials such as load-bearing components, insulation products, and façade systems must meet strict requirements for mechanical strength, durability, moisture resistance, and fire safety (Ashby, 2019), meaning that only specific biomasses, fibre crops, and bio-composites are technically viable, and successful substitution requires targeted technological adaptation rather than the generic use of organic waste. Exporting firms therefore face strategic uncertainty: some sectors may adapt production processes and pursue certification, while others may find compliance too costly or technically infeasible, leading to market withdrawal, redirection to non-EU markets, or loss of competitiveness. This creates uneven impacts across exporting sectors and raises questions about the distribution of regulatory burden.

From a trade perspective, the transition toward stricter bio-based material rules may also lead to market restructuring. If European producers can meet bio-based requirements more easily because of regional access to certified biomass and established infrastructure, European buyers may increasingly shift toward domestic and regional suppliers, and the OECD (2021) suggests that exporters able to meet emerging requirements early may gain first-mover advantages in sustainability-driven markets, a pattern consistent with Porter and

Van der Linde's (1995) argument that well-designed environmental regulation can stimulate innovation and strengthen long-run competitiveness. Understanding these dynamics matters for European policymakers as well as for exporting countries, manufacturers, and investors that depend on long-term access to European markets, because the ability of foreign exporting sectors to adapt will increasingly determine which firms remain competitive in global value chains.

The objective of this research is to examine how upcoming European sustainability and bio-based material regulations may affect non-EU exporting sectors, and to map feasible adaptation strategies-covering production and process changes, material substitution, and business strategy-together with their expected market implications. This objective is addressed through the main research question: which exporting sectors from non-EU countries are most likely to be affected by upcoming European bio-based material regulations, and how can these sectors adapt to remain competitive in the European Union market? Three sub-questions guide the analysis: (1) what are the key European sustainability and bio-based material regulations that will influence imported products over the next five to ten years; (2) what technical, organizational, and economic adaptation strategies can non-EU exporters implement to comply with these regulations; and (3) what are the likely trade and competitiveness outcomes for exporters that comply, partially comply, or fail to comply with European sustainability regulations.

THEORETICAL FRAMEWORK AND HYPOTHESIS FORMULATION

European Sustainability and Bio-Based Material Regulation

European sustainability regulation has developed rapidly in recent years, driven by ambitions to achieve climate neutrality, reduce resource dependency, and promote a circular economy (European Commission, 2019). The principal policy framework is the European Green Deal, introduced by the European Commission in 2019, which sets the goal of a climate-neutral Union by 2050 through measures covering energy, industry, transport, agriculture, and material use. A core element of this strategy is the Circular Economy Action Plan, which addresses resource efficiency, product durability, recycling, and the substitution of fossil-based materials with renewable, low-carbon alternatives; bio-based materials are explicitly positioned as strategic substitutes for carbon-intensive materials in high-impact sectors such as construction, packaging, and manufacturing (European Commission, 2020). For construction specifically, regulation increasingly targets whole-life environmental performance rather than operational energy alone, with instruments such as the Energy Performance of Buildings Directive (EPBD) and emerging whole-life carbon assessment guidelines encouraging low-carbon and bio-based material use (European Commission, 2021), a direction also promoted by the World Green Building Council (2019) as central to reducing embodied carbon in the built environment.

From a trade perspective, European sustainability regulation is closely linked to non-tariff measures affecting market access for foreign producers (OECD, 2021). Certification schemes, carbon disclosure requirements, and due-diligence obligations function as indirect trade barriers when suppliers cannot meet the required standards, and recent developments-including carbon-related border measures-reinforce the trend of environmental performance becoming a competitive condition for EU market access (European Commission, 2021), a trend the World Trade Organization (2022) links to the wider rise of environment-related

technical regulation in global trade. Although these regulations are formally adopted within the EU internal market, the OECD (2021) shows that their effects extend globally through international supply chains, requiring exporting firms in non-EU countries to demonstrate compliance with European sustainability criteria, and UNCTAD (2023) similarly finds that maintaining a position in European value chains increasingly depends on this ability to demonstrate compliance.

