

Insurance as a Catalyst of Circular Economy and ESG Implementation: Risk Governance, Resilience and Financial Performance under the CSRD

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1. Introduction

The circular economy (CE) has moved from a largely normative sustainability concept to a central component of industrial, corporate and public policy strategies. It aims to decouple value creation from the continuous extraction of virgin resources by keeping products, materials and components in productive use for longer and by regenerating natural systems (Geissdoerfer et al., 2017; Ellen MacArthur Foundation, 2019). In contrast to the linear model of take-make-dispose, CE emphasises narrowing, slowing and closing resource loops through eco-design, modularity, product life extension, repair, refurbishment, remanufacturing, recycling and business models based on access rather than ownership (Bocken et al., 2016; Stahel, 2016).

The strategic relevance of CE is reinforced by the European Green Deal, the European Commission's Circular Economy Action Plan and the broader shift towards mandatory corporate sustainability reporting under the CSRD. Circularity is increasingly framed not only as an environmental strategy but also as a component of competitiveness, waste

prevention, climate mitigation, resource security and ESG accountability (European Commission, 2020; European Parliament and Council, 2022). At the firm level, circularity is associated with innovation, resilience, new revenue streams and improved sustainability performance. However, the transition from linear to circular systems remains uneven. Many firms face high upfront investment requirements, uncertain demand for secondary products, complex reverse logistics, weak circularity metrics and a shortage of financial instruments calibrated to circular risk profiles (Tura et al., 2019; Dewick et al., 2020; Saarinen and Aarikka-Stenroos, 2023).

A particularly underdeveloped dimension concerns insurance. Circular business models introduce risk configurations that differ substantially from conventional linear production. Product-as-a-service models require the producer to retain ownership of assets and to remain responsible for performance over longer periods. Refurbished or remanufactured products raise questions about warranty, liability and degradation. Reuse platforms and shared assets depend on behavioural

compliance and data transparency. Reverse logistics systems create interdependencies across multiple actors and jurisdictions. These features increase uncertainty, and uncertainty affects investment decisions, pricing, stakeholder trust and the bankability of circular projects (Linder and Williander, 2017; Ritzen and Sandstrom, 2017).

Insurance is a core institution for organising uncertainty in modern economies. It transfers and pools risk, supports contractual confidence, mobilises loss-prevention expertise and generates data about exposure, frequency and severity. In sustainability transitions, insurers are increasingly expected to integrate environmental, social and governance (ESG) factors into underwriting, claims management, investment portfolios and risk advisory services (UNEP FI, 2012; Gatzert, Reichel and Zitzmann, 2020). Yet the literature on circular economy finance has focused mainly on banking, investment, green bonds and public funding, while insurance has remained peripheral. This omission is theoretically significant because circular economy barriers are often risk barriers, not simply capital barriers.

This article addresses that gap by developing the Insurance-Circularity Nexus: a conceptual framework explaining how insurance can support the scaling of circular economy systems. The central argument is that insurance should be understood not only as an ex-post compensatory mechanism but as an ex-ante catalyst of circular transformation. By absorbing losses, pricing risk, incentivising prevention and signalling reliability, insurance can reduce uncertainty, increase stakeholder confidence and improve the resilience of circular value chains. At the same time, the paper recognises that insurance is not a universal solution. Poorly designed insurance may create moral hazard, reinforce exclusion, rely on insufficient data or support superficial

green claims. A credible Insurance-Circularity Nexus therefore requires sound underwriting, robust circularity metrics, transparent governance and alignment with sustainability objectives.

The article makes three contributions. First, it extends CE theory by adding insurance as a missing institutional enabler of circular business model adoption. Second, it contributes to insurance and risk management theory by showing how underwriting, pooling and prevention can shape innovation diffusion and system resilience. Third, it connects CE with sustainability transitions and green finance by conceptualising insurance as an intermediary between firm-level circular innovation and system-level transformation.

2. Theoretical Background

This section establishes the theoretical foundation for linking circular economy transformation with insurance-based risk governance and ESG implementation. It first clarifies circular economy as a systems-level transformation, then examines the risk architecture of circular business models and finally connects these insights with sustainable underwriting, green finance and the emerging requirements for credible sustainability performance. The review therefore prepares the ground for treating insurance not as a peripheral financial service, but as a governance mechanism capable of supporting circularity, resilience and financially accountable ESG strategies (Geissdoerfer et al., 2017; Kirchherr, Reike and Hekkert, 2017; Gatzert, Reichel and Zitzmann, 2020).

2.1 Circular economy as a systems-level transformation

Circular economy has been defined in many ways, but most definitions converge around the idea of reducing resource input and waste

output through closed-loop material flows (Kirchherr, Reike and Hekkert, 2017). More advanced interpretations go beyond recycling and frame CE as a systemic shift in production, consumption, ownership, design and governance. This distinction matters because recycling alone does not necessarily transform business models or reduce absolute resource use. A systemic view requires attention to product design, value-chain coordination, user behaviour, measurement, financing and institutional support (Korhonen, Honkasalo and Seppala, 2018; Velenturf and Purnell, 2021).

CE strategies are often described through the logic of slowing, narrowing and closing loops. Slowing loops extends product lifetimes through durability, repair and reuse. Narrowing loops improves resource efficiency and reduces material intensity. Closing loops recovers value from products and materials at the end of use through remanufacturing, recycling and cascading. These strategies require different business capabilities and involve different risk profiles. For example, repair and remanufacturing depend on information about product condition, spare-part availability and reverse logistics, while product-as-a-service models require firms to manage assets over the entire lifecycle (Bocken et al., 2016; Stahel, 2016).

