Current Research in Law & Practice

Contents

Current Research in Law & Practice
VOL. 3 NO. 1 JUL. 2025
Brilliance Publishing Limited

The Influence of International Investment Treaties on Environmental and Social Regulation Through Regulatory Chill

Qinyu Liu[1], Clair R. Faulkner[1]*

[1] Simon Fraser University, Canada
* Correspondence: r.clairfaulkner@outlook.com

https://doi.org/10.53104/curr.res.law.pract.2025.07001

Abstract: This paper investigates the influence of international investment treaties on domestic environmental and social regulation through the lens of "regulatory chill." Drawing upon a synthesis of theoretical frameworks, empirical studies, and high-profile arbitration cases, the study examines how investor-state dispute settlement (ISDS) mechanisms embedded in international investment agreements deter or dilute regulatory initiatives by states. The research identifies both anticipatory and reactive forms of chill, where governments either preemptively abandon or subsequently alter public interest laws to avoid litigation or reduce exposure to legal liability. Through an integrated analysis of global ISDS claim trends, environmental legislative patterns, and pivotal investor-state disputes—including Vattenfall v. Germany, Lone Pine v. Canada, and Philip Morris v. Uruguay—the paper illustrates how regulatory chill is neither anecdotal nor isolated, but a structurally embedded consequence of the international investment regime. The study concludes that the regulatory autonomy of states, particularly in the Global South, is increasingly compromised by legal mechanisms originally designed to promote investment. It calls for systemic reform, including the rebalancing of treaty provisions to safeguard the public policy space necessary for sustainable development and social equity.

Keywords: regulatory chill; international investment treaties; ISDS; environmental regulation; social policy; investor-state dispute settlement; public interest law; treaty reform; arbitration; global governance

Received: 23 June 2025

Revised: 31 July 2025

Accepted: 5 August 2025

Published: 6 August 2025

Citation: Liu, Q., & Faulkner, C. R. (2025). The Influence of International Investment Treaties on Environmental and Social Regulation Through Regulatory Chill. *Current Research in Law & Practice, 3*(1), 1-14.

1. Introduction

International investment treaties (IITs) have emerged as foundational instruments of the global economic order. Since the mid-20th century, and particularly in the wake of post-Cold War liberalization, these treaties have proliferated to encompass more than 3,000 bilateral and multilateral agreements worldwide. At their core, IITs aim to encourage and protect foreign direct investment (FDI) by establishing binding rules that constrain host states from treating foreign investors unfairly. Common provisions include guarantees against expropriation, most-favored-nation (MFN) treatment, and fair and equitable treatment (FET). One of the most powerful and controversial tools embedded within these treaties is

the Investor-State Dispute Settlement (ISDS) mechanism, which allows private investors to initiate legal action directly against states in international arbitral tribunals.

Proponents argue that IITs provide certainty and reduce political risk in developing economies, facilitating capital inflows that can support infrastructure, technology transfer, and economic growth. In theory, the protection of investors promotes not only capital mobility but also encourages states to develop transparent and stable regulatory environments. Yet the reality of how these treaties operate in practice has become the subject of escalating academic, legal, and political scrutiny. The focus has shifted from the promises of economic benefit to the constraints IITs impose on states' capacity to regulate in the public interest, particularly in domains where regulatory action could adversely affect investor profits. Central to this critique is the concept of regulatory chill.

Regulatory chill refers to a phenomenon in which governments refrain from enacting, modifying, or enforcing legitimate public interest regulation due to the threat or fear of legal action under international investment agreements. The chilling effect does not depend on actual legal outcomes or the frequency of awards in favor of investors. It is rooted in the anticipatory rationality of governments that internalize the potential risks, costs, and uncertainties of arbitration. A chilling effect can manifest both procedurally and substantively. On the procedural level, regulatory proposals may be stalled during the drafting stage due to legal consultations or internal memos citing treaty obligations. Substantively, policies may be watered down, shelved, or strategically delayed—particularly when they relate to high-risk sectors such as extractives, energy, tobacco, water, or agriculture.

Unlike traditional legal doctrines, regulatory chill operates through soft constraints embedded in the logic of global legal pluralism. States party to IITs are no longer the sole interpreters of what constitutes legitimate public policy. ISDS tribunals, composed of arbitrators with varying interpretations of treaty language, possess the authority to determine whether a measure constitutes indirect expropriation or violates standards such as FET. This external interpretive authority gives rise to legal uncertainty. Given the often vague and broadly drafted provisions of IITs, virtually any policy that negatively impacts an investor's profits can be framed as a potential violation, creating a structural incentive for states to adopt risk-averse postures.

This concern is not merely hypothetical. A growing body of legal scholarship and political economy research has documented instances where the threat of ISDS has materially influenced state behavior. In some cases, governments have admitted that proposed policies—such as environmental taxes, pollution controls, or bans on hazardous substances—were not pursued due to anticipated litigation. In others, civil society actors have obtained access to internal communications through freedom of information requests, revealing that state agencies often modify policy proposals after receiving legal advice referencing investment treaty obligations.

The influence of regulatory chill is amplified by asymmetric legal capacities among states. Wealthier states with strong legal infrastructures and dedicated international law units may possess the capacity to resist investor pressure or mount credible defenses in arbitration. They may also have the political autonomy to enact controversial regulations and absorb reputational or financial costs. In contrast, lower- and middle-income countries may lack the necessary legal expertise or financial resilience to take the risk. For such states, a single ISDS award—sometimes in the hundreds of millions of dollars—can represent a significant portion of the national budget, discouraging not only the law in question but broader regulatory experimentation. The result is a hierarchical chilling effect, where the freedom to regulate becomes a function of national wealth and legal strength, raising concerns about global inequality in environmental and social protection.

Regulatory chill is particularly pronounced in areas of environmental and social regulation, where policies are often both politically sensitive and economically

disruptive. Climate change mitigation efforts, for example, frequently entail phasing out fossil fuels, introducing carbon pricing, or banning certain industrial practices—all of which may affect the profitability of foreign investors in energy, mining, and agriculture. Similar concerns apply to public health policies such as tobacco control, sugar taxes, and chemical bans. These regulations often follow a precautionary logic, where scientific certainty is incomplete but the risks to human or ecological health justify regulatory intervention. In such cases, governments that fear ISDS liability may be reluctant to act without overwhelming evidence, even when such caution contradicts established principles of risk governance.

Theoretical scholars such as Kyla Tienhaara have argued that regulatory chill is not simply a legal reaction but a political-economic dynamic. It reflects the structural imbalance between private investor rights and public regulatory functions in a globalized economy. By privileging investor expectations over sovereign policy discretion, ISDS mechanisms introduce a form of transnational veto power that operates outside of domestic democratic oversight. This has implications for theories of state autonomy, international legal fragmentation, and the privatization of regulatory space.

While the concept of regulatory chill has gained traction in academic circles, it remains contested. Critics argue that it is difficult to empirically verify chilling effects since policy non-decisions are often undocumented or attributable to multiple causes. Some suggest that governments may invoke the risk of ISDS opportunistically to justify regulatory inaction they already favor for political reasons. Others highlight cases where robust regulations have been enacted despite legal threats, indicating that states can, and do, resist investor pressure. These critiques point to the need for a more nuanced understanding of when, how, and under what conditions regulatory chill emerges.

To that end, scholars have proposed various typologies of chill. For example, Schram et al. (2018) distinguish between anticipatory chill (where regulation is preemptively avoided), responsive chill (where enacted policies are retracted or weakened after challenge), and systemic chill (where entire regulatory cultures shift toward legal defensiveness). These distinctions are crucial for developing a granular understanding of the phenomenon and for crafting institutional safeguards that preserve policy space. Whether chill is the result of isolated legal advice or an embedded administrative culture of risk aversion matters significantly for both diagnosis and remedy.

The strategic use of ISDS by investors adds another layer of complexity. Corporations increasingly rely on treaty shopping, restructuring their corporate form to gain access to more favorable BIT protections. This practice, while legally permissible, extends ISDS coverage and multiplies the opportunities for strategic arbitration. Moreover, law firms specializing in ISDS litigation often operate on a contingency fee basis, providing investors with legal firepower at minimal upfront cost. The expansion of third-party funding mechanisms has further fueled this litigation ecosystem, creating a speculative legal market that reinforces the chilling environment faced by regulators.

Civil society organizations, legal reform coalitions, and some governments have begun to respond. Proposals include narrowing treaty language, excluding sensitive policy areas such as public health and environment from ISDS coverage, and transitioning to state-to-state dispute resolution models. Some states have terminated or renegotiated their investment treaties, while others have introduced domestic legal reforms to insulate regulatory agencies from external investor influence. These countermeasures, though promising, face challenges. Renegotiation is often politically costly and diplomatically complex. Legal uncertainty remains due to overlapping treaty obligations and legacy clauses that extend investor protections years after treaty termination.

This paper aims to contribute to these debates by synthesizing existing legal, political, and normative analyses of regulatory chill. It does not claim to

provide original empirical data but seeks instead to trace the conceptual contours and implications of chill in the context of environmental and social governance. It brings together legal interpretations, scholarly models, and real-world cases to develop a comprehensive account of how international investment treaties shape regulatory choices. Through this analysis, the paper highlights the structural tensions between global economic integration and national regulatory autonomy, and the growing need for institutional designs that prioritize public interest over private profit.

2. Mechanisms and Evidence of Regulatory Chill

Regulatory chill describes the strategic or anticipatory withdrawal, delay, or dilution of public interest regulation in response to actual or perceived threats under international investment treaties, particularly those containing investor-state dispute settlement (ISDS) mechanisms. The chilling effect arises not necessarily from legal defeat in arbitration but from the broader deterrent power that the threat of investor claims exerts on state behavior. As international investment law evolved into a dense and powerful global regime, the architecture of legal risk assessment began to shape not only how states regulate but whether they regulate at all.

One principal mechanism through which chill is produced is preemptive legal risk aversion. This occurs during the early stages of the policymaking process, when government agencies or legal departments advise regulatory bodies to alter or abandon proposed measures to avoid triggering arbitration. Kyla Tienhaara explains that this dynamic reflects a structural conflict between economic liberalization and environmental governance, where the mere existence of ISDS mechanisms encourages governments to err on the side of inaction when proposed laws might conflict with investor expectations ("Regulatory chill and the threat of arbitration," 2011, SSRN). In her view, chill emerges as a governance norm, not a legal anomaly, especially in countries whose economies rely heavily on FDI and who face elevated legal vulnerability under existing investment agreements.

In a similar vein, Berge and Berger's empirical research uses cross-national environmental policy data to trace the correlation between BIT exposure and regulatory behavior. Their study finds that states with higher densities of BITs and ISDS clauses are significantly less likely to adopt strong environmental regulations ("Does Investor-State Dispute Settlement Lead to Regulatory Chill?", 2019, PEIO). These findings suggest that chill is not a phenomenon confined to isolated cases but one embedded in the broader policy infrastructure of investment governance. The authors highlight that this pattern holds even when controlling for economic development and political regime type, meaning that both authoritarian and democratic states tend to recalibrate regulation when the risk of legal challenge increases.

A second mechanism is what some scholars refer to as responsive chill—the decision to retract or modify laws following direct investor action or arbitration threats. While this form of chill may be more visible, its evidentiary burden is also higher. Policymakers rarely admit publicly that a regulatory rollback was motivated by legal pressure. However, documents disclosed through freedom of information laws, as well as interviews conducted by legal scholars and journalists, have revealed instances where investment arbitration was explicitly cited as a risk in internal memos that recommended regulatory withdrawal.

Côté (2014) examined this phenomenon through a detailed case study of Canada's health, safety, and environmental policymaking under NAFTA. In her doctoral thesis "A Chilling Effect?", she provides qualitative evidence from interviews with Canadian public officials and policy advisors. These testimonies show that ISDS exposure had become internalized across regulatory departments. Proposals related to pharmaceutical labeling, chemical regulation, and fracking were subjected to intensive legal review, and in some cases diluted or shelved based on the perceived risk of arbitration. What makes Côté's study especially revealing is its focus on a country with high institutional capacity. If regulatory chill is measurable even in Canada, a G7 state with deep legal resources,

the implications for countries with fewer institutional protections are more severe.

A third and critical mechanism is the asymmetry in ISDS exposure, which has been extensively documented by Hagemann (2023) in his comparative analysis of regulatory chill across the Global North and South. His research, "The North-South Divide of Regulatory Chill," highlights that developing countries experience a disproportionately higher number of ISDS claims targeting public welfare laws and are less likely to proceed with proposed regulations once a dispute is initiated. In contrast, wealthier countries have broader fiscal and administrative buffers, allowing them to defend or absorb ISDS-related costs more effectively. This creates a stratified global regulatory landscape, where the very countries most in need of assertive environmental and social protections are structurally discouraged from implementing them. The result is a chilling asymmetry: developing countries are locked in a state of regulatory risk minimization, often choosing policy inertia over reform.

The cumulative evidence supports the conclusion that regulatory chill is not simply a rhetorical device but a material force in international economic law. Its existence is sustained by multiple mutually reinforcing dynamics: the unpredictability of arbitration rulings, the expansive interpretation of vague treaty standards, and the growing presence of aggressive legal firms and third-party funders who actively scout for ISDS opportunities. Chill also stems from norm diffusion, where one state's costly legal defeat becomes a warning to others. For instance, high-profile cases such as *Philip Morris v. Uruguay* or *Vattenfall v. Germany* created widespread awareness among state regulators of the risks involved in pursuing health or climate policies that could affect foreign investors. Even when states win such cases, the financial and political costs involved often serve as deterrents in subsequent policy cycles.

Tienhaara's work underscores this institutionalization of chill. In her 2018 article "Regulatory Chill in a Warming World," she argues that ISDS systems serve as externalized veto points that constrain states from pursuing ambitious environmental policies. These veto points function irrespective of whether arbitration occurs. The decision-making process itself becomes captured by legal risk logic. As governments conduct cost-benefit analyses, the specter of a multi-million-dollar arbitration claim frequently outweighs the social or ecological benefits of regulation. This has been especially true for climate-related policies such as feed-in tariffs, carbon taxes, and coal phase-outs, many of which have been challenged or weakened in jurisdictions anticipating or facing investor litigation.

The methodological challenge in documenting regulatory chill lies in its invisibility. Because it deals with counterfactuals—what might have been regulated but wasn't—it resists traditional legal analysis. Scholars have responded to this by developing conceptual typologies and leveraging mixed methods. For instance, Côté combines policy document analysis with elite interviews to reveal the procedural influence of ISDS threats. Berge and Berger use statistical modeling to isolate treaty effects across national contexts. Tienhaara combines political economy frameworks with interpretive analysis of arbitration decisions and treaty language to trace the diffusion of chilling norms.

Although some critics argue that the empirical basis of regulatory chill remains inconclusive, this skepticism often underestimates the power of governance by anticipation. Unlike traditional forms of legal coercion, regulatory chill operates through what Tienhaara calls "anticipatory obedience," where state actors proactively censor themselves to align with what they think arbitrators might accept. This form of governance—neither fully juridical nor fully political—reshapes the very terrain of public authority.

Some scholars contend that states can and do resist chilling pressures. They point to examples where ambitious regulations were enacted despite legal threats, such as plain packaging laws or climate transition policies in the EU. These counterexamples highlight the importance of institutional capacity, legal literacy, and political will in mitigating chill. However, the existence of resistance does not disprove

chill; it merely illustrates that chill is contingent, not absolute. The presence of outliers strengthens rather than weakens the argument that ISDS provisions create disincentives to regulate.

The mechanisms of chill must also be situated within broader patterns of legal fragmentation and transnational regulatory governance. Investment treaties increasingly intersect with other areas of international law, including human rights, trade, and climate regimes. This intersectionality complicates the legal landscape for policymakers and amplifies the risks of unintended liability. For example, a regulation passed in accordance with a state's obligations under the Paris Agreement may still trigger arbitration under a BIT. Without clear hierarchies between legal regimes, states must navigate a legal minefield where public interest objectives do not necessarily shield them from investor claims.

Regulatory chill functions as a systemic constraint that is legally plausible, politically consequential, and empirically traceable. The mechanisms are varied but consistent: legal risk aversion, responsive rollback, asymmetric exposure, and governance through anticipation. Scholars have demonstrated that ISDS, far from being a neutral dispute resolution mechanism, alters the incentive structures and institutional cultures of policymaking. The evidence is cumulative, cross-jurisdictional, and increasingly difficult to ignore.

3. Health, Safety, and Environment

Case-based evidence provides the most vivid demonstration of how investment treaties and ISDS mechanisms can inhibit, distort, or reverse the development of health, safety, and environmental (HSE) regulation. Regulatory chill, as it unfolds in these contexts, is not confined to abstract legal theory or indirect institutional inference. It is visible in policy paralysis, in the wording of regulatory rollbacks, in the minutes of interdepartmental meetings, and in the apprehensive posture adopted by state actors when confronted with multinational corporations invoking treaty rights. This section explores how ISDS-driven deterrence functions in both developed and developing legal systems by analyzing a series of emblematic cases and scholarly findings.

Céline Côté's (2014) empirical work on Canada remains one of the most detailed accounts of regulatory chill in the HSE field. In her dissertation *A Chilling Effect?*, she documents how Canadian policymakers responded to ISDS exposure under NAFTA. Through interviews with public servants and access to internal policy communications, Côté identifies a persistent legal consciousness among regulators who, even in the absence of actual disputes, treated ISDS risks as central to policy feasibility. This translated into hesitancy across multiple HSE domains including pesticide restrictions, tobacco control, and toxic substance bans. Regulations were often either significantly weakened during interdepartmental vetting or delayed until legal consultations confirmed they posed no "excessive" risk of investor challenge. In some cases, more protective regulations were explicitly rejected in favor of compromise versions that balanced "investment compatibility" with public health priorities. Her findings show that ISDS does not merely alter policy outcomes but restructures internal policy processes in ways that favor legal defensiveness over regulatory ambition (Côté, 2014).