Bio-Based Materials and Sustainable Production

Bio-based materials originate from renewable sources such as plants, wood, fibres, crops, or agricultural residues, including wood, bamboo, hemp, flax, natural fibres, and bio-based plastics (European Commission, 2020). The International Energy Agency (2019) further situates such materials among the substitutes needed to reduce reliance on energy-intensive, fossil-based inputs. These materials are promoted because they generally require less energy to produce than fossil-based materials such as cement, steel, and plastics, and can store carbon during their lifetime, especially in long-lasting products such as buildings and furniture (World Green Building Council, 2019). However, bio-based materials are not automatically sustainable: their environmental impact depends on how raw materials are grown, harvested, processed, transported, and disposed of (European Commission, 2020), and the FAO (2022) warns that unsustainable biomass cultivation can cause deforestation, biodiversity loss, or competition with food production.

To assess whether a bio-based product is genuinely more sustainable, companies and policymakers rely on Life Cycle Assessment (LCA), which evaluates environmental impact across a product's entire life (ISO, 2006), while in construction this information is typically communicated through Environmental Product Declarations (EPDs) based on standardized LCA methods (EN 15804, 2012). Producing with bio-based materials also requires production-process changes, since factories designed for fossil-based or mineral inputs cannot easily switch, and bio-based materials vary in quality, moisture content, and strength, making production more complex, a challenge Ashby (2019) attributes largely to the variability of natural feedstocks relative to engineered materials. Hegger et al. (2020) add that this variability often raises production costs, while Lange (2022) emphasises that bio-based products must still meet the same strict safety, durability, and performance requirements as conventional materials. For non-EU exporters, these challenges are especially significant, as companies that cannot demonstrate compliance through certification, documentation, or reporting may lose EU market access, while those that adapt successfully may access new opportunities (OECD, 2021).

Circular Economy and Sustainable Business Models

The circular economy aims to reduce waste and minimize the use of new materials by keeping products and materials in use for longer through maintenance, reuse, refurbishment, remanufacturing, and recycling (Ellen MacArthur Foundation, n.d.). The concept is strongly embedded in EU policy through the Circular Economy Action Plan, which addresses the entire product life cycle from design through end-of-life management (European Commission, 2020). Circularity also requires firms to adjust their business models: Bocken et al. (2016) argue that product design strongly influences whether a product can be repaired, reused, or recycled, while Lewandowski (2016) notes that firms often need to change supply chains, customer relationships, and revenue models to support circular activities. Lüdeke-

Freund, Gold, and Bocken (2019) identify common circular business model patterns-including repair and maintenance, reuse and redistribution, refurbishment and remanufacturing, recycling, cascading and repurposing, and the use of organic feedstock such as bio-based materials-showing that circularity can range from incremental changes to major transformation.

In construction specifically, Pomponi and Moncaster (2017) argue that circular economy implementation requires both top-down policy action and bottom-up company-level practice, since long building lifespans, complex supply chains, and strict safety standards demand long-term planning rather than end-of-life recycling alone. To support measurement and reporting, the ISO 59000 series-including ISO 59004:2024 on vocabulary and principles and ISO 59020:2024 on measuring circularity performance-provides standardized guidance that helps exporters produce comparable, evidence-based circularity claims (ISO, 2024a, 2024b).

Sustainability Regulation and International Trade

In international trade, non-tariff measures (NTMs) are policy measures other than customs tariffs that affect trade by altering quantities traded or prices; UNCTAD's classification includes technical measures such as health, safety, and environmental protection requirements, meaning that sustainability rules can function as NTMs even when their primary purpose is not to restrict trade (UNCTAD, 2012). The WTO Technical Barriers to Trade (TBT) Agreement covers technical regulations, standards, and conformity assessment procedures, aiming to prevent unnecessary obstacles to trade while allowing countries to pursue legitimate objectives such as health, safety, and environmental protection (WTO, n.d.), and the European Commission similarly recognizes that legal requirements intended to protect the environment can restrict trade if applied unfairly (European Commission, n.d.).

Several EU instruments are particularly relevant for non-EU exporters: the revised Construction Products Regulation, CPR (EU) 2024/3110, sets harmonized marketing rules and technical performance criteria for construction products (European Union, 2024), with implementing guidance further clarified by the European Commission (2025); the Ecodesign for Sustainable Products Regulation (ESPR) strengthens requirements on product durability, circularity, and digital product information (European Commission, n.d.); the Carbon Border Adjustment Mechanism (CBAM) requires that a carbon price be paid for embedded emissions in certain imported goods, beginning with a transitional reporting phase from October 2023 (European Commission, n.d.); and the EU corporate sustainability reporting rules together with the Corporate Sustainability Due Diligence Directive (CSDDD) require in-scope companies to identify and address environmental and human-rights risks across their value chains, indirectly pressuring non-EU suppliers to provide traceability and sustainability data (European Commission, 2024). A related instrument, the EU regulation on deforestation-free products, is particularly relevant for wood- and bio-based supply chains. Collectively, these instruments show that European sustainability policy operates not merely as an internal environmental instrument but as a global regulatory force shaping production standards and material choices (OECD, 2021), with UNCTAD (2023) adding that it increasingly determines international competitiveness for exporting firms.