A mature CE also depends on the capacity to measure circular performance. Measurement is not merely a reporting issue; it shapes investment, regulation, procurement and risk assessment. Recent guidance emphasises the need for indicators that capture material flows, product lifetimes, resource productivity and system-level impacts (UNECE/OECD, 2024). For insurers, measurement is equally important because underwriting requires observable exposure, reliable loss data and meaningful distinctions between genuinely circular practices and superficial sustainability claims.

2.2 Circular business models and their risk architecture

Circular business models translate CE principles into value creation, delivery and capture. They include product life extension, sharing platforms, leasing, performance-based contracts, product-as-a-service, industrial symbiosis, take-back systems and remanufacturing. These models can generate economic and environmental benefits, but they also alter the allocation of risks between producers, users, suppliers, investors and regulators (Linder and Williander, 2017; Geissdoerfer et al., 2020).

The risk architecture of circular business models is distinctive for at least four reasons. First, circular models often extend the time horizon of producer responsibility. A manufacturer that sells a product once can transfer many downstream risks to the customer; a provider of product-as-a-service retains asset ownership and remains exposed to performance, maintenance, user behaviour and residual value. Second, circularity increases dependence on reverse logistics and secondary markets. The value of recovered materials or components may fluctuate, and supply reliability depends on return flows. Third, the quality and performance of reused or refurbished components may be less predictable than those of new components. Fourth, contractual and regulatory liability may be ambiguous, especially where products cross borders or change function across their lifecycle.

These features explain why circular business models may be attractive in theory but difficult to finance and scale in practice. Investors and lenders require confidence in cash flows, collateral value, residual value and legal enforceability. If circular assets lack actuarial history or standardised performance data, capital providers may demand higher risk

premiums or avoid the project altogether (Dewick et al., 2020; Saarinen and Aarikka-Stenroos, 2023). Insurance can intervene at precisely this point by converting uncertain exposures into priced, shared and governed risks.

2.3 Risk, uncertainty and resilience in circular value chains

Risk and uncertainty are not identical. Risk refers to situations where probabilities and impacts can be estimated with some confidence. Uncertainty arises when probabilities, impacts or causal mechanisms are poorly known. Circular systems contain both. Some risks, such as damage to leased assets, can be priced through experience data. Others, such as long-term degradation of innovative materials or legal liability for remanufactured components, may be more uncertain. This distinction is important because insurance functions best where risk can be observed, pooled and priced, but it can still support uncertainty reduction through data generation and prevention.

Circular value chains are interdependent systems. Failure in one part of the loop can affect other actors, especially where reverse logistics, shared infrastructure or industrial symbiosis are involved. Systems-thinking approaches therefore emphasise feedback loops, delays, non-linear effects and systemic risk (AlMashaqbeh et al., 2023). Resilience becomes a central capability: circular systems must be able to absorb disruptions while maintaining the capacity to circulate materials and deliver value (Murray, Skene and Haynes, 2017).

Insurance is directly relevant to resilience because it provides both financial absorption and behavioural incentives. Financially, insurance redistributes losses and supports

recovery after disruption. Behaviourally, underwriting requirements and premium differentiation can encourage risk prevention, maintenance, compliance and data sharing. However, insurance can also produce moral hazard if insured actors reduce care or if premiums fail to reflect risk quality. A circular insurance framework must therefore combine coverage with prevention, governance and measurement.

2.4 Insurance, sustainable underwriting and green finance

Insurance performs several economic functions: it transfers risk from the insured to the insurer, pools risks across many policyholders, prices risk through underwriting, supports prevention through risk engineering and mobilises capital through investment portfolios. In the context of sustainability, these functions are becoming strategically important. Sustainable insurance principles encourage insurers to incorporate ESG issues into decision-making, work with clients and governments, and disclose progress in managing sustainability risks (UNEP FI, 2012).

Existing insurance sustainability literature has focused heavily on climate change, natural catastrophes, transition risk, stranded assets and ESG integration. Gatzert, Reichel and Zitzmann (2020) show that sustainability risks affect insurers on the asset side, the liability side and at the level of corporate strategy. Regulatory attention has also increased, particularly in Europe, where supervisory authorities examine how sustainability risks should be reflected in prudential frameworks and risk management processes (EIOPA, 2024).

Circular economy finance has grown as a topic, but the insurance dimension remains comparatively underdeveloped. Reports on circular finance highlight investment, banking

and capital markets, and some mention insurance as part of the enabling financial ecosystem (Ellen MacArthur Foundation, 2020). However, few studies explain how insurance products, underwriting data, claims practices or risk engineering can directly shape circular business model adoption. This article fills that gap by treating insurance as a mechanism of transition governance rather than as a passive financial add-on.

2.5 The research gap: from finance for circularity to insured circularity

The literature therefore points to a clear gap. CE scholarship identifies uncertainty, trust, investment barriers and fragmented value chains as obstacles. Insurance scholarship explains how risk transfer, underwriting and prevention can support economic activity under uncertainty. Yet there is still no integrated theory of how insurance enables circular economy transformation. The concept of insured circularity addresses this gap. It refers to circular systems in which risk transfer, loss prevention, data governance and sustainability-aligned underwriting are embedded in business model design from the outset.