The Lone Pine v. Canada case, initiated in 2013, illustrates the deterrent power of even pending arbitration. The claim arose when Lone Pine Resources, a U.S.-incorporated company, launched an ISDS suit under NAFTA seeking $250 million in damages. The suit challenged Quebec's moratorium on hydraulic fracturing beneath the St. Lawrence River, a ban grounded in environmental precaution rather than demonstrated harm. Although the arbitration had not been resolved for several years, its chilling effects emerged almost immediately. Policymakers in other Canadian provinces began re-evaluating their plans to introduce similar fracking restrictions. According to environmental law scholars, including Kyla Tienhaara, the case created a policy environment where environmental conservation was subjected to foreign investment vetting before domestic public interest (Tienhaara, 2018).

In Europe, the Vattenfall v. Germany disputes remain among the most cited examples of ISDS-induced regulatory chill in environmental governance. The first Vattenfall case, launched in 2009 under the Energy Charter Treaty, contested water quality standards imposed by the Hamburg government on a proposed coal-fired power plant. The company claimed the measures were disproportionate and violated protections under international law. The dispute was eventually settled, but only after German authorities agreed to lower environmental standards for the project. This direct modification of environmental rules to avoid arbitration laid the groundwork for a more general hesitancy in future regulation of industrial projects. In the second case (2012), Vattenfall challenged Germany's decision to accelerate its nuclear phase-out following the Fukushima disaster. The Swedish energy giant sought €4.7 billion in damages for lost profits. The case, again brought under the Energy Charter Treaty, demonstrated that even democratically justified and broadly supported environmental decisions were vulnerable to private challenge. Policy analysts have since identified a perceptible slowdown in Germany's energy transition deliberations where legal risk assessment increasingly features alongside political and technical feasibility.

In the Philip Morris v. Uruguay arbitration, the ISDS regime collided head-on with national health policy. Philip Morris brought its claim under the Switzerland-Uruguay Bilateral Investment Treaty, challenging Uruguay's tobacco control regulations, particularly its mandate for graphic health warnings and its "single presentation" rule that restricted tobacco branding. The company argued that these measures constituted indirect expropriation and violated its intellectual property rights. Uruguay, a middle-income country with limited litigation capacity, found itself defending its right to regulate tobacco under intense international scrutiny. Although the state ultimately won the arbitration at the International Centre for Settlement of Investment Disputes (ICSID), the case consumed significant financial resources and years of diplomatic and legal effort. Tienhaara points out that the victory, while important symbolically, may still produce a chilling effect elsewhere. Countries with similar aspirations in tobacco control might be deterred from adopting strong measures, not because they anticipate losing an arbitration but because the cost and complexity of the process appear prohibitive (Tienhaara, 2018).

The issue of fiscal asymmetry becomes especially stark in the Global South. Research by Federica Menghini (2023) examines how countries such as Ecuador and Argentina have responded to environmental disputes under international investment agreements. In Ecuador, for example, bans on mining and oil exploration in ecologically sensitive regions were reversed or renegotiated in direct response to legal threats from multinational investors. In some cases, the government invoked investor-state obligations in communications to justify policy shifts to domestic audiences. In Argentina, legal concerns over potential ISDS liability have influenced not only extractive industry regulation but also broader land use and conservation planning. These shifts occurred despite widespread public support for environmental protection, illustrating how ISDS mechanisms can act as a brake on democratic will when investment treaties tip the balance of legal risk toward foreign investors (Menghini, 2023).

Regulatory chill in the HSE sector has several distinguishing features. It often targets precisely those regulations grounded in the precautionary principle. Governments may wish to act before definitive scientific consensus emerges, particularly in areas such as chemical exposure, air pollution, or novel environmental threats. Investment treaties, however, impose evidentiary thresholds and legal standards—such as "necessity" or "proportionality"—that work against such anticipatory governance. The result is a stifling of regulatory creativity in the face of emerging risks. Legal departments within environmental ministries may pre-emptively advise against proposed bans, citing prior cases as negative precedent.

One of the less discussed dimensions of regulatory chill is how it reshapes inter-ministerial dynamics. Health and environment agencies often find

themselves subordinated to trade or foreign affairs ministries that are more attuned to the economic implications of ISDS exposure. In some states, investment promotion agencies gain de facto veto power over public interest proposals. Internal risk assessment becomes a legalistic rather than scientific process, privileging commercial predictability over long-term public benefit.

Chill also discourages legal experimentation and normative innovation. Jurisdictions with progressive aspirations may decide to delay or abandon pathbreaking regulation out of concern that it could trigger arbitration and become a global test case. This is especially relevant in transboundary regulatory areas such as climate change mitigation, deforestation, and biodiversity conservation, where bold initiatives are often needed but legally risky.

The ISDS system, as currently structured, grants foreign investors preferential access to international legal remedies not available to domestic actors. This creates a two-tiered regulatory regime where multinational corporations can discipline state behavior in ways that local communities or environmental NGOs cannot. This legal privilege, coupled with aggressive ISDS litigation strategies, consolidates a system of indirect veto power over state regulation.

Case studies from Canada, Germany, Uruguay, and Ecuador illustrate that ISDS does not require tribunal rulings to generate real regulatory consequences. The mere presence of ISDS mechanisms within investment treaties can condition the policymaking environment, foster bureaucratic caution, and disincentivize the pursuit of innovative public health and environmental strategies. When viewed in aggregate, these dynamics reveal a coherent pattern. Health, safety, and environmental regulation, especially when it involves limiting or transforming market access for powerful investors, becomes constrained by the legal infrastructure of international investment protection. The regulatory space available to states is narrowed not by explicit prohibition, but by procedural risk, fiscal threat, and anticipatory compliance.

4. Global Patterns and Evidence of Regulatory Chill

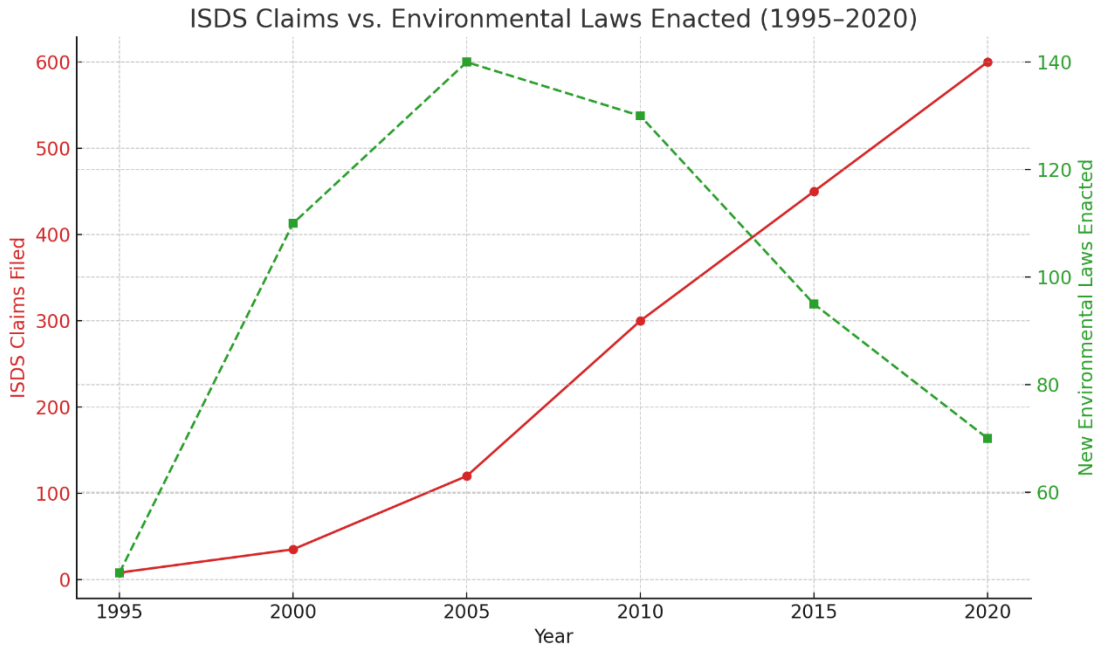

Figure 1. ISDS Claims Vs. Environmental Laws Enacted (1995 – 2020)

Figure 1 illustrates a striking inverse correlation between the frequency of ISDS claims and the global enactment rate of new environmental laws from 1995 to 2020. In 1995, the annual count of new ISDS cases

was negligible, while global environmental legislation expanded steadily. Around 2005, this trend began to diverge. The cumulative number of ISDS filings accelerated sharply, exceeding 600 by 2020, while the enactment of environmental legislation declined in both absolute and relative terms. While causation cannot be established solely through visual trend alignment, this pattern aligns with a growing body of empirical research that links increased exposure to investment arbitration with diminished regulatory ambition.

Tienhaara (2018) argues that ISDS serves as an externalized veto point that restructures how governments prioritize environmental and public interest regulation. This form of governance does not rely on explicit arbitration outcomes. It functions through anticipatory compliance and policy pre-selection, as legal departments routinely screen new proposals for ISDS vulnerability. The observable decline in environmental legislation after 2005 coincides with several highly publicized disputes that brought investor-state litigation to the forefront of both domestic politics and international policy discourse. These include *Metalclad v. Mexico*, *Vattenfall v. Germany*, and *Philip Morris v. Uruguay*. Each case, while context-specific, introduced a broader climate of risk aversion, particularly in middle- and lower-income countries seeking to avoid reputational damage or financial liability.

Berge and Berger (2019) confirm this trend using a cross-national dataset that controls for GDP, political regime type, and treaty ratification density. Their analysis found that higher exposure to investment treaties with ISDS clauses is statistically associated with weaker environmental policy trajectories. This effect is amplified in countries with lower legal capacity or institutional robustness. The empirical significance of these findings lies in their generalizability. Rather than attributing chill to isolated incidents, their work shows it to be a systemic phenomenon embedded in the global investment governance regime (Berge & Berger, 2019).

Table 1. Notable ISDS Cases Involving Environmental or Social Regulation

Case Name	Country	Policy Targeted	Outcome	Treaty Invoked
Metalclad v. Mexico	Mexico	Environmental permit	$15.6M award	NAFTA
Vattenfall v. Germany I	Germany	Water pollution controls	€1.4B compensation drop	Energy Charter Treaty
Philip Morris v. Uruguay	Uruguay	Tobacco control laws	Uruguay won	Switzerland-Uruguay BIT
Lone Pine v. Canada	Canada	Hydraulic fracturing ban	Pending	NAFTA

Sources: ICSID database; Tienhaara (2018).

Table 1 complements the global pattern by providing specific examples of disputes that resulted in either policy retraction, legislative weakening, or transnational deterrence effects. For instance, *Metalclad v. Mexico* established an early precedent under NAFTA where municipal denial of a hazardous waste permit was deemed an indirect expropriation. The outcome—an award of over $15 million—signaled that even subnational regulatory actions could be scrutinized under international law, creating pressure on decentralized policymaking structures.

In *Vattenfall v. Germany I*, the company challenged environmental restrictions on a coal-fired power plant. The case was settled, but only after Hamburg agreed to relax water quality standards. Van Harten and Scott (2019) argue this case demonstrates the regulatory recalibration that occurs when ISDS

functions as a tool of legal leverage rather than final adjudication. The second Vattenfall dispute, involving Germany's nuclear phase-out, reinforced this point by showing how large compensation claims (€4.7 billion) could deter future legislative ambition in the energy sector (Van Harten & Scott, 2019).

The *Philip Morris v. Uruguay* case, while resulting in a legal victory for the state, illustrates the paradox of success in the ISDS arena. Uruguay's defense of its tobacco packaging laws required significant international legal support, including assistance from WHO and external pro bono counsel. Tienhaara emphasizes that the protracted nature of the arbitration created indirect chilling effects, as other states with similar tobacco control goals expressed hesitation due to the financial burden of a possible challenge (Tienhaara, 2018).

Lone Pine v. Canada, arising from a fracking ban in Quebec, never reached a final decision. Yet legal scholars like Côté (2014) and Tienhaara (2018) note that the case contributed to a broader reluctance among Canadian provinces to pursue aggressive environmental reforms related to fossil fuel extraction. The pending status of the case prolonged legal uncertainty and became a reference point in internal governmental discussions across Canada, further embedding caution into regulatory deliberations.

Menghini (2023) identifies a similar pattern in Ecuador and Argentina. In both countries, proposed bans on oil exploration or mining in ecologically sensitive zones were abandoned following formal investor claims or informal warnings. In Argentina, fear of renewed arbitration following the country's economic crisis led to deregulation in sectors previously subject to environmental restrictions. These decisions were not always acknowledged publicly as being driven by ISDS threats, but internal documents and legislative patterns point toward a clear policy trajectory defined by legal avoidance (Menghini, 2023).

The cumulative evidence from Figure 1 and Table 1 reveals that ISDS mechanisms exert a dual influence. At the macro level, they correlate with a decline in environmental regulatory activity. At the micro level, they influence the content and timing of specific policies through both preemptive and reactive chilling. This effect does not depend on whether a state wins or loses a case. The litigation process itself—costly, uncertain, and reputationally risky—is sufficient to produce restraint.

The chilling effect operates through at least three modalities: anticipatory legal screening of proposed laws, administrative withdrawal of politically sensitive policies, and delayed legislative processes resulting from legal consultations. Van Harten (2020) argues that the ISDS system grants foreign investors a form of "asymmetric adjudicative access" that amplifies their influence in regulatory matters beyond what is institutionally available to domestic stakeholders (Van Harten, 2020).

Schill and other legal theorists highlight how the fragmentation of international law exacerbates this effect. When investment treaties intersect with climate obligations or human rights law, regulatory decisions face multiple, often contradictory, legal demands. Governments must therefore navigate a fragmented normative landscape where ISDS mechanisms often dominate due to their binding enforceability and financial consequences (Schill, 2023).

The temporal and geopolitical dimensions of regulatory chill also deserve attention. The post-2010 surge in ISDS filings coincides with a global push for climate action under the Paris Agreement. Many of the policies required to meet climate targets—carbon pricing, fossil fuel phase-outs, green industrial standards—conflict with existing investor expectations protected by investment treaties signed decades earlier. As such, ISDS risks are not merely incidental to environmental lawmaking; they are central to the strategic calculus that determines whether such laws are initiated at all.

The chilling impact is especially profound in developing countries, where the financial and institutional resources required to manage arbitration are less available. Berge and Berger (2020) note that countries with low administrative capacity are more likely to experience procedural and substantive chill

due to their inability to absorb arbitration risk or mount effective legal defenses (Berge & Berger, 2020).

In conclusion, the convergence of global ISDS escalation and the contraction of environmental legislative activity—as captured by Figure 1—and the detailed consequences of investor disputes outlined in Table 1—together depict a world where investment law constrains regulatory sovereignty. These mechanisms are not uniform or universal, but they are widespread, structurally embedded, and increasingly visible across jurisdictions and sectors.

5. Conclusion

At the intersection of global capital flows and sovereign governance, international investment treaties represent a profound experiment in legal globalization. Framed as tools to attract foreign direct investment and reduce political risk, these treaties have evolved into a transnational legal infrastructure with coercive implications for state regulation. The core dilemma exposed throughout this paper is not whether investment protection is desirable but how the legal architecture intended to secure it has functioned to reshape—and often restrain—state authority over matters of public interest. The phenomenon of regulatory chill is not an unintended side-effect of treaty design; it is an embedded consequence of privileging private investor rights in a regime lacking counterbalancing obligations or accountability mechanisms.

Regulatory chill manifests when the possibility of ISDS litigation distorts policy agendas, delays legislative initiatives, or prompts governments to abandon or weaken proposed regulations. This anticipatory behavior does not require the filing of a formal claim. Legal risk assessment becomes internalized within bureaucratic cultures, often preempting democratic deliberation and subordinating public values to the calculus of arbitration vulnerability. Even in states with substantial legal capacity, the threat of costly awards, reputational damage, or political controversy imposes a chilling effect that reverberates through ministries, parliaments, and regulatory agencies. Where laws are passed, they may be stripped of their transformative potential. Where reform is needed, it is postponed or indefinitely deferred.

The environmental, health, and social sectors are particularly vulnerable to these pressures. Regulatory chill in these domains arises precisely because they intersect with contested political terrain and frequently impose costs on transnational capital. Climate change mitigation policies, fossil fuel phase-outs, tobacco control, water quality standards, deforestation restrictions, and hazardous waste bans—all lie at the frontline of 21st-century public interest governance and are inherently disruptive to established investment expectations. These disruptions are often framed as indirect expropriation or violations of "fair and equitable treatment" in investor-state arbitration proceedings. The doctrinal ambiguity of these terms, paired with their expansive interpretation by arbitral tribunals, has given rise to a system where policy discretion is legally constrained in favor of investor certainty.

The burden of regulatory chill falls disproportionately on states least able to absorb its consequences. Developing countries, already constrained by debt obligations, political volatility, and economic dependence, face a unique vulnerability to ISDS mechanisms. The mere prospect of litigation can divert limited fiscal resources, deter needed reforms, and embolden domestic elites aligned with investor interests. These countries operate within a double asymmetry: they are structurally dependent on foreign capital and simultaneously constrained in how they can govern it. The result is a regime of passive compliance, where sovereignty is maintained in name but hollowed in practice. Efforts to address climate injustice, biodiversity loss, and social inequality are tempered not only by material constraints but by juridical anxiety.