Adaptation Strategies for Non-EU Exporters

Building on this literature, this study organises exporter responses into three categories of adaptation. Technical adaptation refers to changes in products, materials, production processes, and technical information systems-including product testing, LCA, EPDs, and digital product data-that help firms demonstrate regulatory compliance. Organizational adaptation refers to changes in internal management systems, compliance processes, and supply chain coordination, including traceability, supplier data collection, due diligence, and standardized reporting. Economic adaptation refers to the financial and strategic decisions firms make in response to regulatory pressure, including budgeting for certification and reporting, investing in data systems, partnering with external actors, or adjusting market focus.

Because this study is exploratory and qualitative in nature, it does not test statistical hypotheses; instead, this conceptual framework-linking regulatory pressure, sector characteristics, and the three categories of adaptation to likely market outcomes-guides the document analysis and comparative sector analysis presented in the following sections. The framework further assumes that the strength of regulatory pressure on a given sector is shaped jointly by the technical complexity of bio-based substitution and the intensity of traceability and reporting obligations placed on that sector, so that sectors facing both high technical constraints and high information demands-such as construction materials-are expected to show the lowest adaptation feasibility, while sectors facing only one of these pressures are expected to show comparatively higher feasibility.

RESEARCH METHOD

This research uses a qualitative, exploratory research design, appropriate because the study aims to understand and interpret European sustainability regulations, sector-level impacts, and exporter adaptation strategies rather than to measure numerical relationships or test statistical models. The design focuses on ‘how’ and ‘why’ questions-how regulations affect exporting sectors and why particular adaptation strategies may be chosen-and is exploratory because many EU bio-based and circular economy regulations are still developing and their effects on global exporters are not yet fully established.

The research strategy combines document analysis with comparative sector analysis. Document analysis is used to examine European sustainability and circular economy regulations together with academic and institutional literature on bio-based materials and exporter adaptation, allowing identification of key regulatory requirements and expectations. Comparative sector analysis is then used to understand how different export-oriented sectors are affected by these regulations and how they may respond, allowing the study to identify common challenges and adaptation strategies at the sector level while supporting the overarching aim of linking EU regulation to exporter adaptation and market outcomes.

Data were collected from secondary qualitative sources, including European Union policy documents, academic literature, and institutional and sector reports related to sustainability regulation, bio-based materials, circular economy, and international trade. Document analysis is appropriate because the research focuses on policy-driven and structural sector impacts rather than individual opinions or firm-level decision-making (Bowen, 2009); the use of multiple document types allows triangulation and strengthens the credibility of the findings. No primary data such as interviews or surveys were collected.

The unit of analysis is export-oriented sectors supplying products to the European Union market, analysed at sector level rather than at the level of individual firms or countries, allowing the identification of common patterns across sectors. Four sectors were selected because they are material- and carbon-intensive and therefore more exposed to bio-based material, circularity, and sustainability reporting requirements: construction materials, packaging, furniture, and textiles.

Data were analysed using thematic analysis (Braun & Clarke, 2006), whereby documents were read to identify important themes, patterns, and differences, focusing on the level of regulatory pressure faced by each sector, the type of sustainability requirement involved, the adaptation strategies available to exporters, and the possible effects on competitiveness in the EU market. This approach allows the study not only to describe regulatory content but also to compare how different sectors may be affected and respond.

The scope of this research is limited to sector-level qualitative analysis based on secondary data; no quantitative analysis or primary data collection, such as surveys, was undertaken, and the analysis does not attempt to measure exact numerical effects. Reliability is supported by the use of official EU policy documents, peer-reviewed academic literature, and reports from recognised international organisations, while validity is ensured by maintaining a clear link between the research aim, questions, literature review, and methodological choices.