Insured circularity does not mean that every circular activity should be insured. Rather, it means that risk governance should become a deliberate component of circular strategy. For high-value assets, long-life products, shared infrastructure and performance contracts, insurance can become part of the value proposition itself. It can reassure customers, reduce capital costs, support regulatory compliance and provide the data necessary for continuous improvement.

3. Methodology Description

This paper is conceptual in nature. Rather than testing a statistical relationship, it develops

a theory-building framework through integrative synthesis. Conceptual articles are particularly useful when a phenomenon is practically important but theoretically fragmented. The intersection between insurance and circular economy is precisely such a case: the CE literature recognises risk, finance and trust as major barriers, while the insurance literature recognises sustainability risks and ESG underwriting, but the two conversations rarely meet in a systematic way.

The research design follows three steps. First, core CE literature is used to identify the risk architecture of circular business models, including asset longevity, ownership retention, reverse flows, performance obligations and systemic interdependence. Second, insurance and sustainable finance literature is used to identify risk-transfer and prevention mechanisms relevant to these challenges. Third, the two streams are integrated into a conceptual model and a set of theoretical propositions. The objective is not to provide an exhaustive bibliometric review but to build a coherent explanatory framework that can guide future empirical research.

The argument is grounded in already established CE concepts, including product design strategies (Bocken et al., 2016), CE definitions and systemic scope (Kirchherr, Reike and Hekkert, 2017), CE barriers and drivers (Ritzen and Sandstrom, 2017; Tura et al., 2019; Mhatre et al., 2021), and sustainability transition theory (Geels, 2002; Markard, Raven and Truffer, 2012). It also draws on insurance-sector sustainability literature, including sustainable insurance principles, ESG underwriting and sustainability risk management (UNEP FI, 2012; UNEP FI, 2020; Gatzert, Reichel and Zitzmann, 2020).

4. Gained Results: Conceptual Framework and Propositions

The gained results of this conceptual study are presented in the form of an integrated framework rather than statistical estimates. This is appropriate because the objective of the article is to clarify the theoretical mechanisms through which insurance can support circular economy transformation, ESG implementation and financially relevant risk governance. The results therefore consist of three connected outputs: the definition of the Insurance-Circularity Nexus, the conceptual model linking insurance mechanisms to circular-economy outcomes, and seven theoretical propositions for future empirical verification.

Building on the literature review, this section develops the central conceptual construct of the paper. The Insurance-Circularity Nexus captures how insurance mechanisms, underwriting practices, data infrastructures and claims design interact with circular business models and ESG-oriented management processes. The section is organised around five mechanisms through which insurance can reduce uncertainty, support lifecycle responsibility, strengthen stakeholder confidence and contribute to the financial viability of circular transformation.

4.1 Definition and conceptual logic

The Insurance-Circularity Nexus is defined here as the set of institutional, financial, contractual and data-driven relationships through which insurance mechanisms influence the adoption, scaling and resilience of circular economy systems. The nexus has two sides. On the demand side, circular firms need risk solutions for assets, products, liabilities, users, suppliers and revenue streams. On the supply side, insurers need data, standards and underwriting models that allow them to

understand circular exposures and price them responsibly.

The core logic of the nexus is straightforward: circularity changes the distribution of risk; insurance can reallocate, price, reduce and govern that risk; and this risk governance can make circular models more investable, trustworthy and resilient. The nexus is therefore not limited to insurance products. It includes underwriting standards, risk engineering, claims rules, warranties, performance guarantees, parametric triggers, IoT-based monitoring, capital-market signalling and ESG-aligned portfolio strategies.

4.2 Mechanism 1: reducing investment and operational risk

The first mechanism is the reduction of investment and operational risk. Circular projects often struggle because investors perceive them as risky relative to linear alternatives. Insurance can mitigate this perception by covering specific exposures: property damage, product liability, business interruption, performance failure, warranty claims, cyber risks in connected assets, environmental liability or transport risk in reverse logistics. When these exposures are insured, the residual risk retained by the firm or investor becomes more transparent.

Insurance can also support operational stability. Circular business models depend on the functioning of assets over longer time horizons. A leasing provider, for example, must ensure that equipment remains usable, repairable and economically viable over repeated cycles. Coverage for damage, theft, downtime, maintenance-related failures or residual-value risk can improve the predictability of cash flows. In financial terms, insurance converts uncertain losses into expected premiums and managed deductibles,

thereby supporting planning and investment readiness.

4.3 Mechanism 2: enabling ownership-retention and performance-based models

Circular models frequently require a shift from selling products to providing services, performance or access. This shift can align incentives for durability and repair because the producer benefits when assets remain productive for longer. However, ownership retention also concentrates risk on the provider. Product-as-a-service firms carry assets on their balance sheets, manage user behaviour, maintain service levels and remain responsible for lifecycle performance.

Insurance can enable these models by separating manageable exposures from entrepreneurial risk. Coverage can be linked to contractual performance, asset degradation, accidental damage, liability or downtime. In more sophisticated arrangements, insurers may combine coverage with preventive services such as condition monitoring, maintenance protocols or user-risk scoring. This is particularly relevant for machinery, mobility, electronics, medical devices and industrial equipment, where high asset values and performance obligations create significant downside exposure.

4.4 Mechanism 3: data-enabled prevention and predictive underwriting

The third mechanism is data-enabled prevention. Circular systems require better information about asset condition, usage intensity, maintenance history, material composition and end-of-life value. Digital technologies - including sensors, digital product passports, IoT platforms, blockchain-enabled traceability and digital twins - can reduce

information asymmetry. For insurers, such data improves underwriting accuracy and claims management. For circular firms, it supports predictive maintenance and lifecycle optimisation.