Even in advanced economies, the shadow of ISDS can mute environmental ambition. The political costs of arbitration—media scrutiny, political opposition, and investor lobbying—combine with fiscal exposure to inhibit progressive legislation. Cases such as *Vattenfall v. Germany* and *Lone Pine v. Canada* demonstrate that

regulatory chill transcends North-South divisions. While legal resilience may buffer richer states, it does not neutralize the chilling effect. Instead, it produces subtler forms of deterrence: diluted policy goals, increased procedural hurdles, and risk-averse legal vetting that sanitize legislative innovation. Regulatory reform is thus not aborted outright but neutered through legal moderation.

This dynamic raises foundational questions about democratic legitimacy and institutional accountability. Public interest laws—often grounded in electoral mandates, constitutional principles, or international environmental commitments—are subordinated to a private adjudicatory system designed with minimal transparency, limited appellate review, and no public participation. Arbitration panels are composed of elite commercial lawyers, frequently cycling between roles as advocates and adjudicators, with no institutional obligation to consider broader societal interests. The legitimacy of these mechanisms is thus structurally undermined by their insulation from democratic oversight and their reproduction of asymmetrical power relations between capital and community.

In response, a global discourse of treaty reform has begun to emerge. Civil society groups, legal scholars, environmental advocates, and some states have proposed an array of responses to mitigate or reverse regulatory chill. One of the most widely endorsed proposals is the inclusion of robust carve-outs for public interest regulation, specifically for environmental, health, and social policies. These carve-outs aim to protect legitimate regulation from being challenged under ISDS or to limit the scope of tribunal jurisdiction in these areas. Some treaties have already incorporated such provisions, including the Comprehensive Economic and Trade Agreement (CETA) and elements of the Regional Comprehensive Economic Partnership (RCEP), though the effectiveness of these clauses remains debatable without binding enforcement mechanisms.

Another reform avenue is procedural transformation. Proposals to replace investor-state arbitration with a multilateral investment court, to introduce appellate mechanisms, or to require transparency and third-party participation in hearings are gaining traction in international legal forums. These reforms seek to re-legitimize dispute resolution by aligning it with public law values. However, procedural adjustments alone may not fully address the structural imbalance at the heart of the system. Without altering substantive standards such as "legitimate expectations" or "minimum standard of treatment," arbitration will continue to serve as a barrier to ambitious regulatory action.

More radical reform proposals involve the wholesale exclusion of ISDS from investment treaties. Countries like South Africa, India, and Indonesia have either withdrawn from or renegotiated several of their treaties to eliminate ISDS mechanisms. These states have articulated a vision of investment governance grounded in domestic courts, balanced obligations, and developmental priorities. This approach reflects a broader attempt to reclaim regulatory autonomy and to insulate public policy from private adjudication. It also challenges the normative assumption that investor protection must be prioritized over all other state functions.

Treaty renegotiation is, however, politically complex. Power asymmetries in trade negotiations, investor lobbying, and fears of reputational loss all inhibit states from unilaterally withdrawing from ISDS regimes. Legal path dependencies also entrench the existing system, as many treaties contain survival clauses that prolong protections even after termination. Multilateral solutions remain slow and contested, with divergent views on the appropriate balance between investor rights and state obligations.

Yet reform, while difficult, is both necessary and possible. The climate crisis, biodiversity collapse, rising inequality, and pandemic threats all demand robust and adaptive public policy. Regulatory chill cannot be tolerated as a permanent feature of economic governance. States must be able to legislate in the public interest without the looming specter of arbitration. This is not merely a legal imperative but a normative one. The future of global investment law

must be grounded in democratic accountability, ecological sustainability, and social justice.

Rebalancing the global investment regime requires not only institutional innovation but conceptual clarity. The very idea of investment must be redefined—not merely as the protection of capital flows, but as the mutual advancement of public and private interests. Investments that undermine environmental integrity, public health, or human rights cannot be treated as neutral economic assets. They must be subject to regulation, accountability, and withdrawal where necessary. States, acting collectively and through domestic renewal, must reaffirm their role as custodians of the public good.

In this light, regulatory chill is not only a legal challenge but a symptom of a deeper epistemological and political crisis. It reveals the limits of a governance model that treats markets as external to, rather than embedded within, democratic institutions. It underscores the need for a new paradigm where law serves society, not the reverse. This transformation will not occur through technical reform alone. It requires a shift in the moral economy of global law, where justice, equality, and sustainability replace certainty, profitability, and efficiency as guiding principles.

The movement for treaty reform, though uneven, is gaining momentum. Networks of scholars, activists, and policymakers are building alternative legal imaginaries that reject the subordination of public policy to private arbitration. These efforts must be expanded, supported, and institutionalized through coordinated diplomatic, legal, and civil society action. Only then can the chilling effect of ISDS be reversed, and the full regulatory capacity of the state be restored.

As we confront ecological tipping points, public health crises, and cascading inequalities, the capacity of states to act boldly in the public interest is not a marginal concern—it is the precondition for human survival. Investment law must be restructured to reflect this urgency. Regulatory chill must end not because it offends legal sensibility, but because it endangers the future of collective life on the planet. A legal system that freezes progress in the name of investor protection is one that has lost its purpose. The time has come to unfreeze the future.

References

Berge, T. L., & Berger, A. (2019). Does investor-state dispute settlement lead to regulatory chill? Global evidence from environmental regulation. Retrieved from https://www.peio.me/wp-content/uploads/2019/01/PEIO12_Paper_78.pdf

Berge, T. L., & Berger, A. (January 20, 2020). Do Investor-State Dispute Settlement Cases Influence Domestic Environmental Regulation? The Role of Respondent State Capacity. Available at SSRN: https://ssrn.com/abstract=3522366 or http://dx.doi.org/10.2139/ssrn.3522366

Côté, C. (2014). A chilling effect? The impact of international investment agreements on national regulatory autonomy in the areas of health, safety and the environment [Doctoral dissertation, London School of Economics and Political Science]. http://etheses.lse.ac.uk/897/

Hagemann, T. A. (2023). *The North-South Divide of Regulatory Chill: A Comparative Analysis of the Impact of Investor-State Dispute Settlement on Policy Makers in Developed and Developing Countries*. [S.l.]: SSRN.

Menghini, Flavio. (2023). An analysis of the regulatory chill hypothesis: environmental protection in international investment law, [Dissertation thesis], Alma Mater Studiorum Università di Bologna. Dottorato di ricerca in Scienze giuridiche, 36 Ciclo. DOI 10.48676/unibo/amsdottorato/10448.

Schill, S. W. (2023). The multilateralization of international investment law: Conceptual foundations and reform implications. Tilburg University Legal Studies Research Paper No. 12/2023. https://arno.uvt.nl/show.cgi?fid=161552

Schram, A., Friel, S., Anthony VanDuzer, J., Ruckert, A. and Labonté, R. (2018), Internalisation of International Investment Agreements in Public Policymaking: Developing a Conceptual Framework of Regulatory Chill. *Glob Policy*, *9*, 193-202. https://doi.org/10.1111/1758-5899.12545

Tienhaara, K. (2018). Regulatory Chill in a Warming World: The Threat to Climate Policy Posed by Investor-State Dispute Settlement. *Transnational Environmental Law*, *7*(2), 229–250. doi:10.1017/S2047102517000309

Van Harten, G. (2020). *The trouble with foreign investor protection*. Oxford University Press.

Van Harten, G., Kelsey, J., & Schneiderman, D. (2019). Phase 2 of the UNCITRAL ISDS Review: Why 'Other Matters' Really Matter". *All Papers*, 328. https://digitalcommons.osgoode.yorku.ca/all_papers/328

Legal Foundations and Property Rights in China's Carbon Emissions Trading System

Ruiqi Zhang[1]*

[1] Yunnan Normal University, Kunming 650092, China
* Correspondence: zhangruiqi01@sina.com

https://doi.org/10.53104/curr.res.law.pract.2025.07002

Abstract: China's Carbon Emissions Trading System (ETS) represents a significant step in integrating market-based mechanisms into the country's climate governance framework. Launched nationally in 2021 after a decade of regional experimentation, the ETS is designed to help achieve China's dual carbon goals—peaking emissions before 2030 and reaching carbon neutrality by 2060. However, the system's long-term effectiveness is heavily contingent upon the clarity and maturity of its legal foundations, particularly the definition and protection of property rights related to carbon allowances. This paper explores the legal evolution of China's ETS, focusing on how administrative measures, environmental laws, and regulatory oversight collectively form its current operational base. It critically examines the legal status of emission allowances, the limits of administrative enforcement, and the implications for market liquidity, financial integration, and investor confidence. Ongoing challenges—such as the lack of a unified carbon trading law, underdeveloped dispute resolution mechanisms, and the ambiguous classification of allowances—are analyzed as part of a dynamic and transitional legal ecosystem. Drawing from both domestic policy discourse and international legal models, the paper offers targeted recommendations for future legal reform aimed at enhancing transparency, legal certainty, and systemic resilience. It concludes that while China's ETS is still in its formative stage, it is on a positive legal trajectory that could shape the development of carbon markets in other emerging economies.

Keywords: ETS; carbon allowances; property rights; legal reform

Received: 24 June 2025

Revised: 7 August 2025

Accepted: 8 August 2025

Published: 11 August 2025

Citation: Zhang, R. (2025). Legal Foundations and Property Rights in China's Carbon Emissions Trading System. *Current Research in Law & Practice, 3*(1), 15-31.

1. Introduction

China's official announcement in September 2020 of its "dual carbon" goals—to reach peak carbon emissions before 2030 and to achieve carbon neutrality by 2060—has significantly reshaped the trajectory of its national environmental and climate policy. This statement, made by President Xi Jinping at the 75th United Nations General Assembly, was not merely symbolic; it marked an inflection point in China's strategic outlook on energy, industrial transformation, and environmental regulation. It placed China at the center of global climate diplomacy, as well as domestic expectations for structural reform in emissions

governance. This commitment requires not only decarbonization of existing economic systems but also a deep institutional shift in how environmental obligations are defined, allocated, and enforced within a rule-based framework.

As the world's largest emitter of greenhouse gases, with emissions exceeding 10 billion metric tons of CO_2 annually, China faces a unique governance dilemma. On one hand, its economy remains structurally dependent on coal and carbon-intensive manufacturing. On the other, China now assumes a leadership role in the international climate regime, particularly after the withdrawal and re-entry of the United States into the Paris Agreement and growing demands for emerging economies to adopt binding mitigation strategies. Balancing national development priorities with international climate expectations has catalyzed the search for scalable, flexible, and economically efficient regulatory mechanisms. In this context, the creation of a national Carbon Emissions Trading System (ETS) has emerged as a central pillar in China's evolving approach to climate governance.

The ETS offers a market-based framework through which emission rights can be priced, allocated, and traded. It shifts the control of carbon emissions from purely administrative command-and-control mechanisms to an incentive-based structure that enables regulated entities to find the most cost-effective path to compliance. By placing an economic value on carbon emissions, the ETS internalizes environmental externalities into corporate decision-making, which ideally leads to innovation in energy efficiency, renewable integration, and process optimization. In practice, the ETS operates as a cap-and-trade system where enterprises receive or purchase a limited number of carbon allowances that they can use or trade based on actual emissions performance.

China's ETS was formally launched at the national level in July 2021, after more than seven years of pilot experimentation across key cities and provinces. These pilot programs, including those in Shenzhen, Beijing, Shanghai, and Guangdong, were authorized by the National Development and Reform Commission (NDRC) and served as regulatory laboratories. Each pilot featured a different allocation method, coverage scope, and legal framework, reflecting local policy preferences and administrative capacities. The experiences of these pilots informed the design of the national system, highlighting best practices and exposing institutional weaknesses, particularly in areas such as monitoring, reporting, and verification (MRV), market liquidity, and enforcement procedures.

The national ETS currently covers the power generation sector, which contributes more than 40 percent of China's annual carbon dioxide emissions. This sectoral focus was chosen for its centralized structure, data availability, and relative ease of emissions measurement. Over time, the system is expected to expand to include other emission-intensive sectors such as cement, steel, petrochemicals, and non-ferrous metals. This progressive expansion reflects the phased logic of policy scaling in China, where initial implementation is deliberately narrow to minimize risk and allow for institutional adaptation.

Unlike its counterparts in the European Union or California, China's ETS is not founded on a comprehensive legislative statute. Instead, it is governed by administrative regulations, primarily the Interim Measures for the Administration of Carbon Emissions Trading, issued by the Ministry of Ecology and Environment (MEE) in January 2021. These Measures establish procedural rules on allowance allocation, registration, trading platforms, MRV protocols, and non-compliance penalties. While they constitute an important step toward national coordination, they do not possess the legal status of national law enacted by the Standing Committee of the National People's Congress. This administrative basis creates uncertainty about the legal durability of the system, the enforceability of market rules, and the protection of participant rights.

At the heart of these institutional challenges lie complex legal questions about the status and nature of carbon allowances. In jurisdictions such as the EU and California, carbon allowances are recognized as

tradable property interests or financial instruments that can be held, traded, and used in structured financial products. These classifications grant legal certainty to market participants and enable integration with broader capital markets. In China, by contrast, allowances are generally treated as **administrative licenses**, issued at the discretion of the state and subject to unilateral modification or revocation. This classification reflects the administrative logic of Chinese regulatory governance, in which the state remains the ultimate authority over the use of public resources, including the right to emit pollutants.

The classification of carbon allowances as administrative permissions rather than property rights has significant legal and economic implications. It limits the scope of ownership claims that entities can assert over their allowances, restricts the use of allowances as collateral or investment assets, and creates legal ambiguity in the event of market disputes. Enterprises face difficulties in asserting rights to consistent treatment under the system, particularly when allocation methods change or when administrative errors occur in emissions verification. The lack of clear legal protection may deter investment in abatement technology and reduce long-term market engagement.

China's legal system does not currently provide a singular statutory definition of carbon allowances, nor does it incorporate them into its Civil Code as property-like assets. Although some legal scholars have proposed recognizing emission rights as **usufruct rights** under civil law—a model that allows the use and benefit of a resource without transferring ownership—this proposal remains theoretical. Without legislative clarification, carbon allowances occupy a legal grey zone, shaped more by policy discretion than by enforceable legal principles. This has profound implications for market confidence and stability, particularly as China moves to scale the ETS across sectors and link it with financial instruments such as futures, options, and green asset-backed securities.

The absence of a comprehensive Carbon Emissions Trading Law further complicates the situation. While there have been repeated mentions in legislative planning documents and political speeches of a future carbon market statute, no such law has yet been introduced for public consultation or parliamentary review. This delay reflects both the technical complexity of carbon trading and the institutional difficulty of coordinating across ministries, particularly between the MEE, the Ministry of Finance, and the National Development and Reform Commission. The lack of a legislative foundation weakens regulatory predictability and reduces the scope for judicial interpretation or legal remedy in the event of disputes.

Legal enforceability is also limited by the absence of specialized judicial or quasi-judicial institutions to handle carbon market cases. Most disputes over allocation errors, non-compliance penalties, or fraudulent MRV practices must be resolved within administrative channels or under general administrative law, which lacks carbon-specific provisions. This legal vacuum may inhibit regulated entities from pursuing formal remedies and reduce accountability for regulatory oversight.

Despite these limitations, the creation and expansion of the ETS in China represent a significant institutional innovation. It reflects a transition from rule-by-policy to rule-based governance, albeit one that remains administratively anchored. The introduction of market mechanisms into environmental regulation marks a departure from earlier reliance on direct command-and-control tools such as emissions quotas, sectoral targets, and pollution levies. The ETS requires a more sophisticated legal infrastructure, one that supports property rights, contractual freedom, and procedural fairness, while also allowing for administrative flexibility in a rapidly evolving policy context.

This paper explores the legal foundations of China's ETS by examining the statutory, regulatory, and administrative structures that currently govern carbon trading. It pays particular attention to the property rights implications of carbon allowances, analyzing

whether and to what extent these allowances can be understood as tradable legal interests under Chinese law. The analysis draws on doctrinal legal interpretation, comparative institutional analysis, and the evolving literature on carbon market regulation. The paper argues that while China's ETS has made considerable technical and operational progress, its legal architecture remains provisional and fragmented, thereby limiting its ability to deliver long-term environmental and economic outcomes.

The central contention of the paper is that the development of a legally coherent carbon market in China requires more than improved regulatory design or market efficiency. It demands a fundamental rethinking of the legal status of emission rights, a recalibration of institutional authority between administrative agencies and courts, and the enactment of statutory protections that can anchor the market in a rule-based legal order. Without these reforms, the ETS risks remaining a technocratic mechanism whose performance is constrained by legal ambiguity, weak enforcement, and low stakeholder confidence.

China's incrementalist policy tradition allows for gradual adaptation, and the ETS is likely to evolve through continued experimentation, consultation, and policy refinement. This evolutionary process mirrors earlier phases of Chinese regulatory reform, including in environmental protection, energy pricing, and financial regulation. Over time, the ETS may acquire the legal features that define mature carbon markets in other jurisdictions. Until then, its performance will depend not only on the stringency of emissions caps or the sophistication of trading platforms, but on the strength of the legal foundations upon which the system rests.

2. Evolution of the Legal Framework

The development of China's legal framework for its national carbon emissions trading system (ETS) reflects a path-dependent process shaped by regulatory decentralization, institutional experimentation, and evolving central authority. The early phase of China's ETS development was not built upon statutory law but emerged from a series of local-level policy trials encouraged by national authorities. Between 2013 and 2016, seven regional pilot carbon trading programs were launched in major cities and provinces, including Beijing, Shanghai, Shenzhen, Chongqing, Tianjin, Guangdong, and Hubei. These pilots were designed to test different institutional configurations, allowing local governments to develop their own rules for allocation, verification, registry, and market operation within a controlled administrative sandbox. They operated under soft law frameworks, primarily administrative measures and municipal regulations, rather than legally binding national statutes.