RESEARCH RESULTS AND DISCUSSION

Key European Regulations Affecting Non-EU Exporters

Several EU regulations and policy developments are particularly relevant for non-EU exporters that intend to continue supplying the European market (European Commission, 2020), and UNCTAD (2019) notes that together they increase the level of sustainability, product information, and traceability required from suppliers. Product-level rules such as the Construction Products Regulation (CPR) set harmonised requirements for marketing construction products and place growing attention on sustainability alongside safety and technical performance (European Union, 2024). The Ecodesign for Sustainable Products Regulation (ESPR) further strengthens requirements on durability, circularity, and digital product data, meaning exporters may increasingly need to provide technical documentation and conformity evidence (European Commission, n.d.).

Company-level rules, including EU corporate sustainability reporting rules and the CSDDD, mainly target in-scope EU companies but influence non-EU suppliers indirectly, as EU buyers request more sustainability, traceability, and sourcing information to meet their own obligations (European Commission, 2024); the EU regulation on deforestation-free products is a related example that is particularly relevant for wood-based and bio-based supply chains. The Dutch 30-30-30 strategy, although a national rather than EU-wide measure, illustrates how ambitious bio-based material targets can shape market expectations and purchasing decisions, and demonstrates that the Netherlands is likely to remain dependent on international supply even as local sustainability expectations rise. Overall, these developments suggest that competitiveness in the EU market increasingly depends not only on price and quality but on the ability to provide technical, environmental, and traceability information, positioning European sustainability regulation as an environmental

policy (European Commission, 2020) that UNCTAD (2019) characterizes as simultaneously a market-shaping force.

Sector-Level Effects on Selected Export Sectors

The effects of European sustainability and bio-based material regulation are not uniform across sectors. Construction materials appear to face the strongest direct pressure because construction products must meet strict requirements for strength, durability, fire safety, and moisture resistance, meaning that substitution with bio-based or lower-carbon alternatives requires extensive testing, certification, and proof of real-world performance; combined with growing product-information obligations under the revised CPR and the logistical cost of transporting heavy, bulky materials over distance, adaptation in this sector is likely to be technically demanding and costly.

Packaging faces strong but comparatively more manageable pressure, since circular economy rules on recyclability, material efficiency, and product information allow greater flexibility in material choice, product redesign, and production adjustment, even though exporters still need to strengthen supply-chain coordination and compliance documentation. Furniture faces moderate pressure: although not subject to the same structural safety requirements as construction materials, furniture exporters must demonstrate responsible and traceable sourcing of wood and other bio-based inputs, alongside circular design features such as longer product life and easier disassembly, reuse, or recycling. Textiles face moderate-to-high pressure, driven less by technical safety standards than by circular economy expectations, product-information requirements, and the complexity of tracing long, multi-country supply chains, meaning that market access increasingly depends on exporters' ability to provide reliable information on materials, sourcing, and environmental performance.

A comparative reading across the four sectors indicates that, while all sectors face increasing pressure from sustainability expectations, product-information requirements, and traceability demands, construction materials are the most exposed because of strict technical standards and difficult bio-based substitution, whereas packaging and textiles face pressure mainly through circularity, reporting, and traceability, and furniture falls between the two. Table 1 summarises this comparison in the form of an adaptation feasibility map.

Table 1. Adaptation Feasibility Map by Sector

Sector	Regulatory pressure	Needed adaptation	Feasibility	Likely market outcome
Construction materials	Strong pressure from construction rules, embodied-carbon expectations, safety standards, and bio-based material targets	Product testing, LCA, EPDs, certification, technical documentation, and performance proof	Medium-to-low	Compliant exporters may stay competitive; those without testing/certification may lose EU buyers
Packaging	Strong pressure from circular economy rules, recyclability expectations, material efficiency, and product information	Use of recycled/bio-based inputs, redesign for recyclability, supplier coordination, sustainability documentation	Medium-to-high	Early adapters remain attractive to EU buyers; weaker firms face higher compliance cost
Furniture	Moderate pressure from responsible sourcing, traceability, circular design, and	Sustainable sourcing, certification, traceability systems, product	Medium	Exporters with proof of responsible materials gain buyer trust; those

	sustainability documentation	redesign, longer product life		without documentation lose competitiveness
Textiles	Moderate-to-high pressure from circular economy expectations, supply-chain transparency, and due diligence	Supplier monitoring, material traceability, sustainability reporting, documentation systems, circular design	Medium	Exporters with strong traceability keep EU access; less organised suppliers lose position in EU value chains

Source: compiled by the author from the thematic document analysis presented in this study.

As shown in Table 1, construction materials face the strongest regulatory pressure and the lowest relative feasibility of adaptation, while packaging appears more adaptable; furniture and textiles fall in the middle, with feasibility depending largely on sourcing and traceability capacity.