The value of insurance in this context is not only the payment of claims. It is also the production of risk intelligence. Underwriting can reveal where losses are likely to occur, which behaviours increase asset degradation and which preventive measures are economically justified. In this sense, insurance can become a learning infrastructure for circular systems. Premiums, deductibles and coverage conditions can be designed to reward prevention, reparability, safe use and transparent reporting.

However, data-driven insurance also creates governance challenges. The use of sensor data raises questions about privacy, cyber security, ownership of data, algorithmic bias and the potential exclusion of higher-risk users. A credible Insurance-Circularity Nexus therefore requires transparent data governance and proportionality: the data collected should be relevant to risk prevention and circular performance, not merely to surveillance or discriminatory pricing.

4.5 Mechanism 4: building trust, legitimacy and market coordination

The fourth mechanism is trust. Circular markets often suffer from scepticism regarding quality, durability and responsibility. Customers may doubt the reliability of refurbished products. Investors may question whether circular revenues are stable. Regulators may worry about liability and compliance. Suppliers may hesitate to enter long-term take-back arrangements. Insurance can signal that risks have been assessed, priced and governed.

This signalling function is especially important in markets where circular offerings are new. An insured warranty for remanufactured equipment, a performance guarantee for leased assets or liability coverage for reused components can reduce perceived risk and increase acceptance. Insurance does not eliminate uncertainty, but it can make commitments credible. In institutional terms, it helps transform circularity from an experimental practice into a contractually governable market arrangement.

4.6 Mechanism 5: systemic resilience and value-chain stabilisation

The fifth mechanism is systemic resilience. Circular systems are vulnerable to disruptions in material return flows, repair capacity, logistics networks, secondary markets and regulatory conditions. Insurance can stabilise these systems by absorbing shocks and supporting recovery. Business interruption insurance, supply-chain coverage, environmental liability coverage and parametric products can be relevant where disruptions would interrupt circular flows.

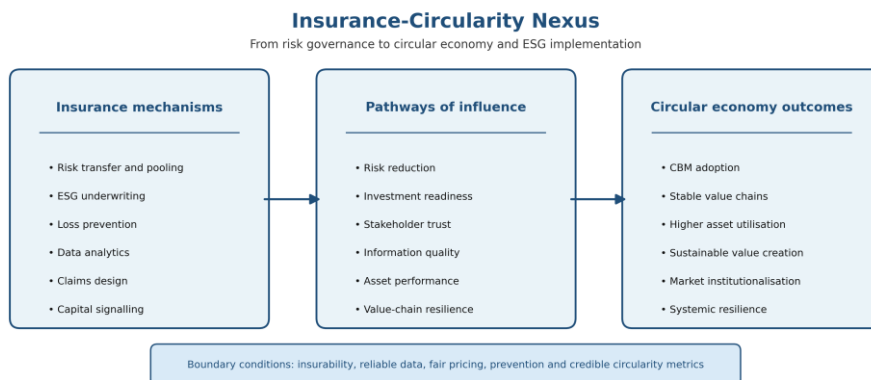
Beyond individual policies, insurers can contribute to resilience by aggregating knowledge across firms and sectors. Because insurers observe losses across a portfolio, they can identify recurrent vulnerabilities and advise on prevention. This portfolio perspective is valuable in circular systems, where risks may not be visible to any single firm. Insurance can therefore operate as a system-level feedback mechanism, translating loss experience into improved design, maintenance, logistics and governance.

4.7 Conceptual model

The preceding sections identified insurance as a set of interrelated mechanisms rather than as a single financial product. For the purpose of the conceptual framework, these mechanisms are organised into a causal sequence that links the supply of insurance capacity with the adoption and stabilisation of circular business models. The model therefore translates the argument from an institutional level to a business-model level: insurers affect circular transformation by changing how risks are identified, allocated, priced, mitigated and communicated. This logic is consistent with CE research emphasising systemic coordination and business-model innovation (Bocken et al., 2016; Kirchherr, Reike and Hekkert, 2017; Geissdoerfer et al., 2020) and with sustainable insurance literature that frames underwriting and prevention as tools for managing ESG-related exposures (UNEP FI, 2012; Gatzert, Reichel and Zitzmann, 2020).

Figure 1 should therefore be read as an explanatory framework rather than as a deterministic model. It does not claim that insurance alone causes circular transformation. Instead, it specifies the pathways through which insurance may create enabling conditions for circularity: by reducing operational and financial risk, increasing information quality, improving stakeholder trust and strengthening resilience. These pathways are particularly relevant in circular settings because value creation depends on long asset lifetimes, repeated use cycles, reverse logistics, performance obligations and lifecycle responsibility (Linder and Williander, 2017; Dewick et al., 2020).

Figure 1 » *The Insurance-Circularity Nexus Model*



Source: author's conceptual elaboration based on CE, insurance and sustainability-transition literature.

Figure 1 summarises the conceptual logic of the Insurance-Circularity Nexus. Insurance mechanisms operate as upstream enablers that affect intermediate pathways such as risk reduction, trust, investment readiness and resilience. These pathways, in turn, influence the adoption and stability of circular business models. The model implies that insurance affects circular transformation both directly, by absorbing or pooling losses, and indirectly, by shaping market confidence, data quality, preventive behaviour and financing conditions.