Each pilot system reflected distinct regulatory philosophies and legal interpretations. Guangdong, for instance, employed a hybrid allocation system that combined free allocation with auctioning and relied on more transparent MRV protocols. Shenzhen developed a comparatively liberal trading platform with a greater degree of private-sector engagement, but its legal enforcement mechanisms remained weak and discretionary. Across the pilot regions, gaps emerged in data quality, allocation transparency, market oversight, and the legal enforceability of compliance penalties. As Dai and Pollitt (2024) observe, the coexistence of multiple local carbon markets without standardized legal infrastructure led to inconsistent enforcement and investor confusion regarding the scope and durability of rights conferred by emission allowances. These limitations underscored the difficulty of implementing market-based instruments without a unified legal foundation.

A pivotal shift occurred in 2018 when administrative oversight of climate policy was transferred from the National Development and Reform Commission (NDRC) to the Ministry of Ecology and Environment (MEE). This realignment marked not only a bureaucratic consolidation but also a redefinition of legal authority in emissions governance. Under the NDRC, carbon trading had been treated largely as an economic and industrial adjustment tool, often integrated into broader macroeconomic planning. Under the MEE, the ETS has become more deeply embedded in environmental law and administrative regulatory mechanisms. This transfer allowed for a more coordinated approach to environmental

regulation, but it also highlighted institutional tensions regarding regulatory priorities and the degree of legal formalism to be applied to emissions trading.

In January 2021, the MEE issued the Interim Measures for the Administration of Carbon Emissions Trading, which for the first time provided a nationwide administrative framework for ETS implementation. These Measures detailed procedures for allowance allocation, account registration, MRV requirements, compliance timelines, and penalties for noncompliance. Although these rules established procedural uniformity, they were issued as an internal ministerial document rather than through national legislative channels. As such, they lack the binding legal status and interpretative clarity typically associated with statutory law. Zhang (2015) notes that without a national law, the ETS relies heavily on administrative discretion, raising questions about the stability of rights granted through allocation and the predictability of enforcement decisions.

The reliance on administrative regulations reflects a broader pattern within Chinese governance, where policy precedes law and where ministries exercise broad discretion in implementing reform agendas. While the Interim Measures represent a meaningful step toward national harmonization, their legal force is limited to the domain of administrative enforcement. Courts in China have no statutory basis for adjudicating disputes related to carbon trading, and regulated entities have no guaranteed recourse to independent judicial review in the event of regulatory misapplication. This lack of judicialization reduces legal certainty and may hinder the development of complex carbon financial products, which require clear definitions of ownership, transferability, and contract enforceability.

China's ETS also operates within a fragmented legal landscape that includes several environmental and administrative statutes but no dedicated carbon trading law. Existing laws, such as the Environmental Protection Law (2014 revision) and the Air Pollution Prevention and Control Law (2015 revision), provide overarching principles regarding environmental accountability, emission monitoring, and governmental responsibility. However, they make no explicit provision for emissions trading or the legal nature of carbon allowances. Similarly, the Administrative Measures for the Reporting of Greenhouse Gas Emissions by Enterprises provide a basis for data collection but fall short of establishing legal rights or obligations in a market context. In practice, this means the ETS is governed by a patchwork of policy documents and departmental notices, none of which have been integrated into a single legislative text capable of guiding judicial interpretation or legislative scrutiny.

Efforts to draft a comprehensive Carbon Emissions Trading Law have been intermittently discussed since 2015, with renewed urgency following the national ETS launch. Legislative planning documents have included references to carbon market legislation, and multiple stakeholders, including the MEE, the People's Bank of China, and legal scholars, have called for codification of the system. Yet no official draft has been released to date, and legislative progress remains slow. Duan and Zhou (2017) attribute this delay to conflicting institutional interests, overlapping jurisdictional mandates, and uncertainty about how carbon allowances should be treated under property and financial law. These unresolved questions have direct implications for market liquidity, investor confidence, and the compatibility of the ETS with China's civil law framework.

A national carbon law would clarify the legal status of emission allowances, establish standardized allocation principles, define compliance liabilities, and delineate the jurisdiction of administrative and judicial bodies in enforcement. It would also create the legal basis for integrating the ETS with financial markets, allowing for the securitization of allowances and the development of derivatives. Lo (2016) emphasizes that without such legislation, China's carbon market will remain vulnerable to institutional inertia, policy reversals, and inconsistent enforcement. In the absence of legal guarantees, market participants may hesitate to make long-term investments or to treat carbon allowances as reliable financial assets.

Comparatively, China's ETS legal structure diverges significantly from other major jurisdictions. The European Union Emissions Trading System (EU ETS) is anchored in the EU ETS Directive, a legally binding framework that defines allowances as marketable instruments with full legal protection under EU law. Disputes are adjudicated by the European Court of Justice, and national courts must interpret domestic provisions in accordance with the Directive. California's Cap-and-Trade Program operates under the California Global Warming Solutions Act (AB 32), a state-level statute enacted in 2006, which explicitly authorizes carbon trading and mandates transparency, public participation, and judicial review. These legal regimes provide a sharp contrast to China's administratively constructed ETS, which is primarily governed through executive fiat and lacks meaningful legislative or judicial anchoring.

The contrast does not necessarily suggest that China's approach is flawed. It reflects a governance model that prioritizes incrementalism, policy experimentation, and administrative flexibility. In this model, legislation often follows successful implementation rather than preceding it. Yet as the national ETS grows in scale, begins to cover additional sectors, and engages more deeply with financial and international markets, the need for robust legal underpinnings becomes increasingly urgent. Regulatory adaptation alone will not be sufficient to support the system's maturation into a stable and credible market mechanism.

China's 14th Five-Year Plan (2021–2025) includes language affirming the government's commitment to strengthening climate governance, improving carbon accounting, and promoting market-based environmental tools. While these policy statements suggest future legislative activity, they offer little clarity about the timeline, content, or institutional form that such laws will take. In the interim, the ETS remains governed by a layered hierarchy of administrative guidance, none of which has full legal effect beyond the regulatory remit of the MEE.

In summary, the evolution of the legal framework for China's ETS has progressed from local experimentation to national administrative harmonization. Despite significant technical advances and growing institutional capacity, the absence of a dedicated carbon trading statute, the reliance on ministerial regulations, and the lack of judicial engagement leave the legal system fragmented and provisional. Addressing these limitations through legislative codification, judicial integration, and inter-ministerial coordination will be essential for ensuring that China's ETS can serve as an effective, credible, and durable tool for carbon mitigation.

3. Carbon Allowances and Property Rights

The legal characterization of carbon allowances sits at the heart of the functionality and legitimacy of China's national emissions trading system (ETS). Unlike many financial instruments or commodities in mature markets, carbon allowances in China are not currently classified as private property under statutory law. They are instead defined by administrative regulation as state-issued emission quotas, conferring upon the holder the conditional right to emit a specific volume of CO_2 within a prescribed compliance cycle. These allowances are non-perpetual, allocated without direct cost in most cases, and are subject to revocation or modification at the discretion of the Ministry of Ecology and Environment (MEE), which maintains regulatory authority over the national ETS.

This treatment follows the logic of state ownership over natural resources, including the atmosphere, which remains a collective good managed on behalf of the public interest. Scholars such as Jiang (2013) have argued that the Chinese approach reflects a regulatory tradition in which administrative licensing dominates over individualized property rights, particularly in environmental governance domains (Jiang, 2013). This orientation prioritizes state oversight, environmental risk control, and compliance assurance over the economic monetization of emissions allowances.

The Interim Measures for the Administration of Carbon Emissions Trading (2021), which currently guide the operation of the national ETS, do not define allowances as property. Instead, they refer to them as administrative indicators of compliance

responsibility, capable of transfer within regulated parameters. Although these allowances can be traded on designated exchanges such as the Shanghai Environment and Energy Exchange (SEEE), their legal structure excludes the rights typically associated with property: the rights to possess, use, dispose, and derive value autonomously. In effect, allowances function more as temporary compliance obligations than as durable financial assets, making them difficult to integrate into corporate finance practices or risk management frameworks.

There are significant economic implications to this administrative conceptualization. Regulated enterprises are unable to carry unused allowances into future compliance periods in many cases, limiting their ability to strategize long-term emissions reductions. Banking and borrowing of allowances remain subject to central regulatory control. Because allowances lack formal recognition as transferable assets in civil or commercial law, they cannot be used as collateral for loans, securitized into financial products, or easily valued on corporate balance sheets. This restricts the market's depth and liquidity. As Liu et al. (2015) note, the constrained legal identity of allowances suppresses financial innovation and limits participation from private capital, including banks and carbon investment funds (Liu et al., 2015).

Institutional investors, particularly foreign ones, tend to demand legal certainty regarding the assets they hold or transact. The lack of clarity over whether emission allowances can be legally owned or protected through civil litigation deters deeper market engagement. In the absence of well-defined property rights, firms remain hesitant to make abatement investments that depend on allowance value appreciation or monetization. This risk aversion undermines the market's intended incentive function and slows progress toward the national carbon peaking and neutrality goals.

In contrast, international systems offer more robust legal treatment of emission allowances. The European Union Emissions Trading System (EU ETS) treats allowances as fungible assets that can be held, transferred, and counted as financial positions. Although not defined as property per se under all national legal systems in the EU, these allowances benefit from statutory protections, standardized registry protocols, and court-enforceable transfer rules. Boute & Zhang (2019) underscore that legal recognition of emissions allowances as secure, transferable rights is crucial for market stability and price reliability (Boute & Zhang, 2019).

California's Cap-and-Trade Program similarly recognizes emission allowances as instruments that are fully transferable within the market and can serve as the underlying for derivative products, albeit within regulatory boundaries. In both cases, allowances are embedded in legal regimes that offer transparency, administrative consistency, and the potential for judicial resolution in the event of disputes. These characteristics help reinforce market credibility and provide certainty for investors and regulated parties alike.

Chinese legal scholars have proposed several frameworks to resolve the ambiguity surrounding the nature of carbon allowances. One influential proposal is to treat them as "usufruct rights" under China's civil law system. Usufruct rights, codified under the Civil Code, allow an entity to use and benefit from property owned by another—typically the state—while enjoying a degree of legal protection and economic autonomy. According to Liang et al (2018), classifying carbon allowances as usufructs would balance state ownership of atmospheric resources with market participants' need for certainty, transferability, and investment security (Liang et al, 2018).

Under this model, the state would remain the ultimate owner of emission rights as environmental commons, but enterprises would hold robust legal claims to use quotas under specified conditions, subject to judicial defense. This reframing could open the door to more sophisticated financial instruments linked to emissions performance, such as carbon forwards, swaps, insurance products, or carbon-linked green bonds. As Pei et al. (2013) argue, establishing carbon allowances as new categories of property rights could help rescue China's market from institutional

ambiguity and offer legal remedies for firms that operate across compliance cycles (Pei et al., 2013).

Legal codification of allowance rights would also support the development of secondary carbon markets. These are essential to efficient carbon pricing and dynamic allocation of abatement resources across firms and sectors. Without transferable, enforceable assets, the carbon market remains confined to its primary issuance function, unable to deliver on the full promise of cost-effective emissions reductions. Experience from the SO_2 trading program in the United States and the Kyoto Protocol's Clean Development Mechanism suggests that legal certainty around tradable instruments is a precondition for market liquidity and institutional trust.

Another issue tied to property rights is enforcement and dispute resolution. Since the current system lacks judicialized mechanisms for resolving ETS disputes, questions over allowance revocation, erroneous allocation, or transfer failure fall under the purview of administrative bodies. There is no legal channel for regulated entities to sue regulators for wrongful deprivation or denial of quota use. This absence of legal recourse further reduces confidence in the durability of carbon allowances as economic assets. As Duan, Pang, and Zhang (2014) highlight, a legal basis for allowance operations is fundamental to the implementation of any ETS (Duan et al., 2014).

Some proposals suggest that China adopt a two-tiered model. In this model, compliance allowances would remain under tight administrative control, but voluntary carbon units or surplus quotas could be granted more liberal property status, subject to market trading and financial regulation. This could allow a gradual expansion of legal protection without compromising state oversight of core regulatory instruments. It would also facilitate linkages between China's ETS and international carbon markets, which demand asset standardization and legal interoperability.

Defining carbon allowances as property rights is not merely a technical matter of legal drafting. It raises deeper questions about the relationship between the state and the market, and about the nature of environmental governance under conditions of climate emergency. The legal status of carbon allowances shapes not only who bears the cost of pollution but also who profits from its reduction. A system that confers durable, transferable rights may stimulate investment and innovation but may also introduce financialization risks if not adequately regulated. A system that denies property status may preserve state control but fail to generate meaningful market incentives. The path forward requires careful calibration between legal certainty, environmental integrity, and economic flexibility.

China's carbon market, still in a developmental phase, can benefit from international best practices while preserving its unique institutional context. Any move toward clearer legal recognition of carbon allowances must be accompanied by complementary reforms in registry governance, judicial review capacity, and financial supervision. A comprehensive Carbon Emissions Trading Law could serve as the vehicle for defining the nature, scope, and protections of emission rights, anchoring them in China's legal architecture in a way that supports both environmental and economic goals.

4. Market Operation and Legal Safeguards

The operational framework of China's national carbon market is anchored in the Shanghai Environment and Energy Exchange (SEEE), which acts as both the central trading venue and the national registry for carbon allowances. The SEEE manages account registration, records all transactions in the primary and secondary markets, and facilitates the surrender of allowances during the compliance cycle. It serves as the digital backbone of the national ETS, maintaining data integrity through a combination of secure database infrastructure, real-time transaction monitoring, and standardized reporting interfaces. All entities covered by the ETS are required to open accounts in the registry, where they must receive allocations, trade allowances, and submit compliance reports. The Ministry of Ecology and Environment (MEE) exercises supervisory authority over this system, issuing operational guidance, coordinating

provincial-level environmental departments, and enforcing compliance obligations.

At the core of the ETS's credibility is the Monitoring, Reporting, and Verification (MRV) mechanism. MRV protocols ensure that the emissions data underpinning allocation and compliance are accurate and verifiable. Under the Interim Measures for the Administration of Carbon Emissions Trading (2021), regulated entities must submit annual greenhouse gas emissions reports. These reports must be prepared in accordance with sector-specific technical guidelines issued by the MEE and verified by independent third-party verification agencies accredited by the ministry. The verification process involves cross-checking operational data, energy consumption records, and production output, with site visits in certain cases. Once verified, the data are entered into the national registry, forming the basis for calculating each entity's compliance obligation. Duan, Pang, and Zhang (2014) emphasize that MRV serves as both a technical and legal foundation for the credibility of trading, acting as a prerequisite for any meaningful market-based regulation (Duan et al., 2014).

While MRV is formally binding nationwide, its implementation quality is uneven across provinces. Some regions have well-developed verification industries with highly trained auditors, while others rely on a small pool of verification bodies with limited technical capacity. This variation can lead to discrepancies in emissions reporting and create opportunities for misreporting or strategic underestimation of emissions. The transparency of MRV data also varies; while the MEE has released aggregate compliance statistics, detailed facility-level data are often withheld, limiting external scrutiny. The absence of mandatory public disclosure of verified emissions data reduces the capacity of civil society and independent researchers to monitor market integrity, which is a safeguard present in systems such as the EU ETS.

The trading rules themselves are structured primarily through administrative norms. The Interim Measures grant the MEE authority to impose penalties for non-compliance, including monetary fines, rectification orders, and public naming of violators. These measures create a deterrent effect but do not provide a specialized judicial or quasi-judicial process for market-related disputes. If a company disputes the allocation of its allowances, challenges a verification outcome, or alleges trading irregularities, it must pursue remedies through the general administrative reconsideration process or bring claims under administrative or contract law. Neither route is tailored to the technical nature of carbon trading, and courts have yet to develop a body of case law specific to the ETS. This contrasts with the European Union, where disputes over allowance allocation or compliance penalties can be adjudicated under EU law and national administrative law, with the European Court of Justice serving as the final arbiter.

The absence of explicit legal recognition of carbon allowances as enforceable property rights exacerbates the problem. Without such recognition, participants face uncertainty over whether they can seek judicial protection against fraud, breach of contract, or expropriation of allowances. In the event of trading platform malfunctions, cybersecurity breaches, or price manipulation, the lack of a liability framework specific to the carbon market could leave buyers and sellers without recourse. Financial institutions considering participation as intermediaries, custodians, or insurers have raised concerns about their legal standing in transactions involving assets that lack statutory recognition. As Boute and Zhang (2019) argue, markets require both price stability and legal certainty in asset ownership to attract sustained investment (Boute & Zhang, 2019).

Market oversight in China is concentrated in the MEE, which holds a dual mandate as both market administrator and enforcement authority. This centralization offers advantages in policy coherence and administrative efficiency but raises questions about accountability and checks on regulatory discretion. The absence of independent oversight bodies or specialized carbon market tribunals limits the avenues for impartial review of enforcement actions. Some scholars, such as Liang (2018), have recommended the establishment of dedicated dispute resolution mechanisms for the ETS, possibly in the

form of specialized arbitration panels or environmental courts with carbon trading expertise (Liang, 2018).

International experience suggests that a degree of institutional separation can enhance market credibility. In the EU, for example, the European Securities and Markets Authority (ESMA) oversees certain aspects of carbon trading from a financial regulation perspective, complementing environmental regulators. California's system operates under the California Air Resources Board (CARB) but allows for judicial review of CARB decisions in state courts, with specialized administrative law judges hearing environmental compliance cases. Such separation helps reduce conflicts of interest and reinforces due process guarantees for market participants.

The legal safeguards in China's ETS are also being tested by the prospect of expanding into carbon financial derivatives. The development of futures, options, and swaps on carbon allowances would require integration with the Securities Law and oversight by the China Securities Regulatory Commission (CSRC). This would necessitate clear definitions of the legal status of allowances, as well as detailed provisions on market manipulation, insider trading, and investor protection. Without such safeguards, the introduction of derivatives could amplify systemic risks, particularly in the absence of robust transparency and risk management protocols.