Adaptation Strategies for Non-EU Exporters

Non-EU exporters are not only passive subjects of regulation; they can respond through three interrelated forms of adaptation. Technical adaptation involves adjusting products, materials, and production processes and building the technical information systems needed to demonstrate compliance-this includes product testing to prove safety and performance (Ashby, 2019) and the technical documentation required under EU conformity assessment procedures (European Commission, n.d.), Life Cycle Assessment to measure environmental impacts across a product's life cycle in line with ISO 14040/14044, preparation of Environmental Product Declarations following EN 15804 core product category rules for construction products, and building digital product data compatible with instruments such as the ESPR's Digital Product Passport (European Commission, n.d.).

Organisational adaptation involves internal restructuring to manage compliance, traceability, and supplier coordination. In practice this includes establishing a clear internal compliance process, often through a dedicated role or team that manages documentation, testing, and regulatory updates; improving traceability and supplier data collection in response to EU sustainability reporting requirements that push EU buyers to request more information from suppliers (UNCTAD, 2024); beginning supply-chain due diligence, consistent with the OECD's guidance that due diligence helps firms identify and address actual and potential negative impacts in their operations and value chains (OECD, 2021), an approach now embedded in the EU's own due-diligence requirements for in-scope companies (European Commission, 2024); and adopting standardised templates and repeatable reporting formats to manage the similar sustainability and product-information requests received from multiple EU buyers efficiently.

Economic adaptation involves the financial and strategic decisions exporters must make in response to regulatory pressure, since compliance is costly, covering laboratory testing, certification, and record-keeping systems (UNCTAD, 2019), with the OECD (2021) adding that emissions-tracking obligations impose a further layer of cost. This includes budgeting for testing, certification, and data systems, since conformity assessment requires both time and expenditure; investing in measurement and reporting for carbon-related rules such as CBAM, which requires firms to report embedded emissions during its transitional phase (European Commission, n.d.); and deciding whether to upgrade capabilities independently, partner with external actors such as testing bodies and consultants, or refocus on products and markets where compliance is comparatively easier. Because regulatory compliance

shapes which firms can access and remain competitive in the EU market, economic adaptation ties directly to long-term competitive positioning rather than being merely a cost of doing business.

Likely Market and Competitiveness Outcomes

The likely market outcome for non-EU exporters depends strongly on the degree of compliance achieved. Exporters that successfully comply are likely to retain, and in some cases improve, their competitive position, since EU buyers facing heavier scrutiny increasingly favour suppliers that can provide clear evidence on materials, emissions, and sourcing; compliance can therefore function less as a burden and more as a means of building buyer trust (OECD, 2021), consistent with Porter and Van der Linde's (1995) broader argument that environmental compliance can become a source of competitive advantage rather than merely a cost. Countries such as Indonesia, Viet Nam, India, Türkiye, and Brazil illustrate the range of non-EU exporting countries whose firms could benefit from successful compliance across sectors such as palm oil, textiles, footwear, machinery, and mineral products, although the primary focus of this study remains at sector rather than country level.

Exporters that only partially comply face a more precarious position: they may retain market access in the short term, particularly in niches where enforcement is still developing, but typically face higher compliance costs and more frequent buyer scrutiny (UNCTAD, 2019), and the OECD (2021) adds that this translates into weaker long-term stability as EU requirements continue to tighten. Exporters that fail to comply risk losing competitiveness, being excluded from EU buyer networks, or being confined to narrower market segments, since UNCTAD (2019) finds that sustainability rules can function as an effective barrier when suppliers cannot provide the necessary verification, a pattern consistent with the WTO's (n.d.) broader recognition that technical regulations can restrict trade when compliance capacity is uneven.

At a broader level, these dynamics point toward gradual market restructuring rather than the wholesale exclusion of non-EU suppliers. Because European industries remain structurally dependent on global supply chains, sustainability regulation is more likely to make the EU market more selective-favouring suppliers that can demonstrate solid technical specifications and credible sustainability evidence-than to close it entirely to exporters outside the Union (OECD, 2021), a reading consistent with UNCTAD's (2023) assessment that sustainability standards tend to reshape rather than eliminate developing-country participation in EU value chains.