The model also highlights that circular economy outcomes are not automatic. Insurance contributes to circularity only when it is aligned with genuine circular practices. Conventional insurance products may cover circular firms, but they do not necessarily promote circular transformation. The catalytic role emerges when underwriting, pricing, claims management and prevention explicitly support durability, repairability, reuse, traceability and lifecycle value retention.

Table 1 » Insurance mechanisms and their expected circular-economy effects

Insurance mechanism	Circular risk addressed	Expected effect	Illustrative application
Risk transfer	Asset damage, liability, performance failure, business interruption	Lower residual uncertainty and improved planning	Coverage for leased industrial equipment or remanufactured products
Risk pooling	Volatile and idiosyncratic losses across firms and users	Stabilised loss experience and more predictable costs	Portfolio insurance for sharing platforms or take-back networks
Risk engineering	Preventable failures and maintenance-related losses	Improved prevention, repair protocols and operational reliability	Insurer-led audits of reverse logistics and maintenance systems
Data-driven underwriting	Information asymmetry about use, condition and degradation	More accurate pricing and predictive maintenance	IoT-enabled insurance for product-as-a-service assets
Trust and signalling	Customer and investor scepticism about circular quality	Greater legitimacy and market acceptance	Insured warranties for refurbished or remanufactured products
Claims and recovery design	Linear replacement incentives after loss	Support for repair, reuse and resource retention	Claims rules prioritising repair or certified refurbished replacement

Source: author's elaboration

4.8 Theoretical propositions

The propositions below derive from the conceptual model and serve as analytically testable statements. They are not intended as final empirical claims, but as theoretical expectations that specify how the Insurance-Circularity Nexus may operate under observable conditions. Each proposition links one insurance mechanism to a circular-economy outcome and identifies the underlying pathway through which the effect is expected to occur.

In formulating the propositions, the article follows a conditional logic. Insurance is expected to support circular transformation when coverage is connected to prevention, credible data, appropriate risk pricing and transparent sustainability criteria. This is important because circular business models differ in their exposure structure: risk transfer is likely to matter more where ownership, performance and lifecycle responsibility remain with the provider than where circularity is limited to conventional end-of-life recycling

(Linder and Williander, 2017; Saarinen and Aarikka-Stenroos, 2023).

Proposition 1 (risk reduction and adoption). The availability of insurance products tailored to circular business models positively influences circular economy adoption by reducing perceived operational and financial risks. Circular business models become more attractive when firms, investors and customers can identify which risks are transferred, which are retained and how losses will be managed.

Proposition 2 (risk pooling and resilience). Risk pooling and risk transfer enhance the systemic resilience of circular value chains by reducing vulnerability to technological, environmental and market shocks. The effect is strongest where circular actors share reliable exposure data and where insurance is combined with preventive governance.

Proposition 3 (data-enabled prevention). Data-driven underwriting and predictive prevention reduce information asymmetry and improve the operational performance of circular business models. Better lifecycle and usage

data can lower claims uncertainty, support predictive maintenance and increase asset utilisation.

Proposition 4 (capital cost and bankability). Insurance can reduce capital-cost barriers for circular investments by lowering the risk premium demanded by investors and lenders. This effect depends on whether coverage is credible, financially robust and aligned with the project's key cash-flow risks.

Proposition 5 (business-model specificity). The enabling role of insurance is stronger for ownership-retention and performance-based circular models than for simple recycling models. Product-as-a-service, leasing and remanufacturing create longer-term and more concentrated risk exposures, making insurance more strategically relevant.

Proposition 6 (ESG underwriting and circular integrity). ESG and CE-aligned underwriting can accelerate circular transformation only when supported by credible circularity metrics and transparent standards. Without such metrics, insurance may inadvertently legitimise weak or superficial circular claims.

Proposition 7 (institutionalisation of circular markets). A mature Insurance-Circularity Nexus contributes to the institutionalisation of circular markets by aligning firms, investors, regulators and customers around shared expectations of risk governance, lifecycle responsibility and sustainable value creation.

Taken together, the seven propositions present insurance as a multi-level enabler of circular transformation. Propositions 1-4 focus primarily on firm-level and project-level effects: adoption, resilience, data-enabled prevention and bankability. Propositions 5-7 move toward system-level effects by specifying when insurance becomes strategically relevant, how underwriting quality protects circular integrity and how shared expectations may support market institutionalisation. This

progression reflects the broader sustainability-transitions perspective, according to which durable transformation depends on the interaction between innovations, market structures, institutions and governance arrangements (Geels, 2002; Markard, Raven and Truffer, 2012).

The propositions also create a bridge between the conceptual framework and the empirical research agenda. Future studies can test them through comparative case studies, survey-based modelling, actuarial analysis, investment-cost comparisons or sectoral research in areas such as mobility, construction, electronics, machinery and healthcare equipment. In this respect, the propositions are not merely descriptive; they operationalise the Insurance-Circularity Nexus and define the conditions under which insured circularity may become a measurable field of research.

5. Discussion

The discussion interprets the proposed framework in relation to three scholarly conversations: circular economy theory, insurance and risk management theory, and sustainability transitions with green finance. It also clarifies the limits of the framework, because insurance can support circular and ESG-oriented transformation only under specific conditions of insurability, credible data, transparent governance and alignment with real lifecycle value retention.

5.1 Contribution to circular economy theory

The proposed framework contributes to CE theory by making risk governance explicit. Much CE literature emphasises materials, technology, design and business model innovation. These dimensions are essential, but they do not fully explain why circular models remain difficult to scale. The Insurance-

Circularity Nexus shows that circular transformation also depends on institutions that make long-term, uncertain and interdependent commitments credible.