Despite these structural challenges, China has taken steps toward institutionalizing transparency and compliance in the ETS. The centralization of registry functions, the standardization of MRV guidelines, and the digitization of trading records have improved the reliability of market operations. The MEE has also signaled interest in strengthening third-party verification and enhancing data disclosure, as reflected in policy discussions during the 14th Five-Year Plan period. The gradual introduction of auctions for allowance allocation could also bring more price discovery into the system, although this too would require legal adjustments to ensure fairness and competitive neutrality.

To transform the ETS from an administratively managed compliance tool into a mature market mechanism, legal safeguards must evolve alongside market operations. This means clarifying the rights and obligations of participants, introducing statutory recognition of allowances as enforceable assets, creating specialized dispute resolution pathways, and developing oversight structures that separate administrative functions from adjudicative ones. Such reforms would align China's ETS with international best practices while respecting its governance traditions, thereby enhancing investor confidence, market stability, and the system's overall capacity to deliver sustained emissions reductions.

5. Progress and Ongoing Challenges

Since its formal inauguration in July 2021, China's national emissions trading system (ETS) has advanced from a patchwork of regional experiments into the largest carbon market in the world in terms of emissions coverage. This transformation has involved a substantial consolidation of institutional functions under the Ministry of Ecology and Environment (MEE), replacing the fragmented governance of the earlier pilot programs. The creation of a centralized national registry hosted by the Shanghai Environment and Energy Exchange (SEEE), the establishment of a uniform trading platform, and the release of the *Interim Measures for the Administration of Carbon Emissions Trading* in 2021 have together provided a unified procedural and operational structure. This shift from regional diversity to national uniformity reflects a deliberate policy choice to prioritize coherence and administrative control in the formative years of the market.

The operational progress is particularly visible in the development of the Monitoring, Reporting, and Verification (MRV) infrastructure. Technical guidelines issued by the MEE for different industrial sectors have standardized emissions measurement methodologies, providing a clearer basis for compliance obligations. Third-party verification agencies have been accredited to conduct audits of reported data, and a growing number of verifiers have received capacity-building training in carbon

accounting techniques. The introduction of a national digital reporting platform has streamlined the submission and review process, reduced manual data errors, and allowed regulators to access real-time information on compliance performance. In its first compliance cycle, the national ETS recorded a compliance rate reportedly exceeding 95% for covered entities in the power sector, an outcome that the MEE has cited as evidence of the system's credibility and operational readiness.

These achievements indicate that the Chinese ETS has succeeded in creating an administrative foundation for market-based climate governance. Yet beneath these successes lie structural and legal deficiencies that could limit the system's ability to fulfill its long-term mitigation objectives. Chief among these is the absence of a dedicated *Carbon Emissions Trading Law*. Current operations are grounded in ministerial-level administrative measures, which lack the legal authority, permanence, and interpretative clarity of a statute enacted by the Standing Committee of the National People's Congress. Without a statutory framework, the ETS occupies a subordinate position within China's legal hierarchy, rendering it vulnerable to shifts in administrative priorities and leaving many aspects of its operation subject to regulatory discretion.

The lack of a comprehensive law also impedes integration of the ETS with other legal regimes, including property law, contract law, and financial regulation. Carbon allowances are currently treated as revocable administrative licenses rather than proprietary assets. This classification means that they cannot be fully transferred across different sectors of the economy, pledged as collateral, or securitized into carbon-linked financial products. The legal ambiguity surrounding allowances discourages financial institutions from developing products such as carbon futures, swaps, or emissions-linked bonds, thereby limiting the market's ability to attract private investment capital. In addition, the administrative nature of allowances complicates the development of intertemporal trading mechanisms. Banking of surplus allowances into future compliance periods and borrowing of future allocations remain subject to ad hoc regulatory approvals, which reduces predictability for enterprises making multi-year decarbonization investments.

Transparency constitutes another area of partial progress but continuing weakness. The MRV system has improved the reliability of reported emissions data, yet public disclosure remains limited. Aggregate compliance outcomes have been published, but facility-level data and detailed verification reports are not systematically made available. This lack of openness constrains external scrutiny by civil society, academics, and market analysts. In systems such as the European Union Emissions Trading System (EU ETS), public disclosure of verified emissions data has been a key element of market credibility, enabling independent actors to identify anomalies and hold both market participants and regulators accountable. In China, the absence of equivalent transparency may fuel perceptions of opacity and diminish trust among investors and international partners.

Institutional gaps in dispute resolution and judicial oversight also pose a barrier to the market's maturation. Disagreements over allowance allocation, verification outcomes, or allegations of market misconduct cannot be adjudicated by a specialized carbon tribunal or environmental court with ETS expertise. Instead, affected parties must navigate general administrative reconsideration procedures or pursue claims under the broad categories of administrative or civil law. These processes often lack the technical specificity to address the complexities of carbon trading, such as the treatment of registry errors, contractual breaches in allowance transfers, or disputes over the validity of verification methodologies. The reliance on administrative enforcement without independent review mechanisms creates the risk of regulatory overreach and erodes procedural fairness. In international practice, specialized adjudication bodies have played an important role in reinforcing market confidence. For example, in the EU ETS, allocation disputes have been litigated before national courts and, in some cases, elevated to the European Court of Justice, producing a body of jurisprudence that clarifies market rules and participant rights.

Market oversight in China remains concentrated within the MEE, which combines the roles of policy-maker, administrator, and enforcer. While this centralization facilitates rapid decision-making and ensures policy alignment with national climate objectives, it raises governance concerns about the absence of checks and balances. The potential for conflicts of interest—where the same body designs the rules, implements them, and adjudicates alleged breaches—has been noted by domestic legal scholars as a structural weakness in the current arrangement. Independent oversight bodies or multi-agency governance structures, which are common in mature carbon markets, could introduce greater accountability without sacrificing administrative efficiency.

Another emerging challenge is the prospective expansion of the ETS into carbon financial derivatives. The MEE has indicated an interest in allowing futures and other financial instruments to be developed on the basis of carbon allowances. Such a move would necessitate collaboration with the China Securities Regulatory Commission (CSRC) and alignment with the *Securities Law* to address issues such as market manipulation, insider trading, and systemic risk. Without statutory recognition of allowances as financial assets, derivatives markets would operate in a legal grey area, potentially amplifying risk for both traders and the broader financial system.

Despite these constraints, the ETS continues to evolve in ways that suggest a trajectory toward greater legal and institutional maturity. Policy statements in the 14th Five-Year Plan have emphasized the need to improve the legal framework for market-based climate instruments and to explore legislative codification of the carbon market. Academic proposals have called for granting carbon allowances the status of *usufruct rights* under the Civil Code, which would preserve state ownership of atmospheric resources while granting market participants secure rights to use and benefit from their allocated quotas. This approach could strengthen the enforceability of allowances, support the development of carbon finance, and encourage long-term abatement investments.

China's approach to environmental governance often follows a pattern of pilot experimentation, incremental scaling, and eventual legal consolidation. The current institutional and legal gaps in the ETS can thus be understood as transitional features of an adaptive regulatory process. This process allows for flexibility and policy learning but comes at the cost of temporary uncertainty for market participants. Addressing these challenges will require deliberate legal reform to solidify the market's foundation. A dedicated *Carbon Emissions Trading Law* could clarify the legal status of allowances, set binding transparency requirements, establish specialized dispute resolution mechanisms, and define the division of oversight responsibilities between the MEE, financial regulators, and the judiciary.

The success of such reforms will determine not only the domestic effectiveness of the ETS but also China's ability to engage credibly with international carbon markets. As global climate cooperation increasingly emphasizes market linkages, robust legal underpinnings will be essential for integrating the Chinese ETS with other trading systems. A legally coherent, transparent, and institutionally accountable carbon market would position China as a central actor in global carbon governance, capable of influencing the evolution of market-based climate policies beyond its borders.

6. Recommendations for Legal Development

As China's ETS advances from a formative administrative scheme to a system with the ambition to function as a sophisticated market-based climate instrument, reinforcing its legal architecture is no longer an optional enhancement but a strategic necessity. The existing framework, though operational and administratively coordinated, does not yet provide the degree of legal certainty, institutional stability, and inter-system compatibility needed to sustain market confidence, stimulate financial innovation, and meet the demands of international integration. Moving toward a comprehensive legal framework requires a multi-dimensional reform agenda that addresses statutory codification, property rights clarification,

transparency, dispute resolution, and financial market alignment.

A priority reform is the enactment of a National Carbon Emissions Trading Law to serve as the statutory foundation of the ETS. This legislation should codify the market's operational principles and define the scope of regulatory authority, clarifying the jurisdictional boundaries between the Ministry of Ecology and Environment (MEE), the Ministry of Finance, the People's Bank of China, and the China Securities Regulatory Commission (CSRC). Such a law must harmonize carbon trading rules with other legal regimes, including environmental protection, property rights, and financial regulation. Provisions should address the methodologies for quota allocation, eligibility of market participants, compliance obligations, MRV standards, and a penalty framework calibrated to deter non-compliance without discouraging market participation. Institutionalizing these provisions through national law would not only anchor the ETS in China's legislative hierarchy but also reduce the risk of policy discontinuity and provincial divergence. In systems such as the EU ETS, the anchoring directive has provided the legal certainty necessary for consistent implementation across diverse jurisdictions, a precedent that China can adapt to its unitary system.

Equally significant is the need to legally define the status of carbon allowances. Current administrative practice treats allowances as revocable licenses, which inhibits their use in financial transactions and limits their market value. While granting allowances the status of absolute private property may not align with China's public ownership principle over natural resources, civil law models such as usufruct rights or quasi-property rights offer a viable middle ground. Recognizing allowances as usufruct rights under the Civil Code would allow entities to possess, use, and benefit from them within regulatory limits, while preserving state ownership of the atmospheric commons. This status should carry statutory protection against arbitrary revocation and include rights to compensation in the event of wrongful expropriation or allocation errors. Legal scholars such as Liang (2018) and Boute & Zhang (2019) have underscored that without clear property-like protection, investment in carbon abatement projects and carbon-linked financial products will remain limited, constraining the ETS's ability to leverage private capital.

Transparency and public oversight require deliberate legal design. Although China's MRV infrastructure has improved data accuracy, disclosure obligations remain narrow. Legislation should mandate timely publication of verified emissions data, aggregated trading statistics, and compliance outcomes, subject to legitimate confidentiality protections for trade secrets. Public accreditation of third-party verifiers and regular audits of their performance should be codified to ensure independence and technical competence. In the EU ETS, public access to emissions and allocation data has strengthened market discipline and public trust; adopting a tailored version of such disclosure rules could enhance the legitimacy of China's ETS and facilitate external monitoring by researchers, civil society, and investors.

Dispute resolution mechanisms must also be embedded within the legal framework. The complexity of carbon market transactions—spanning allocation disputes, contractual breaches, verification disagreements, and allegations of manipulation—demands specialized adjudicative capacity. Establishing carbon-specific arbitration bodies or dedicated environmental court divisions with ETS jurisdiction would create an expert-driven forum for resolving such disputes. Judicial review of administrative penalties, registry decisions, and allocation methodologies should be available to ensure procedural fairness and to develop a jurisprudence that guides both regulators and market participants. The experience of the California Cap-and-Trade Program, where regulatory decisions are subject to judicial scrutiny, shows that the availability of independent review enhances both compliance discipline and stakeholder confidence.

Integrating carbon allowances into the financial market ecosystem is another legislative imperative. As the ETS matures, the need for hedging instruments

such as carbon futures, options, and swaps will intensify. The legal recognition of allowances as underlying assets for such derivatives requires statutory clarity, coordination with the CSRC, and alignment with the Securities Law and related financial regulations. Rules addressing market conduct—such as prohibitions on insider trading, price manipulation, and excessive speculation—should be incorporated into the carbon trading statute or parallel financial legislation. This proactive integration will enable the ETS to support sophisticated risk management and investment strategies without compromising its environmental objectives.

A comprehensive reform strategy should combine statutory clarity with regulatory adaptability. The ETS operates within a dynamic context of evolving emissions caps, technological innovation, and shifting macroeconomic conditions. Legislation should set out foundational rights and obligations while authorizing the MEE and other relevant agencies to adjust technical parameters, allocation methodologies, and compliance schedules within defined legal boundaries. Sunset clauses, periodic legislative reviews, and mandatory stakeholder consultations can be embedded in the law to ensure that the system remains responsive to both environmental imperatives and market realities.

Such reforms will not only strengthen the ETS domestically but also prepare China for deeper engagement with international carbon markets. As cross-border carbon pricing mechanisms gain prominence—exemplified by the EU's Carbon Border Adjustment Mechanism—legal convergence on asset definitions, transparency standards, and dispute resolution will be critical for facilitating market linkages. A legally mature ETS would position China to shape global norms for carbon market governance, leveraging its scale to influence both market design and environmental ambition.

By advancing legislative codification, clarifying property rights, institutionalizing transparency, enabling specialized dispute resolution, and integrating with financial regulation, China can transform its ETS from a primarily administrative compliance tool into a credible, investment-friendly, and internationally interoperable market instrument. Such a transformation would not only secure the domestic environmental benefits of emissions trading but also elevate China's role as a central actor in the architecture of global climate governance.

7. Conclusion

China's Emissions Trading System (ETS) is a landmark institutional innovation in the architecture of environmental governance, reflecting an effort to reconcile the efficiency of market-based instruments with the strategic authority of centralized state regulation. As the largest national carbon market in terms of covered emissions, it operates both as a domestic compliance mechanism aligned with China's development model and as a potential reference for how large emerging economies may structure their climate change mitigation efforts. Its trajectory embodies a deliberate policy pattern: initiating with pilot experimentation, consolidating institutional capacity, and advancing toward gradual legal codification. This process mirrors broader trends in China's governance reforms, where practical implementation precedes legislative entrenchment, allowing for policy calibration before locking in legal form.

The ETS's evolution from fragmented regional pilots to a unified national market under the supervision of the Ministry of Ecology and Environment (MEE) demonstrates a degree of institutional consolidation rare in complex environmental policy domains. The creation of a national registry, standardization of monitoring, reporting, and verification (MRV) protocols, and integration of compliance and enforcement functions into a single administrative framework have provided a functional operational base. These developments have created institutional knowledge, improved intergovernmental coordination, and enhanced technical capacity for emissions accounting and compliance oversight.

The system's current reliance on ministerial regulations and administrative instruments reflects its transitional nature. Without a dedicated *Carbon*

Emissions Trading Law, the ETS remains anchored in a legal structure that lacks the statutory authority, judicial enforceability, and normative stability associated with national legislation. This legal incompleteness is both a limitation and an opportunity. It limits the market's ability to integrate with the financial system, constrains the development of property rights over carbon allowances, and restricts the use of judicial or arbitral remedies for disputes. At the same time, it provides flexibility for regulators to adapt allocation methodologies, expand sectoral coverage, and adjust compliance rules in response to market feedback.

The durability and credibility of the ETS will ultimately depend on consolidating its operational gains into a coherent legal foundation. Clarifying the legal nature of carbon allowances is a critical step. If they continue to be treated solely as administrative licenses, their market value will remain limited, and participation from financial institutions will be cautious. Recognizing allowances under civil law—potentially as usufruct rights—could align them with property protection norms without undermining state ownership of environmental commons. Such recognition would also facilitate the development of carbon-linked financial instruments, allowing the market to mobilize capital for emissions reduction projects.

Institutional safeguards are equally important. The establishment of specialized dispute resolution mechanisms, whether through dedicated arbitration panels or environmental court divisions with ETS expertise, would create procedural fairness and build market trust. Embedding these mechanisms in statute would help balance the MEE's role as regulator with the need for independent adjudication of contested decisions. International experience, including the European Union's judicial oversight of the EU ETS and California's integration of carbon market disputes into its administrative law framework, demonstrates that such safeguards enhance both compliance discipline and investor confidence.

Transparency in market operation and regulatory enforcement is another determinant of the system's legitimacy. Public disclosure of verified emissions data, allocation methodologies, and compliance outcomes can deter misconduct, improve price discovery, and allow for informed participation. Aligning China's disclosure standards with global best practices would also facilitate cross-border market compatibility, a consideration of growing relevance as the EU's Carbon Border Adjustment Mechanism (CBAM) and similar policies link international trade with carbon accounting.

From a global perspective, China's ETS offers several insights for climate governance. It shows that large-scale carbon markets can be constructed within a unitary political system, provided there is sustained political commitment, technical competence, and policy coherence. It also illustrates that market-based climate instruments do not require wholesale adoption of Western legal property regimes to function, though clearer legal entitlements can enhance efficiency and integration with financial systems. For emerging economies where institutional capacity is uneven and political priorities are diverse, the Chinese model may serve as an adaptable template—one that demonstrates how incrementalism can be harnessed to gradually build complex governance mechanisms.

Challenges remain and are not trivial. Legislative incompleteness leaves the ETS exposed to regulatory discretion. Administrative dominance limits the role of independent oversight. Ambiguity over property rights continues to deter deeper market engagement. These features, however, can be understood as transitional characteristics of a system in mid-formation rather than permanent defects. China's governance style—iterative policy design informed by pilot experimentation—suggests that many of these issues will be addressed through phased legal reform. The drafting and eventual enactment of a national carbon trading statute, integration of allowances into civil and financial law, and development of specialized dispute resolution pathways are all foreseeable steps in this trajectory.

In the longer term, the maturation of the ETS will also have geopolitical significance. As climate governance

becomes more interconnected through linked markets, cross-border allowance trading, and trade measures tied to carbon intensity, China's legal choices in structuring its ETS will influence the evolution of global norms. A legally coherent and operationally credible Chinese carbon market could act as both a domestic tool for emissions reduction and an international standard-setter, shaping how other emerging economies design their own market mechanisms.