Policy Implications

These findings carry direct implications for policymakers, trade support institutions, and export-oriented firms in non-EU exporting countries. First, sustainability compliance should be treated as a competitiveness issue and not solely an environmental one, meaning support institutions should assist exporters with product testing, certification, traceability systems, and sustainability reporting rather than focusing purely on export promotion (OECD, 2021), a shift UNCTAD (2024) also recommends as part of a broader due-diligence support agenda. Second, because the four sectors examined face different levels of regulatory pressure and different feasibility of adaptation, policy support should be sector-specific rather than uniform: construction materials require stronger technical-compliance infrastructure, including testing facilities and certification support in line with EU conformity procedures

(European Commission, n.d.), together with LCA and EPD expertise built around ISO life-cycle methodology (ISO, 2006) and the EN 15804 core product category rules (EN 15804, 2012). Packaging, furniture, and textiles, meanwhile, require greater investment in traceability and sustainability information systems to manage complex, multi-tier supply chains in line with EU corporate sustainability reporting expectations (European Commission, 2024); UNCTAD (2024) highlights persistent capacity gaps among smaller exporters in meeting these demands, while the ISO 59000 series offers a common basis for measuring and reporting circularity performance (ISO, 2024b).

Third, because economic adaptation may fail even where firms understand the regulatory requirements if costs are prohibitive, targeted financial and organisational support-such as training subsidies, co-financing schemes, and shared certification services-is particularly important for small and medium-sized exporters, a priority UNCTAD (2024) identifies as central to inclusive trade policy, and one consistent with the WTO's (n.d.) recognition that conformity-assessment costs can fall disproportionately on smaller firms. Finally, because European sustainability regulation is likely to reshape competition over time (European Commission, 2019, 2020), sustainability adaptation should be integrated into long-term export strategy and industrial policy rather than treated as a short-term compliance exercise, allowing early adapters to convert regulatory pressure into a source of competitive advantage, as Yamaguchi (2021) argues in the context of circular-economy-aligned trade policy.

Discussion

Taken together, these findings extend the theoretical framework outlined earlier by showing that regulatory pressure, sector characteristics, and adaptation capacity interact to shape competitive outcomes rather than operating independently. The Porter hypothesis (Porter & Van der Linde, 1995) suggests that well-designed environmental regulation can stimulate innovation and improve long-run competitiveness, a claim later supported empirically by Ambec et al.'s (2013) review of the evidence; the sector comparison here is broadly consistent with that view, since exporters that treat compliance as an investment in technical capability and reporting infrastructure appear better positioned than those that treat it purely as a cost. At the same time, the findings support the non-tariff-measure perspective set out by UNCTAD (2012), because overlapping product, reporting, and due-diligence rules raise the cost and complexity of market entry regardless of their environmental intent, a dynamic the OECD (2021) similarly documents in its analysis of regulatory divergence. The analysis also nuances the circular economy business-model literature by showing that the feasibility of the patterns identified by Bocken et al. (2016), Lewandowski (2016), and Lüdeke-Freund et al. (2019) is not uniform: sectors with lower technical and safety constraints, such as packaging, can adopt circular design changes relatively quickly, whereas construction materials require the slower, more capital-intensive coordination described by Pomponi and Moncaster (2017), suggesting that generic circular economy frameworks should be interpreted through a sector-specific lens when applied to export competitiveness.

CONCLUSION

The study finds that the impact of EU sustainability and bio-based material regulations on non-EU exporters varies across sectors. Construction materials face the greatest pressure due to strict safety, performance, and testing requirements, while packaging

is more adaptable because changes are driven mainly by circular economy and material-efficiency demands. Furniture and textiles occupy an intermediate position, with greater emphasis on traceability, responsible sourcing, and sustainability reporting. Exporters can adapt through three interconnected dimensions: technical adaptation through testing and environmental documentation, organisational adaptation through compliance and traceability systems, and economic adaptation through investment and budgeting. Compliance therefore depends on the integration of product, organisational, and financial capabilities and is likely to influence exporters' long-term competitiveness in the EU market.

The feasibility of adaptation differs by sector, with construction materials being the most difficult and capital-intensive, packaging the most adaptable, and furniture and textiles falling between the two. Overall, EU regulations are more likely to restructure and selectively shape the supplier base than completely exclude non-EU exporters, rewarding firms that adapt effectively. Policymakers and trade-support institutions should therefore provide technical assistance, traceability infrastructure, and financing support, while exporters should begin sector-specific adaptation early. This study is limited by its qualitative, sector-level approach; future research could strengthen the findings through firm-level case studies, interviews, quantitative trade analysis, and country-specific studies, particularly on exporters from countries such as Indonesia.

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