By introducing insurance into CE theory, the framework shifts attention from circularity as a technical design challenge to circularity as a contractually and financially organised system. This is important because circularity often requires actors to trust future performance: a customer trusts that a refurbished product will work, an investor trusts that service revenues will cover asset costs, a regulator trusts that reused components remain safe, and a supplier trusts that take-back commitments will be honoured. Insurance can support these trust relationships by making risk allocation explicit.

5.2 Contribution to insurance and risk management theory

For insurance theory, the article reframes insurance from a compensatory mechanism to a transition-enabling institution. Traditional insurance analysis often asks how risks can be transferred, priced and diversified. The circular economy context adds a further question: how can insurance design influence innovation, prevention and sustainable value creation? This question aligns insurance with the broader agenda of sustainable finance and responsible underwriting.

The framework also highlights the prevention function of insurance. In circular systems, the most valuable insurance contribution may not be claim payment but the reduction of loss probability through maintenance, data analysis, risk engineering and contractual discipline. This prevention logic is particularly compatible with CE principles because avoiding loss, extending asset life and repairing rather than replacing products can all support resource productivity.

5.3 Contribution to sustainability transitions and green finance

Sustainability transition theory emphasises that systemic change requires interactions between technologies, markets, institutions, regulations and user practices (Geels, 2002; Markard, Raven and Truffer, 2012). Insurance can influence these interactions by changing the risk-reward profile of emerging circular niches. When circular business models are insured, they may become more acceptable to incumbent firms, financiers and customers. Insurance can therefore function as a bridge between niche experimentation and broader market diffusion.

The paper also extends circular finance debates. Circular finance is often framed as the mobilisation of capital into circular projects. The Insurance-Circularity Nexus suggests that capital mobilisation depends not only on capital availability but also on risk transformation. Without credible risk transfer and data, circular projects may remain financially unattractive even when sustainability benefits are clear. Insurance can complement banking and investment by improving the bankability of circular cash flows.

5.4 Boundary conditions and unintended effects

The catalytic role of insurance has limits. First, insurance requires insurability. Some circular risks may be difficult to price because loss data are scarce, exposures are correlated or legal liability is unclear. Second, insurance may create moral hazard if firms or users reduce preventive effort after transferring risk. Third, insurance may reinforce exclusion if high premiums make coverage unaffordable for smaller circular innovators. Fourth, data-driven underwriting may raise privacy, cyber and fairness concerns. Fifth, ESG-labelled

insurance may contribute to greenwashing if it is not connected to credible circularity criteria.

These limitations do not weaken the Insurance-Circularity Nexus; rather, they define the conditions under which it can operate responsibly. Insurance supports circular transformation when coverage is coupled with prevention, transparent data governance, appropriate regulation, risk-based pricing, fair access and credible sustainability metrics. A poorly designed insurance product may merely protect the status quo. A well-designed product can become part of the institutional infrastructure of circularity.

5.5 Policy and managerial implications

The practical relevance of the Insurance-Circularity Nexus lies in its implications for the actors who shape circular and ESG implementation in practice. Insurers, circular firms, investors, policymakers and regulators all influence whether circular business models remain experimental niches or become financially credible and reportable components of corporate sustainability strategy. In the context of CSRD-related transparency, these implications are particularly important because firms increasingly need to connect sustainability claims with governance processes, risk management and measurable performance.

5.5.1 Implications for insurers

Insurers should develop underwriting frameworks that recognise the specific risk profiles of circular business models. This requires moving beyond generic ESG screening towards more granular assessment of durability, reparability, residual value, traceability, reverse logistics, secondary-market dependence and lifecycle liability. Insurers can also work with firms to co-design coverage for product-

as-a-service models, refurbished products, remanufacturing operations and take-back systems.

Claims management is another strategic area. If insurance claims automatically lead to replacement with new products, they may reinforce linear resource use. Claims rules that prioritise safe repair, certified refurbished replacement or material recovery can align insurance practice with CE principles. Such approaches must preserve consumer protection and safety, but they can reduce waste and strengthen circular markets.

5.5.2 Implications for circular firms and investors

Firms adopting CE models should integrate insurance into business model design rather than treating it as a late-stage compliance requirement. When developing leasing, sharing, remanufacturing or product-as-a-service offerings, firms should identify the exposures that may undermine customer trust, revenue stability or investor confidence. Insurance can then be structured around these exposures and combined with maintenance systems, user education and data collection.

Investors should evaluate insurance not only as a cost but as a signal of risk maturity. A circular venture with transparent risk allocation, adequate coverage and preventive controls may be more bankable than a similar venture without such arrangements. However, investors should also examine whether insurance coverage genuinely addresses the main risks of the circular model or merely provides generic protection.

5.5.3 Implications for policymakers and regulators

Policymakers can support the Insurance-Circularity Nexus by clarifying liability rules for reused, repaired and remanufactured

products; supporting circularity measurement standards; enabling digital product information; and encouraging public-private risk-sharing for early-stage circular infrastructure. Regulatory clarity is particularly important where firms hesitate to use secondary components because liability is uncertain.

Supervisors should also consider how sustainability risk regulation can recognise the role of prevention and circularity. Prudential frameworks should avoid simplistic incentives but can encourage insurers to understand how circular practices affect underwriting risks, claims patterns and resilience. Public procurement and extended producer responsibility schemes can further stimulate demand for insured circular solutions.