China's ETS is thus best understood as a dynamic institution—neither fully formed nor static, but evolving in response to domestic priorities and international pressures. Its capacity to transform environmental goals into enforceable market rules depends on legal clarity, institutional trust, and adaptive governance. By embedding these qualities in a robust statutory framework, China can not only secure the ETS's role in meeting its 2030 peak and 2060 neutrality targets but also contribute to the architecture of global climate governance in a way that reflects both national circumstances and shared international objectives.

References

Boute, A., & Zhang, H. (2019). Fixing the emissions trading scheme: Carbon price stability in the EU and China. *European Law Journal*, *25*(4), 333–347. https://doi.org/10.1111/eulj.12307

Dai, C., & Pollitt, M. G. (2024). From Local Carbon Emissions Pilots to the National Carbon Emissions Trading Scheme in China. https://doi.org/10.17863/CAM.118384

DUAN, M., & ZHOU, L. (2017). Key issues in designing China's national carbon emissions trading system. *Economics of Energy & Environmental Policy*, *6*(2), 55–72. https://www.jstor.org/stable/26189178

Duan, M., Pang, T., & Zhang, X. (2014). Review of Carbon Emissions Trading Pilots in China. *Energy & Environment*, *25*(3-4), 527-549. https://doi.org/10.1260/0958-305X.25.3-4.527

ICAP (International Carbon Action Partnership). (2023). *Emissions Trading Worldwide: Status Report 2023*.

Jiang, X. (2013). The rise of carbon emissions trading in China: a panacea for climate change? *Climate and Development*, *6*(2), 111–121. https://doi.org/10.1080/17565529.2013.857590

Liang, C., Liu, S., & Pan, X. (2018). *Legal nature of the emission allowance in China's national carbon trading scheme.* Duke University.

Liu, L., Chen, C., Zhao, Y., & Zhao, E. (2015). China's carbon-emissions trading: Overview, challenges and future. *Renewable and Sustainable Energy Reviews, 49*, 254–266. https://doi.org/10.1016/j.rser.2015.04.076

Lo, A. Y. (2015). Challenges to the development of carbon markets in China. *Climate Policy*, *16*(1), 109–124. https://doi.org/10.1080/14693062.2014.991907

MEE (Ministry of Ecology and Environment). (2021). Interim Measures for the Administration of Carbon Emissions Trading.

Pei, Q., Liu, L., & Zhang, D. D. (2013). Carbon emission right as a new property right: Rescue CDM developers in China from 2012. *International Environmental Agreements: Politics, Law and Economics, 13*(3), 307–320. https://doi.org/10.1007/s10784-012-9191-0

Zhang, Z. (2015). Carbon emissions trading in China: the evolution from pilots to a nationwide scheme. *Climate Policy*, *15*(sup1), S104–S126. https://doi.org/10.1080/14693062.2015.1096231

Study on the Protection Mechanism of Reliance Interests Within the Framework of Administrative Compensation

Pengfei Bao[1]*

[1] Dalian Ocean University, Liaoning, China
* Correspondence: okaybpf@163.com

https://doi.org/10.53104/curr.res.law.pract.2025.07003

Received: 2 July 2025

Revised: 21 July 2025

Accepted: 25 July 2025

Published: 11 August 2025

Citation: Bao, P. (2025). Study on the Protection Mechanism of Reliance Interests Within the Framework of Administrative Compensation. *Current Research in Law & Practice, 3*(1), 32-40.

Abstract: In modern rule-of-law societies, the administrative compensation system serves as an essential legal means to safeguard the legitimate rights and interests of citizens, legal persons, and other organizations. The improvement of this system is directly linked to the realization of social fairness and justice. The protection of reliance interests, as one of the core concepts in the field of administrative compensation, has rich connotations and a broad scope. It concerns the legality and rationality of administrative actions, as well as the reasonable trust that citizens place in such actions. In administrative compensation cases, whether reliance interests are protected is not only related to whether the damaged parties can obtain adequate and reasonable compensation but also to the establishment and maintenance of government credibility and the advancement of building a government based on the rule of law.

Keywords: protection of reliance interests; administrative compensation; protection mechanism

1. Research Background

At present, there are still many deficiencies in the protection mechanism of reliance interests in the field of administrative compensation in China. On the one hand, the relevant laws and regulations do not clearly define reliance interests, resulting in a lack of unified standards and basis for determining which reliance interests should be protected and how to define the scope of reliance interests in practice. For example, although the "State Compensation Law" mentions administrative compensation, it does not provide detailed provisions on the specific connotation and constituent elements of reliance interests. This makes it difficult for courts to accurately grasp the recognition standards of reliance interests when hearing administrative compensation cases involving reliance interests in judicial practice, thereby affecting the determination of compensation liability and the calculation of compensation amounts. On the other hand, the administrative compensation procedure pays insufficient attention to the protection of reliance interests. In the stages of application, acceptance, and trial of administrative compensation, there is a lack of effective procedural provisions and safeguard measures for the investigation, recognition, and protection of reliance interests. For example, in the application stage of administrative compensation, applicants may fail to fully and accurately state the

damage to their reliance interests due to a lack of professional legal guidance, resulting in administrative organs or courts failing to fully recognize the existence and importance of reliance interests. In the trial stage, there are also no clear rules for the allocation of the burden of proof and the examination of evidence regarding reliance interests, making the protection of reliance interests procedurally difficult. In addition, from a social perspective, the public's understanding and awareness of the protection of reliance interests are also insufficient. Some citizens, legal persons, and other organizations fail to fully realize the reliance interests they possess when facing administrative actions, and that they can seek relief through administrative compensation when their reliance interests are damaged by illegal or improper administrative actions. This lack of awareness not only causes some damaged parties to miss the opportunity to protect their legitimate rights and interests, but also affects the effective implementation of the protection mechanism of reliance interests and the public's trust in the administrative compensation system.

Based on the above background, exploring the protection mechanism of reliance interests in the field of administrative compensation has important practical significance. By in-depth research on the connotation, constituent elements, and protection mechanism of reliance interests, we can not only provide theoretical support and practical guidance for the improvement of China's administrative compensation system, but also better protect the legitimate rights and interests of citizens, legal persons, and other organizations, and maintain social fairness and justice. At the same time, it will also help to improve the level of law-based administration of the government, enhance government credibility, promote the construction of a rule-of-law government, and drive the harmonious and stable development of society.

2. Theoretical Basis of the Protection of Reliance Interests

Concept of Reliance Interests: Reliance interests refer to the interests that one party generates based on a reasonable trust that the other party will enter into a contract or administrative action with them. In law, reliance interests are usually manifested as losses suffered due to a change in one's situation because of trust in the other party's actions. For example, in contract law, if one party incurs expenses or misses other opportunities due to trust in the other party's promise, and the other party fails to fulfill the promise, then the losses suffered by that party due to trust are considered reliance interests. The principle of reliance protection originated in Germany in the 1950s and aims to address the relationship between public power and private rights, ensuring that the legitimate interests formed by citizens' reasonable arrangements based on good faith trust in the legal status are recognized and protected by law. In administrative law, if an administrative action is invalid or revoked, and the relative party suffers losses due to trust in that action, such losses also fall within the scope of reliance interests. Administrative organs play an important role in the development of the principle of reliance protection, but they have long been neglected by academia. The "behavioral repetitiveness review standard" and the "subjective fault review standard" can be extracted from administrative experience to enrich the theoretical connotation of the principle of reliance protection and provide specific standards for judicial review. These standards can serve as institutional templates in future administrative procedural codes. (Wang Zichen, 2021)

2.1 Characteristics of Reliance Interests

Transactional: Reliance interests typically arise in the course of transactions, with the purpose of safeguarding transactional security.

Staged: Reliance interests mainly occur during the stages before a contractual relationship is established or after it has been terminated.

Statutory: The occurrence and remedies for reliance interests are explicitly stipulated by law.

Inherent and Cost-related: Reliance interests are part of the existing interests of the parties involved and involve the necessary costs incurred due to trust.

Dual Nature: Reliance interests can be both property-related and may involve personal aspects.

2.2 Theoretical Foundations of Reliance Interest Protection

2.2.1 Principle of Good Faith

The principle of good faith is the most direct theoretical source of reliance interest protection. In civil law, the principle of good faith requires that civil subjects follow the principle of honesty and integrity when engaging in civil activities and must not engage in fraudulent or concealing behaviors. In the field of administrative law, this principle is equally applicable, requiring administrative authorities to act in good faith and not to arbitrarily change, revoke, or abolish administrative actions already made. The principle of reliance protection is based on the principle of good faith, emphasizing that the reasonable trust of administrative counterparts in administrative actions should be protected.

2.2.2 Principle of Legal Stability

The principle of legal stability is another important theoretical basis for the protection of reliance interests. This principle requires the stability of legal relations to maintain social order and the authority of the law. When administrative counterparts place trust in an administrative action, the administrative authority must not arbitrarily change the action, otherwise it will disrupt the stability of legal relations and damage the legitimate rights and interests of administrative counterparts. The principle of reliance protection safeguards the reliance interests of administrative counterparts to maintain the stability of the legal order.

2.2.3 Principle of Fundamental Rights

Although the principle of reliance protection itself does not belong to the category of fundamental rights, it is closely related to citizens' fundamental rights. The implementation of the principle of reliance protection helps to protect the legitimate rights and interests of citizens that are damaged by improper administrative actions, thereby indirectly safeguarding citizens' fundamental rights. For example, in the field of administrative licensing, the principle of reliance protection can prevent administrative authorities from arbitrarily revoking or changing administrative licenses, thereby protecting the property rights, business rights, and other fundamental rights of administrative counterparts.

2.2.4 Principle of Balancing Interests

The principle of reliance protection also involves the balancing of interests. In the process of changing or revoking administrative actions, it is necessary to weigh the reliance interests of administrative counterparts against the public interest. When the reliance interests of administrative counterparts are significantly greater than the public interest, administrative authorities must not arbitrarily change or revoke administrative actions. Conversely, if the public interest is significantly greater than the reliance interests, administrative authorities may change or revoke administrative actions, but they must compensate for the losses of reliance interests suffered by administrative counterparts. This mechanism of interest balancing aims to achieve a balance between public and private interests.

2.2.5 International Influence of the Principle of Reliance Protection

The principle of reliance protection has been widely applied and developed in continental law countries such as Germany. Based on the principles of legal stability and good faith in civil law, German administrative courts have gradually established the principle of reliance protection and incorporated it into the basic principles of administrative law. The establishment of this principle has had an important impact on the development of administrative law in other countries and regions, and many countries have also introduced the principle of reliance protection into their administrative law.

2.3 A Framework of Administrative Rationality–Reliance Stability Tension in China

The old ideas of good faith and legal stability help explain why we need to protect reliance interests. But they do not fully show the built-in conflict. This conflict is between administrative rationality and reliance stability. It is a key part of China's legal system.

China's way of governing now puts more focus on flexible policies and quick administrative changes. This often means officials need to rethink or take back permissions they gave before. They do this to serve public interests that are changing. This kind of flexible governing makes things very unpredictable. It can hurt the stability of what people can fairly expect. It can also damage the trust between citizens and the state.

So, this paper offers a new way to analyze the issue. It is called the "administrative rationality–reliance stability tension." The idea is this: to understand reliance interests in China, we need to check two things about administrative decisions. These decisions change rights or interests that were already set. We need to see if they are balanced and if there is a good reason for them. Under this framework, courts should look at certain things when they review decisions. They should check if the officials' use of their power has enough reasoning. They should see if it is clear and open. They should make sure it fits with the public interest being talked about. At the same time, they need to think about how much people's reliance interests are harmed.

2.4 Comparative Insights: Divergent Doctrinal Approaches in Germany and China

Looking at other countries helps show how different legal cultures shape the rules for protecting reliance interests. In Germany, reliance interests are part of the Rechtsstaat tradition. This tradition stresses that the law must be clear. It also says the state should not act randomly—individuals must be protected from that. German administrative courts always use a strict proportionality test. This test directly balances public interests against two things: how predictable private reliance is, and how strong it is. China's approach is different. It is not as clearly written in laws. It also leaves more room for officials to decide things on their own. Courts in China often care more about making administration easy or meeting policy goals. They pay less attention to private reliance. This difference shows that China needs clearer rules for courts to follow. This would stop things from varying too much. It would also make the use of reliance protection in administrative compensation cases more predictable.

In Germany, reliance interest protection is firmly anchored in administrative law. It is based on the codified principles of legitimate expectation (Vertrauensschutz) and proportionality (Verhältnismäßigkeit). The Administrative Procedure Act (§48 and §49 VwVfG) clearly says this: if an unlawful administrative act is revoked, the affected party must get compensation. This is true if they relied on the act in good faith and suffered economic or personal loss. German courts use a structured proportionality test. It makes authorities balance private reliance against very important public interest. Compensation is set by looking at actual spending, lost profits, and sometimes extra damages that follow. China's legal framework does not have such clear written rules or obvious procedural duties. The German model shows that reliance interests can be protected consistently. This is done by combining written rules and detailed procedural safeguards. But using these approaches in China has some limits. China's administrative compensation system has always put state discretion and policy flexibility above private expectations. Also, there are no uniform standards for balancing public and private interests. This makes reform harder. The German proportionality test focus on procedural fairness offer useful lessons. This difference shows that China needs clearer rules for courts to follow. This would stop things from varying too much. It would also make the use of reliance protection in administrative compensation cases more predictable.

3. Current Practice of Reliance Interest Protection in Administrative Compensation

3.1 Legislative Status

Legal Basis: In China, although the principle of reliance interest protection has been widely discussed in academia, it has not been explicitly stipulated in legislation. However, Article 8 and Article 69 of the "Administrative Licensing Law" are regarded as the legal basis for the substantial establishment of the principle of reliance interest protection. These provisions stipulate that if an administrative authority revokes or changes an administrative license and causes property losses to the administrative counterpart, it shall provide compensation in accordance with the law. The academic community's attention to the practice of this principle in China is still insufficient, as scholars often focus on whether it meets the requirements of foreign theories rather than paying attention to the specific requirements or characteristics of its practice in China. (Chen Lu, 2024)

Scope of Application: Although the principle of reliance interest protection is clearly reflected in the field of administrative licensing, its application in other administrative fields, such as administrative promises, administrative agreements, administrative guidance, and the determination of illegal buildings, is not unified. Courts and parties also cite the principle of reliance interest protection for reasoning in these cases, but there is a lack of clear legal basis.

3.2 Challenges in Judicial Practice

Lack of Unified Criteria: Due to legislative deficiencies, there is no unified standard for the recognition of reliance interests in judicial practice. Different regions and levels of courts have differences in the recognition of reliance interests, leading to different outcomes in similar cases.

Inadequate Compensation System: The current administrative compensation system in China mainly compensates for the actual objective losses caused by administrative authorities, but lacks provisions for compensation for mental losses. At the same time, there are no clear regulations on the scope, standards, and procedures for compensation for reliance interest losses, resulting in a lack of operability and fairness in the compensation process.

Difficulties in Balancing Interests: Balancing public interests and reliance interests in administrative compensation is a challenge. Administrative authorities often need to consider public interests when exercising their powers, but there may be deficiencies in protecting reliance interests. In addition, the criteria for weighing public interests and reliance interests are not clear, making it difficult to make fair decisions in practice.

3.2.1 Judicial Case Illustrations

In administratively compelled demolition cases, Chinese courts have begun to acknowledge the importance of protecting reliance interests. A notable example is the Laizhou Nursery Case, adjudicated by the Laizhou People's Court (2013) Laizhou Xing Chu No.6. The court ruled that "administrative demolition in violation of reliance interest protection requires compensation at least equivalent to the market value of the demolished structure". The plaintiff had invested over 4.2 million RMB to build a greenhouse and nursery, believing in the legality of her investment. When the local land bureau demolished her facility unilaterally, the court recognized not only the illegality of the demolition but also the plaintiff's reliance interest. But it did not go into detail about the exact way to calculate compensation, except to mention market value. This leaves courts and administrative bodies without set procedural guidelines. Judicial statistics show that in similar demolition disputes, courts generally uphold reliance-based compensation. But the amounts granted vary and are not consistent. This is because there are no set criteria. This lack of uniformity in legal practice shows that more concrete statutory norms are needed. These should cover evidentiary rules, valuation benchmarks, and procedural safeguards.

In July 2020, the Supreme People's Court issued a ruling regarding Tianrui Aluminium Company v. Shanxian County Natural Resources Bureau (2019) ZuiGaoFa Xing Shen No.6862. It affirmed that Tianrui Aluminium held legitimate reliance interests. This

was true even though it had not yet signed a formal state-owned land-use contract. This conclusion was based on a fact that Tianrui had entered into two successive land acquisition agreements with the Industrial Park Management Committee. It had made partial payments and received official confirmation from the Municipal Government. The court emphasized that despite the absence of a formal grant contract, such actions—including financial investment and preparatory development—showed a reasonable expectation of obtaining land rights. So, it upheld all lower-court findings of administrative illegality. It also rejected the subsequent appeals by the local government.

This landmark decision is significant for several reasons. First, it expands the scope of reliance interest beyond formal administrative approvals. It includes preparatory acts based on government representations. Second, the court's reasoning changes legal practice. It makes clear that investment and expectation based on administrative behavior should be protected. This is true even if procedural formalities are not complete. But finally, the judgment does not provide a clear method for calculating compensation. It also does not specify procedural criteria for proving reliance. This leaves practical guidance for courts and stakeholders somewhat unclear.

3.3 Suggestions for Improvement

Improve Legislation: It is suggested to clarify the status and scope of application of the principle of reliance interest protection in legislation to provide a clear legal basis for judicial practice. At the same time, the successful experience of other countries and regions can be drawn upon to formulate a more comprehensive system for the protection of reliance interests.

Unify Criteria for Recognition: Through judicial interpretations or guiding cases, unify the criteria for the recognition of reliance interests to ensure fair handling of similar cases. At the same time, strengthen the training and education of judges to improve their ability and level in recognizing reliance interests.

Improve Compensation System: Establish a more comprehensive administrative compensation system, clarify the scope, standards, and procedures for compensation for reliance interest losses. At the same time, consider including mental losses in the scope of compensation to more comprehensively protect the legitimate rights and interests of administrative counterparts.

Enhance Interest Balancing: In administrative compensation, fully consider the balance between public interests and reliance interests. Establish an interest-balancing mechanism to objectively assess public interests and reliance interests to ensure the fairness and rationality of decisions.

In summary, the current practice of reliance interest protection in administrative compensation faces problems such as legislative deficiencies and judicial challenges. To improve this situation, efforts are needed in improving legislation, unifying criteria for recognition, improving the compensation system, and enhancing interest balancing.

4. Measures to Improve the Protection of Reliance Interests in Administrative Compensation

4.1 Improve Legislative Provisions

Clarify the Principle of Reliance Interest Protection: Clearly define the status and scope of application of the principle of reliance interest protection in relevant laws and regulations to provide a clear legal basis for administrative compensation. Formulate a special administrative compensation law or related provisions to refine the specific regulations on reliance interest protection, including the scope, standards, and procedures for compensation.

Unify Criteria for Recognition: Through judicial interpretations or guiding cases, unify the criteria for the recognition of reliance interests to ensure fair handling of similar cases. Establish the constitutional status of the principle of reliance interest protection in the Constitution. (Wu Wenyue, 2023) Clarify the constituent elements of reliance interest damage, such as the actions of administrative authorities, the

reasonable expectations and trust of administrative counterparts, and the fact of reliance interest damage.

4.2 Strengthen Protection in Judicial Practice

Expand Scope of Application: Apply the principle of reliance interest protection to a wider range of administrative fields, such as administrative promises, administrative agreements, and administrative guidance, to ensure the full protection of the legitimate rights and interests of administrative counterparts.

Improve Compensation System: Establish a more comprehensive administrative compensation system, clarify the scope, standards, and procedures for compensation for reliance interest losses. The scope of compensation should include direct and indirect losses, as well as possible mental losses. Determine reasonable compensation standards to ensure that the compensation amount can fully compensate for the losses suffered by administrative counterparts due to reliance interest damage.

Enhance Interest Balancing: Fully consider the balance between public interests and reliance interests in administrative compensation. Establish an interest-balancing mechanism to objectively assess public interests and reliance interests to ensure the fairness and rationality of decisions. When public interests are significantly greater than reliance interests, administrative authorities have the right to make decisions in favor of public interests in accordance with legal procedures, but they should provide reasonable compensation to administrative counterparts.

4.3 Enhance the Integrity and Sense of Responsibility of Administrative Authorities

Strengthen Integrity Building: Administrative authorities should establish a sense of integrity, abide by laws and regulations, and keep their commitments to ensure the stability and predictability of administrative actions. Strengthen supervision and management of administrative authorities to prevent their abuse of power and illegal administrative actions from damaging the reliance interests of administrative counterparts.

Improve Decision-making Procedures: Before making administrative actions, administrative authorities should fully listen to the opinions and suggestions of administrative counterparts to enhance the acceptability and trustworthiness of their actions.

Establish and Improve Decision-making Procedures and Supervision Mechanisms: Ensure the legality and propriety of administrative actions.

4.4 Enhance Public Education and Participation

Improve Public Legal Awareness: Strengthen legal education and publicity to improve the public's understanding and awareness of administrative compensation and the protection of reliance interests. Encourage the public to actively participate in administrative activities, supervise the actions of administrative authorities, and protect their legitimate rights and interests.

Establish Consultation Mechanisms: Build consultation mechanisms involving all parties in administrative compensation legal relationships, specifying consultation times, methods, organizers, participants, etc., to promptly resolve administrative compensation disputes. Expand channels and methods for public participation, such as establishing information-sharing platforms, to increase the transparency and fairness of administrative compensation.

In summary, improving the protection of reliance interests in administrative compensation requires efforts from multiple aspects, including legislation, judicial practice, the integrity and sense of responsibility of administrative authorities, and public education and participation. The implementation of these measures will help protect the legitimate rights and interests of administrative counterparts, maintain social fairness and justice, and promote social harmony and stability.

4.5 Implementation Pathways and Institutional Responsibilities

To effectively realize the improvements proposed in this paper, it is essential to establish a phased and coordinated implementation strategy. In the

legislative domain, reform should begin with targeted amendments to the State Compensation Law and the Administrative Procedure Law, clarifying the status and scope of reliance interest protection as well as procedural guarantees for affected parties. The Standing Committee of the National People's Congress can initiate specialized legislative research and solicit public opinions to build consensus. Parallel to statutory reforms, the Supreme People's Court should issue judicial interpretations and guiding cases to provide clear standards for courts when recognizing and measuring reliance interests, particularly in situations involving administrative revocation or modification of approvals.

From an institutional perspective, the Ministry of Justice should work with provincial justice departments and local governments. They should set up test programs to try new compensation procedures and rules for evidence. The tests can focus on areas where reliance-based disputes happen a lot. Such as land use, construction permits, and environmental approvals. The phased implementation can follow a sequence of legislative clarification, localized experimentation, and gradual national rollout based on assessment of pilot outcomes. There may be problems with the reforms. One is that administrative agencies may resist. They might worry about having more responsibility. Another is that it may be hard to balance public interests and private reliance in sensitive policy areas. To deal with these, we need a group that includes different departments. It should have the Ministry of Justice, the Supreme People's Court and the State Council's Legislative Affairs Office. This group will make sure reform measures work well together. It will solve problems between central orders and local action. We also need to involve people affected. This means consultation with industries that could be affected, legal scholars and civil society. This will help make the new system legitimate and gain public trust.

5. Conclusion

This paper explores the protection mechanism of reliance interests in the field of administrative compensation, revealing the importance and urgency of reliance interest protection in modern administrative law. As a basic principle of administrative law, the core of the principle of reliance interest protection lies in safeguarding the reasonable trust of administrative counterparts in administrative actions and protecting their legitimate rights and interests from improper infringement. In practice, the application of the principle of reliance interest protection helps to balance public and private interests, promote government integrity, and improve administrative efficiency. However, there are still many deficiencies in the protection of reliance interests in China, such as unclear legislative provisions, non-unified judicial application criteria, and an imperfect compensation mechanism. These problems not only affect the full protection of the legitimate rights and interests of administrative counterparts but also restrict the effective implementation of the principle of reliance interest protection in the field of administrative compensation. The principle of reliance interest protection is still a new phenomenon in the field of law in China, lacking comprehensive theoretical research and being in the initial stage of practice. (Yang Haikun, 2007) To improve the protection mechanism of reliance interests, this paper proposes several suggestions, including strengthening legislative construction, unifying judicial standards, and improving the compensation system. The implementation of these measures will help build a more scientific and rational system for the protection of reliance interests and promote the further development of China's administrative compensation system. At the same time, the improvement of reliance interest protection will also provide strong support for the construction of a rule-of-law government and promote the realization of social fairness and justice.

In conclusion, the improvement of the protection mechanism for reliance interests is a systematic project that requires the joint efforts of legislation, judiciary, and administration. In the future, with the continuous improvement of relevant systems and the continuous exploration of practice, the principle of reliance interest protection will play a more important role in the field of administrative compensation, making

greater contributions to the protection of citizens' legitimate rights and interests and the construction of a rule-of-law society.

References

Chen Lu. (2024). The Current Application and Improvement Path of the Principle of Reliance Interest Protection in China's Administrative Law. *Legal System and Society*, (15), 34-36.

Wang Zichen. (2021). On the Principle of Reliance Protection in Administrative Context. *Jiangxi Social Sciences, 41*(11), 189-199.

Wu Wenyue. (2023). The Application Dilemmas and Improvement Suggestions of the Principle of Reliance Interest Protection in Administrative Law. *Journal of Social Sciences of Jiamusi University, 41*(04), 47-51.

Yang Haikun. (2007). The Principle of Administrative Reliance Protection and Human Rights Protection. *Journal of Nanjing Xiaozhuang University*, (04), 45-52.

Legal Challenges in Attributing Responsibility for Autonomous Driving Accidents

Yuanqi Luo[1]*

[1] Jiangxi University of Finance and Economics, Jiangxi, China
* Correspondence: luoyq2001@163.com

https://doi.org/10.53104/curr.res.law.pract.2025.07004

Abstract: The rise of autonomous vehicles (AVs) presents unprecedented legal, ethical, and regulatory challenges to existing frameworks of liability and responsibility. Traditional legal doctrines, built around human agency and fault-based liability, are increasingly strained by the complexity and opacity of machine decision-making systems. This paper examines the fragmented distribution of responsibility across manufacturers, software developers, users, and regulators, and highlights the legal ambiguity that emerges when causality is shared across distributed technical systems. It explores the regulatory and conceptual gaps that hinder effective adjudication, the influence of public moral expectations on the legitimacy of liability frameworks, and the philosophical dilemmas involved in delegating moral judgment to algorithmic systems. Drawing on legal scholarship, empirical studies, and ethical theory, the paper argues for a multi-stakeholder approach to legal reform, one that incorporates hybrid liability models, institutional coordination, and participatory governance. It concludes by advocating for a reconceptualization of responsibility in the age of autonomous mobility—grounded in transparency, fairness, and normative clarity.

Keywords: autonomous vehicles; public trust

Received: 18 July 2025

Revised: 8 August 2025

Accepted: 11 August 2025

Published: 14 August 2025

Citation: Luo, Y. (2025). Legal Challenges in Attributing Responsibility for Autonomous Driving Accidents. *Current Research in Law & Practice, 3*(1), 41-54.

1. Introduction

The advent of autonomous vehicles (AVs) marks a watershed moment in the evolution of human mobility. In the span of little more than a decade, what once seemed confined to science fiction has emerged as a burgeoning reality: intelligent systems capable of operating complex machines without direct human intervention. These vehicles, powered by advanced sensors, deep-learning algorithms, and real-time data analytics, promise a revolution in traffic efficiency, safety optimization, and urban planning. They signify a shift not just in the mechanics of driving but in the very fabric of how transportation systems function. Yet this promise comes entangled with a deep and unresolved legal uncertainty: when an autonomous vehicle is involved in an accident, who is to blame?

Conventional legal frameworks are structured around the assumption that a human agent is in control. This presumption is so deeply embedded in tort and criminal law that it informs doctrines of negligence,

recklessness, and intent across jurisdictions. Human drivers are held accountable for speeding, running red lights, texting behind the wheel, and making poor decisions under stress. When an accident occurs, courts investigate driver behavior, level of attentiveness, and compliance with traffic laws to determine liability. The insurance system, in turn, aligns with this fault-based architecture. Even in cases of no-fault liability or strict liability, there remains an anchoring assumption: the human is the operative center of decision-making.

Autonomous vehicles disrupt this assumption at a foundational level. Their intelligence derives not from a conscious agent but from millions of lines of code operating across layered systems of perception, planning, and control. These vehicles "see" the world through LiDAR and radar, "decide" how to act through probabilistic models, and "execute" those decisions via actuators governed by software architectures. In high levels of autonomy—particularly Level 4 and 5, as defined by the Society of Automotive Engineers—the human occupant is not only relieved of control but may be completely removed from the decision loop. The accident, if one occurs, cannot be traced to human reaction time or poor judgment. Instead, it is a consequence of system architecture, edge-case misclassification, sensor failure, GPS inaccuracies, or flaws in the training dataset used in the vehicle's machine learning module.

This technical complexity introduces not just a factual challenge but a philosophical one. Responsibility, in the legal sense, is tethered to notions of volition, foreseeability, and causation. If the vehicle's decision-making process is opaque even to its developers—a phenomenon known as the "black box" problem—how can one ascertain intent or negligence? Can a software engineer be held liable for a decision the AV made in an unforeseen scenario months or years after deployment? Is the manufacturer responsible if the vehicle behaved exactly as programmed but produced an undesirable outcome? These are not merely hypothetical musings. They go to the core of what legal systems must now confront in practice.

The problem is amplified by the layered structure of modern autonomous systems. Unlike a single individual operating a vehicle, the AV comprises subsystems developed by different entities. The sensors may be produced by one company, the machine-learning model trained by another, the vehicle platform built by yet another, and the final integration performed by a separate autonomous mobility firm. Each of these components may function independently under different intellectual property regimes, safety standards, and corporate liability policies. When a crash occurs, disaggregating fault becomes an exercise in technical forensics and contractual analysis. Legal systems, which traditionally rely on proximate cause and binary fault attribution, find themselves in unfamiliar territory. The question is no longer who turned the wheel, but which layer of code, hardware, or network latency contributed to the failure—and whether this failure was reasonably preventable.

The challenge extends into the realm of public policy and governance. Lawmakers are tasked with constructing a regulatory framework that incentivizes innovation while protecting public safety. Overregulation may stifle technological progress, pushing developers to offshore jurisdictions with looser constraints. Underregulation, however, could result in significant harm to citizens and erosion of public trust. Finding this balance requires a nuanced understanding not only of AV technologies but of their evolving social context. The legal system must be adaptive, forward-looking, and capable of engaging with technical standards in a meaningful way. Yet, most courts and legislatures are not currently equipped with the institutional capacity to deal with these issues at the necessary level of granularity.

Further complicating the legal landscape is the shifting nature of human responsibility in human-machine interactions. In partially autonomous systems—such as those operating at Level 2 or Level 3—the human driver is still nominally in charge but may be lulled into complacency by the vehicle's high level of assistance. Studies have shown that when drivers are not actively engaged, their situational awareness deteriorates rapidly. When the vehicle

suddenly demands human intervention—say, in a sensor-occlusion scenario or when facing an unanticipated road hazard—the driver may not respond in time. This creates a paradox: the human is legally responsible, but functionally incapable of exercising control. Courts must then determine whether to treat such drivers as negligent or to adjust liability doctrines to reflect the psychological and cognitive limitations imposed by the vehicle's own level of autonomy.

This shifting boundary of control also raises insurance questions. Traditional auto insurance models are based on driver profiles: age, experience, driving history, and behavior patterns. Autonomous vehicles render these models obsolete. If the vehicle does most of the driving, should premiums be based on its performance record instead? Should liability insurance shift from private individuals to manufacturers and software developers? Should governments mandate universal accident compensation funds for AV incidents, akin to workers' compensation schemes in labor law? The insurance industry, like the legal system, must reconceptualize its risk models to reflect this new ecosystem.

One cannot overlook the sociocultural and ethical dimensions that underlie legal adaptation. Different societies have different tolerance levels for automation, varying perceptions of fairness in blame attribution, and diverse traditions of liability. In civil law systems, for instance, the role of codified statutes is paramount, and legislative updates may be required to incorporate AV-specific clauses. In common law jurisdictions, judicial interpretation plays a central role, and precedents must evolve case by case. Public opinion, too, influences legal change. If citizens broadly perceive AVs as safer, courts may be less inclined to impose strict liability. Conversely, high-profile accidents involving AVs may trigger populist backlash and reactionary legislation. Legal institutions operate within these shifting cultural currents.

What emerges from this picture is not merely a gap in doctrine but a conceptual vacuum. Autonomous vehicles confront us with a new kind of actor on the road: a non-human, non-conscious agent capable of real-time decision-making with physical consequences. This actor does not possess intent, cannot be punished or deterred, and cannot pay compensation out of moral obligation. The legal system, rooted in centuries of human-centered jurisprudence, must find new language to describe this presence. It must develop doctrines that assign responsibility not based solely on individual fault but on system-wide accountability. Only then can justice be done in a world where machines share our roads and our risks.

2. Fragmented Responsibility and Legal Ambiguity

The legal attribution of responsibility has historically relied on the existence of a clear, traceable human actor capable of decision-making and error. The premise underlying most tort and criminal liability frameworks is that a human agent, endowed with agency and control, can reasonably foresee the consequences of their actions. This legal scaffolding begins to collapse when applied to autonomous vehicles (AVs), which are defined by the absence or reduction of human control, and by their operation through a distributed system of inputs, outputs, and software-driven decision-making. The result is a landscape in which liability becomes a diffuse problem, fractured across a multitude of actors, each of whom may plausibly deny sole responsibility.

The structural complexity of AVs lies at the heart of this fragmentation. Modern autonomous driving systems are built atop multiple interdependent components that include real-time object recognition algorithms, high-definition mapping systems, LiDAR and radar sensors, deep-learning models trained on dynamic datasets, and actuators coordinated by embedded software. These components are often produced by different entities across a decentralized industrial supply chain. For example, one firm may manufacture the camera system, another may design the neural network architecture for perception and decision-making, while a third may integrate these systems into the vehicle's onboard control infrastructure. The final deployment may occur under the banner of a ride-hailing platform or an automobile

brand, which itself may not own or directly oversee the development of any of the component parts.

When an autonomous vehicle causes an accident, the causal chain that must be unraveled includes potential failures at any of these levels. A mislabeling of road signage by the vision model may result from inadequate training data. A failure to yield may arise from faulty decision logic in the software stack. A delayed braking response may stem from a miscalibration of sensor thresholds. Yet each of these failures may be invisible to the end-user or vehicle operator, who cannot reasonably detect or intervene in real time. In legal theory, assigning liability under such circumstances becomes significantly more challenging. Courts must navigate between doctrines of strict liability, negligence, and product defectiveness, none of which were originally designed to accommodate black-box systems whose internal reasoning processes are neither transparent nor predictable.