5.6 Future research agenda

The Insurance-Circularity Nexus opens several empirical research avenues. First, quantitative studies could test whether insured circular projects attract capital at lower costs than comparable uninsured projects. Second, firm-level research could examine whether insurance coverage increases customer acceptance of refurbished, shared or performance-based offerings. Third, comparative case studies could analyse insurer-firm partnerships in sectors such as mobility, construction, electronics, machinery and healthcare equipment.

Fourth, actuarial and risk-modelling research could investigate how lifecycle data, digital product passports and IoT monitoring improve underwriting for circular assets. Fifth, policy research could examine how liability rules influence insurability and market development for repaired and remanufactured products. Sixth, transition studies could explore whether insurance accelerates the movement of circular business models from niche experimentation to

mainstream adoption. Finally, critical research should investigate potential downsides, including affordability, exclusion, data governance, moral hazard and greenwashing.

6. Conclusion

This article developed the concept of the Insurance-Circularity Nexus to explain how insurance can support circular economy transformation. The central argument is that the transition to circularity is constrained not only by technology, behaviour or regulation but also by risk. Circular business models alter ownership, liability, asset performance, data requirements and value-chain interdependence. These changes create uncertainty for firms, investors, customers and regulators.

Insurance can help convert this uncertainty into governable risk. Through risk transfer, pooling, underwriting, prevention, data analytics and trust-building, insurance can improve investment readiness, support circular business model adoption and strengthen systemic resilience. The article therefore reframes insurance as an enabling institution of circular transformation rather than a peripheral financial service.

At the same time, the framework is deliberately conditional. Insurance contributes to sustainable circularity only when it is supported by credible metrics, transparent data governance, prevention-oriented underwriting and alignment with genuine lifecycle value retention. If these conditions are absent, insurance may fail to support transition or may even legitimise weak circular claims. The proposed propositions and future research agenda provide a foundation for empirical testing and for the development of more robust circular finance and sustainable insurance strategies.

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REFERENCES

- ALMASHAQBEH, S. AND MUNIVE-HERNANDEZ, J. E.: 2023. Risk analysis under a circular economy context using a systems thinking approach, *Sustainability*, 15(5), 4141. Doi 10.3390/su15054141.
- BOCKEN, N.M.P., DE PAUW, I., BAKKER, C. AND VAN DER GRINTEN, B.: 2016. Product design and business model strategies for a circular economy, *Journal of Industrial and Production Engineering*, 33(5), pp. 308-320. Doi 10.1080/21681015.2016.1172124.
- DE JESUS, A. AND MENDONCA, S.: 2018. Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy, *Ecological Economics*, 145, pp. 75-89. Doi 10.1016/j.ecolecon.2017.08.001.
- DEWICK, P., BENGTTSSON, M., COHEN, M.J., SARKIS, J. AND SCHRODER, P.: 2020. Circular economy finance: Clear winner or risky proposition?, *Journal of Industrial Ecology*, 24(6), pp. 1192-1200. Doi 10.1111/jiec.13025.
- EIOPA: 2024. Final Report on the Prudential Treatment of Sustainability Risks. Frankfurt am Main: European Insurance and Occupational Pensions Authority.
- ELLEN MACARTHUR FOUNDATION: 2019. Completing the Picture: How the Circular Economy Tackles Climate Change. Cowes: Ellen MacArthur Foundation.
- ELLEN MACARTHUR FOUNDATION: 2020. Financing the Circular Economy: Capturing the Opportunity. Cowes: Ellen MacArthur Foundation.
- EUROPEAN COMMISSION: 2020. A New Circular Economy Action Plan for a Cleaner and More Competitive Europe, COM(2020) 98 final. Brussels: European Commission.
- EUROPEAN PARLIAMENT AND COUNCIL: 2022. Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting. Official Journal of the European Union, L 322, pp. 15-80. Available at: <https://eur-lex.europa.eu/eli/dir/2022/2464/oj> (Accessed: 20 June 2026).
- GATZERT, N., REICHEL, P. AND ZITZMANN, A.: 2020. Sustainability risks and opportunities in the insurance industry, *Zeitschrift für die gesamte Versicherungswissenschaft*, 109, pp. 311-331. Doi 10.1007/s12297-020-00482-w.
- GEELS, F.W.: 2002. Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study, *Research Policy*, 31(8-9), pp. 1257-1274. Doi 10.1016/S0048-7333(02)00062-8.
- GEISSDOERFER, M., PIERONI, M.P.P., PIGOSSO, D.C.A. AND SOUFANI, K.: 2020. Circular business models: A review, *Journal of Cleaner Production*, 277, 123741. Doi 10.1016/j.jclepro.2020.123741.
- GEISSDOERFER, M., SAVAGET, P., BOCKEN, N.M.P. AND HULTINK, E.J.: 2017. The circular economy - A new sustainability paradigm?, *Journal of Cleaner Production*, 143, pp. 757-768. Doi 10.1016/j.jclepro.2016.12.048.
- HART, J., ADAMS, K., GIESEKAM, J., TINGLEY, D.D. AND POMPONI, F.: 2019. Barriers and drivers in a circular economy: The case of the built environment, *Procedia CIRP*, 80, pp. 619-624. Doi 10.1016/j.procir.2018.12.015.
- KIRCHHERR, J., REIKE, D. AND HEKKERT, M.: 2017. Conceptualizing the circular economy: An analysis of 114 definitions, *Resources, Conservation and Recycling*, 127, pp. 221-232. Doi 10.1016/j.resconrec.2017.09.005.
- KORHONEN, J., HONKASALO, A. AND SEPPALA, J.: 2018. Circular economy: The concept and its limitations, *Ecological Economics*, 143, pp. 37-46. Doi 10.1016/j.ecolecon.2017.06.041.
- LINDER, M. AND WILLIANDER, M.: 2017. Circular business model innovation: Inherent uncertainties, *Business Strategy and the Environment*, 26(2), pp. 182-196. Doi 10.1002/bse.1906.
- MARKARD, J., RAVEN, R. AND TRUFFER, B.: 2012. Sustainability transitions: An emerging field of research and its prospects, *Research Policy*, 41(6), pp. 955-967. Doi 10.1016/j.respol.2012.02.013.
- MHATRE, P., PANCHAL, R., SINGH, A. AND BIBYAN, S.: 2021. A systematic literature review on the circular economy initiatives in the European Union, *Sustainable Production and Consumption*, 26, pp. 187-202. Doi 10.1016/j.spc.2020.09.008.
- MURRAY, A., SKENE, K. AND HAYNES, K.: 2017. The circular economy: An interdisciplinary exploration of the concept and application in a global context, *Journal of Business Ethics*, 140(3), pp. 369-380. Doi 10.1007/s10551-015-2693-2.
- OECD: 2019. Business Models for the Circular Economy: Opportunities and Challenges for Policy. Paris: OECD Publishing. Doi 10.1787/g2g9dd62-en.
- RITZEN, S. AND SANDSTROM, G.O.: 2017. Barriers to the circular economy - Integration of perspectives and domains, *Procedia CIRP*, 64, pp. 7-12. Doi 10.1016/j.procir.2017.03.005.
- SAARINEN, A. AND AARIKKA-STENROOS, L.: 2023. Financing-related drivers and barriers for circular economy business: Developing a conceptual model from a field study, *Circular Economy and Sustainability*, 3, pp. 1187-1211. Doi 10.1007/s43615-022-00222-5.
- STAHEL, W.R.: 2016. The circular economy, *Nature*, 531(7595), pp. 435-438. Doi 10.1038/531435a.
- STUCKI, T., WOERTER, M. AND LOUMEAU, N.: 2023. Clearing the fog: How circular economy transition can be measured at the company level, *Journal of Environmental Management*, 326, 116749. Doi 10.1016/j.jenvman.2022.116749.
- TURA, N., HANSKI, J., AHOLA, T., STAHEL, M., PIIPARINEN, S. AND VALKOKARI, K.: 2019. Unlocking circular business: A framework of barriers and drivers, *Journal of Cleaner Production*, 212, pp. 90-98. Doi 10.1016/j.jclepro.2018.11.202.
- UNECE/OECD: 2024. Guidelines for Measuring Circular Economy. Part A: Conceptual Framework, Indicators and Measurement Framework, ECE/CES/STAT/2023/5. Geneva: United Nations Economic Commission for Europe.
- UNEP FI: 2012. Principles for Sustainable Insurance. Geneva: United Nations Environment Programme Finance Initiative.
- UNEP FI: 2020. Managing Environmental, Social and Governance Risks in Non-Life Insurance Business. Geneva: United Nations Environment Programme Finance Initiative.
- VELENTURF, A.P.M. AND PURNELL, P.: 2021. Principles for a sustainable circular economy, *Sustainable Production and Consumption*, 27, pp. 1437-1457. Doi 10.1016/j.spc.2021.02.018.

Insurance as a Catalyst of Circular Economy and ESG Implementation: Risk Governance, Resilience and Financial Performance under the CSRD

ABSTRACT

The transition towards a circular economy is increasingly embedded in ESG-oriented management processes and corporate sustainability reporting regimes, particularly under the Corporate Sustainability Reporting Directive (CSRD). Circular business models can support resource productivity, resilience and long-term sustainable value creation, yet their scaling remains constrained by risk-related barriers, including uncertain asset performance, ambiguous liability structures, fragmented reverse logistics, limited lifecycle data and insufficient access to patient capital. These barriers are not merely technological or behavioural; they also affect financial performance, investment readiness and the credibility of ESG implementation. Despite this, the role of insurance in enabling circular economy transformation has received limited theoretical attention. This paper develops the concept of the Insurance-Circularity Nexus and proposes a conceptual framework explaining how insurance mechanisms can act as catalysts for circular and ESG-oriented transformation. Drawing on circular economy theory, risk management, sustainability transitions, green finance and sustainable insurance, the article argues that insurance is not only a compensatory instrument but also a risk-governance institution that reduces uncertainty, strengthens stakeholder trust, improves investment readiness and enhances systemic resilience. The framework identifies five interrelated mechanisms: risk transfer and pooling, operational risk mitigation, data-enabled prevention, trust and legitimacy building, and value-chain stabilisation. The study formulates seven testable propositions and discusses boundary conditions such as moral hazard, data asymmetry, affordability, regulatory ambiguity and greenwashing risk. The article contributes to theory by positioning insurance as an enabling institution within circular economy and ESG systems and provides a research agenda for future empirical studies on insured circularity, sustainable underwriting, CSRD-relevant risk governance and financially robust circular business models.

KEYWORDS

circular economy; ESG implementation; insurance; risk governance; sustainable insurance; CSRD; financial performance; circular business models; green finance; resilience

JEL CLASSIFICATION

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