This challenge is compounded in semi-autonomous systems, where the boundaries of human and machine control blur. Level 3 vehicles, as defined by the Society of Automotive Engineers, allow the driver to disengage from active control in specific conditions, with the understanding that they must retake control upon system request. Yet real-world evidence increasingly shows that human drivers often fail to reengage in a timely or effective manner due to cognitive disengagement or overreliance on automation. In such scenarios, determining fault requires an assessment of whether the system provided an adequate warning, whether the driver was given sufficient time and contextual awareness to respond, and whether the expectation of human intervention is realistic given human attentional limitations. These questions are not easily answered by existing legal standards, which presume a binary distinction between operator and machine.

The Uber self-driving fatality in Arizona in 2018—although occurring outside China—demonstrated the profound difficulty of isolating legal responsibility in AV accidents. Investigations revealed a litany of contributing factors: a disabled emergency braking system, a distracted human safety driver, flawed software categorization of the pedestrian, and organizational oversight failures. While criminal charges were ultimately filed against the human safety driver, the corporate entities involved were shielded by the diffusion of responsibility across technical and organizational domains. This case, though often cited in global legal discourse, serves not as a clear precedent but as a warning: absent coherent legal frameworks, accidents involving AVs will continue to fall into grey areas of attribution where responsibility is both shared and diluted.

A key conceptual issue in this domain is the lack of a singular controlling mind. In traditional vehicular accidents, courts look for a "mens rea" or a legally relevant state of mind such as recklessness, negligence, or intent. Machines, of course, have no mind to speak of, and the developers of such systems rarely have specific intent concerning particular outcomes. Thus, the legal system is forced to pivot toward frameworks based on risk distribution and system-level accountability. Some scholars advocate treating AV manufacturers and software developers as "designers of risk environments," a position that aligns them with product liability standards. This approach draws from long-established principles in consumer protection law, where manufacturers are liable for defects in design, manufacture, or warnings, regardless of intent. Yet the application of product liability to software remains unsettled in many jurisdictions. The intangible nature of code complicates notions of defectiveness, and the iterative nature of software updates muddies the question of when liability attaches to a particular version of the codebase.

Academic literature has begun to engage these questions, emphasizing the epistemic and moral complexity of assigning responsibility in hybrid human-machine environments. Liu, Du, and Li (2021) argue that the misattribution of legal responsibility in AV contexts has not only psychological consequences for individual actors but also structural effects on regulatory legitimacy. Their study highlights how systems that superficially preserve the appearance of human control may in fact undermine moral

accountability by masking the underlying complexity of AV decision-making. When drivers are blamed for system failures they could neither foresee nor correct, public trust in legal processes and technological oversight is eroded (Liu et al., 2021).

Another strand of scholarship focuses on the necessity of legal harmonization and the construction of unified liability regimes that account for the systemic nature of AV technologies. Wei and Guo (2025), in their comparative study of liability frameworks in China and Germany, underscore the fragmented nature of current legal approaches and call for integrated regulatory instruments that transcend jurisdictional inconsistencies. They note that while both civil law and common law traditions recognize forms of vicarious and enterprise liability, neither has yet developed a mature framework for distributed systems where decision-making is non-linear, probabilistic, and emergent. The authors suggest that future legislation should be grounded in a systems-theoretic understanding of responsibility, where liability is allocated not on the basis of singular fault but in proportion to the actor's role in the causal architecture of the vehicle's operation (Wei & Guo, 2025).

The ambiguity surrounding AV responsibility also affects contractual relationships within the mobility ecosystem. Suppliers, manufacturers, and service providers must negotiate indemnification clauses that anticipate accident scenarios without clear legal precedent. In practice, this often leads to risk-averse behavior, with companies seeking to limit their exposure through layered contractual insulation and complex liability waivers. Yet such arrangements do little to address the needs of victims, who may face protracted litigation with multiple parties each disclaiming liability. The net result is a legal environment in which accountability is scattered and justice delayed.

From a policy perspective, fragmented responsibility raises critical questions about the future architecture of legal systems. Should regulators create new liability categories specific to artificial agents? Would it be appropriate to establish centralized compensation funds for AV-related harm, similar to vaccine injury compensation schemes, to decouple victim relief from the uncertainties of fault attribution? These proposals have gained traction in academic and legislative circles but have yet to materialize into concrete law. Any such move would require rethinking foundational legal concepts such as personhood, agency, and foreseeability, none of which currently accommodate the unique characteristics of autonomous systems.

The fragmented nature of responsibility in AV contexts is not merely a challenge of legal formalism but one that touches upon deeper epistemic and institutional deficiencies. The law, in its current form, is ill-suited to apportion blame in systems where causality is distributed, intent is absent, and transparency is limited. Without a coherent theory of machine-integrated responsibility, legal systems will continue to produce inconsistent and unsatisfying outcomes. This gap must be addressed not only through doctrinal innovation but through a broader reconceptualization of what it means to be responsible in the age of autonomous technologies.

3. Regulatory and Conceptual Gaps

The rapid evolution of autonomous vehicle (AV) technologies has outpaced the development of legal and regulatory frameworks across jurisdictions. While the promise of reduced traffic fatalities and enhanced transportation efficiency is compelling, the lack of legal clarity concerning responsibility for accidents involving AVs introduces significant regulatory uncertainty. This uncertainty is not confined to one legal tradition or national context; it spans civil law and common law systems alike, revealing the structural limitations of legal systems designed around human agency when faced with autonomous decision-making machines.

At the core of the regulatory vacuum is the incompatibility between traditional legal doctrines and the technical realities of autonomous driving. The principle of negligence, foundational to tort law, presumes that liability is attached to a breach of a duty of care by an individual who could reasonably foresee

the consequences of their actions. In the case of an AV operating in autonomous mode, there may be no direct human act or omission to evaluate. When a vehicle swerves unexpectedly or fails to recognize a pedestrian due to a misclassification in its machine vision system, the question becomes whether this malfunction constitutes negligence and, if so, whose negligence it is. The legal subject here is no longer a person but a technological composite whose behavior is emergent and, in some cases, non-deterministic. This undermines the doctrinal tools that courts use to draw causal inferences and assess fault.

Strict liability regimes, often invoked in product liability claims, offer one possible avenue for resolving these questions. Under strict liability, manufacturers may be held accountable for harm caused by defective products regardless of fault or intent. However, this doctrine, when applied to AVs, raises novel challenges. In traditional product liability cases, the defect is typically physical—such as a faulty brake pad or a malfunctioning airbag. With AVs, the defect may lie in software logic or in a failure of the system to generalize correctly from training data to real-world scenarios. Determining whether such an error constitutes a "defect" under legal definitions, or whether it was an unavoidable limitation of current AI technologies, requires a technical sophistication that many courts are not equipped to exercise. The opaqueness of AV decision-making processes—often referred to as the "black box" problem—further complicates matters by rendering it difficult to trace the internal causality of the system's actions.

This legal ambiguity is exacerbated by the tension between encouraging technological innovation and ensuring public safety. Legislators are often caught between two conflicting imperatives. On one hand, they are under pressure to promote the development and deployment of AVs as part of national strategies for smart transportation, industrial upgrading, and carbon reduction. On the other hand, they are responsible for protecting the rights and interests of citizens who may be exposed to new and uncertain risks. The absence of clearly defined liability rules may deter consumers from trusting AVs and companies from investing in long-term innovation. The result is a chilling effect that benefits neither public safety nor economic competitiveness.

Some legal scholars have proposed that autonomous vehicles require a sui generis regulatory regime, one that does not merely modify existing liability doctrines but rethinks them entirely. This argument stems from the recognition that AVs represent a new class of agents—non-human, non-conscious, but autonomous in operation—that current law is ill-prepared to categorize. Creating new categories of legal responsibility, such as "algorithmic accountability" or "systemic fault," would allow the law to assign liability based on the systemic features of AVs rather than attempting to fit them into existing human-centered categories. This approach would also support the development of standardized benchmarks for software safety, data integrity, and algorithmic transparency.

The comparative study by Wei and Guo (2025) illustrates how different legal traditions are struggling to respond to these challenges. In their analysis of Chinese and German liability regimes, the authors show that while both countries recognize the unique risks posed by AVs, their legal responses diverge significantly. Germany has adopted a more proactive legislative stance by introducing specific provisions for autonomous driving in its Road Traffic Act, including requirements for data recording and liability insurance that reflect the technical realities of AV operation. China, by contrast, has relied on general provisions in its Tort Liability Law and Road Traffic Safety Law, supplemented by local pilot regulations in cities such as Beijing and Shanghai. This fragmented regulatory landscape creates uncertainty not only for legal practitioners but also for manufacturers and developers seeking to operate in multiple jurisdictions (Wei & Guo).

The regulatory gap is not solely a legal issue; it is also deeply conceptual. Law is a normative system that relies on shared understandings of agency, fault, and causation. AVs challenge these foundations by introducing machines that act without intention, learn without explicit programming, and adapt to environments in ways that even their creators may not

fully predict. Legal theorists such as A. Hevelke and J. Nida-Rümelin have argued that holding users responsible for the decisions of autonomous systems is morally indefensible when those users neither understand nor control the mechanisms by which decisions are made (Hevelke & Nida-Rümelin, 2015). This position implies that traditional fault-based liability, whether criminal or civil, may be normatively inappropriate in the context of full autonomy.

The conceptual gap also extends to the issue of foreseeability. One of the key elements in establishing legal responsibility is the notion that the harmful outcome was foreseeable and therefore preventable. But AVs operate on probabilistic reasoning. Their behavior is governed by neural networks that process inputs and generate outputs based on statistical inference rather than deterministic rules. This makes it difficult to predict how the vehicle will behave in novel or edge-case scenarios, such as an unexpected road closure or an ambiguous pedestrian gesture. When an accident occurs, it is often unclear whether it was the result of a failure in system design or an unavoidable limitation of the technology. The legal system, which depends on hindsight evaluation and counterfactual reasoning, is ill-suited to adjudicate such uncertainty.

One potential solution is the integration of mandatory technical standards into the regulatory framework. By establishing baseline performance metrics—such as minimum detection rates, decision latency thresholds, and fail-safe response protocols—regulators can create a clearer standard of care against which AV behavior can be judged. This would align the legal evaluation of AV accidents with the operational metrics used by engineers and developers. It would also shift the emphasis from retrospective blame to prospective safety assurance. However, setting such standards is not trivial. It requires close collaboration between legal experts, engineers, ethicists, and policymakers. It also requires continuous updating, as the pace of technological change is relentless.

Another emerging strategy involves the use of event data recorders (EDRs) and black-box systems to capture the operational state of the vehicle before and during an accident. These devices can provide vital evidence for reconstructing accidents and attributing fault. Some jurisdictions have already mandated their inclusion in autonomous vehicles, and the data they collect may play a critical role in future litigation and regulation. Yet the use of EDRs raises concerns about data privacy, ownership, and admissibility in court. The tension between transparency and confidentiality is a recurring theme in the regulation of AVs, reflecting the broader dilemma of how to balance individual rights with collective safety.

Cross-border regulatory coordination also presents a formidable challenge. As AVs are often developed by multinational corporations and tested across different legal environments, the absence of harmonized international standards creates regulatory arbitrage and enforcement gaps. Vehicles that meet the safety requirements in one country may fall short in another. Discrepancies in liability laws, data governance, and technical certifications hinder both consumer confidence and commercial scalability. Efforts by international bodies such as the United Nations Economic Commission for Europe (UNECE) to develop uniform regulations for automated driving systems have made some progress, but implementation remains uneven. Legal convergence in this area will require not just intergovernmental agreements but also shared philosophical commitments about the role of law in managing technological risk.

Finally, the conceptual reworking of liability must be accompanied by institutional reform. Courts may need to develop specialized technical benches or expert panels capable of understanding the nuances of machine learning and autonomous systems. Regulatory agencies must be endowed with sufficient authority and resources to monitor compliance, enforce standards, and update rules in light of new developments. Law schools and continuing legal education programs must prepare future practitioners to operate in a world where legal questions increasingly intersect with software design, data ethics, and systems engineering. Without these institutional adaptations, even the most forward-

looking regulations will remain difficult to implement and enforce.

The transition to autonomous mobility represents not just a technological shift but a jurisprudential crisis. The conceptual and regulatory frameworks that once provided legal certainty on the roads are being unmoored by the rise of non-human agents whose actions defy conventional theories of control and fault. Bridging these gaps will require a comprehensive reimagining of legal responsibility, grounded in interdisciplinary collaboration and an openness to normative innovation. Until such frameworks are developed, the law will continue to lag behind the machine, leaving society exposed to both legal uncertainty and moral ambiguity.

4. The Role of Moral and Social Expectations

Legal systems do not operate in isolation from the societies they serve. They are grounded in culturally and historically contingent expectations about fairness, accountability, and justice. Laws derive their legitimacy not only from formal authority but also from their resonance with widely held moral intuitions. When technology radically alters the structure of responsibility, the gap between legal determinations and public perceptions of right and wrong can widen, sometimes dramatically. Autonomous vehicles present precisely such a disruption, generating a new and uncertain space in which legal doctrines struggle to keep pace with evolving social attitudes.

Public intuitions about responsibility in road accidents are shaped by centuries of interaction with human drivers. When an accident occurs, people instinctively seek a human cause—a lapse of attention, a reckless maneuver, a failure to yield. This pattern of attribution is deeply ingrained, reinforced by insurance procedures, police reports, courtroom protocols, and everyday conversations. The shift to autonomous systems destabilizes this pattern. Machines lack consciousness and moral intent; they do not learn in the human sense, nor do they experience guilt, remorse, or care. Their actions are the outcome of algorithms, probability distributions, and sensor inputs. As such, the kinds of explanations they provide do not align with the psychological expectations most people bring to questions of blame and accountability.

Zhai, Wang, and Liu (2024) explored this mismatch in a controlled experimental setting. They presented over 2,600 participants with vignettes describing accidents involving fully automated vehicles. Even when the scenario clearly established that the vehicle was in control and the human occupant had no opportunity to intervene, respondents continued to assign significant moral and legal responsibility to the human "driver" (Zhai et al., 2024). This finding reveals not just a cognitive bias but a moral heuristic: people expect that someone, not something, should be held responsible. Responsibility in this sense is not just about causation; it is about personhood, intention, and the ethical structure of social relationships.

This cognitive and emotional expectation poses serious challenges for the legal regulation of AVs. If courts or legislatures adopt liability rules that diverge too sharply from public moral judgment, the result may be perceived as unjust, even when such rules are technically defensible. This perception, in turn, could erode trust in both the legal system and the technology itself. Public acceptance is not merely a matter of engineering; it is deeply bound up with questions of moral legitimacy. Trust in AVs requires not only confidence in their safety but also reassurance that when harm does occur, responsibility will be fairly assigned and justice meaningfully pursued.

The ethical complexity of AV decision-making is most evident in the so-called "trolley problem" scenarios, where the vehicle must choose between two harmful outcomes. These edge cases, although statistically rare, have become central to the moral discourse surrounding AVs. When a human driver makes a split-second decision that harms one person to save another, legal systems often treat it as a tragic accident without criminal liability. But when an AV makes such a decision, even if the outcome is statistically optimal, the absence of human agency transforms it into a profound moral dilemma. The public demands to know who programmed the algorithm, whose values were embedded in the decision matrix, and why a

machine was allowed to decide life and death outcomes at all.

These concerns are not purely hypothetical. In a study by Li, Zhao, and Malle (2016), participants were asked to evaluate different AV accident scenarios that required sacrificing one life to save many. The responses showed deep ambivalence. Many supported utilitarian decision rules in theory but rejected them when applied to AVs they themselves might ride in. This inconsistency—supporting a rule in the abstract while rejecting it in practice—reflects the fraught terrain of moral decision-making in automated contexts (Li et al., 2016). Ethical preferences become unstable when the agent is a machine, and the consequences directly affect the self.

This tension points to a broader phenomenon: the asymmetry in how people judge human and machine agency. Machines are often held to higher moral and safety standards than humans, even though they are not capable of moral reasoning. This is partly due to the perception that machines are controllable, programmable, and predictable—qualities that invite higher expectations. At the same time, people are less forgiving of machine failure, perceiving it not as a lapse but as a design flaw. When an AV causes harm, the public does not treat it as an accident in the traditional sense. Instead, it becomes evidence of technological overreach, systemic failure, or corporate negligence.

This asymmetry creates a dilemma for designers and regulators. On one hand, AVs must be trusted to make decisions in unpredictable environments. On the other hand, they must operate within a normative framework that aligns with public values, many of which are underdeveloped or contested. Embedding ethics into AV design—whether through ethical programming, value-sensitive engineering, or human-in-the-loop protocols—requires clarity about which values are at stake and whose values they are. Yet public opinion is often fragmented, inconsistent, and culturally variable.

Moral expectations around AVs also intersect with broader societal narratives about automation, control, and accountability. In societies with strong collectivist traditions, there may be greater tolerance for system-level solutions to harm, such as no-fault compensation schemes or collective liability models. In societies that emphasize individual responsibility and legal formalism, there may be greater insistence on identifying a culpable party. These differences influence how new technologies are received and what kinds of legal reforms are politically and culturally acceptable.

The role of media in shaping moral expectations cannot be overlooked. High-profile AV accidents, even when statistically rare, generate intense public scrutiny. They are often framed in emotive and sensationalist terms, emphasizing loss, malfunction, and corporate irresponsibility. This framing reinforces the moral intuition that machines should not be in control and that when they are, someone should answer for the consequences. Legal responses shaped in the aftermath of such events may reflect not reasoned analysis but reactive sentiment, leading to regulations that are either too stringent or inadequately justified.

Educational and institutional strategies may help bridge the gap between legal doctrines and moral expectations. Public engagement initiatives, citizen juries, and participatory design processes can democratize the conversation around AV ethics and responsibility. By involving stakeholders early and transparently, regulators can foster a shared understanding of the trade-offs involved and the principles that should guide AV behavior. This, in turn, can inform legal reforms that resonate with both normative commitments and technological realities.

In the longer term, societal expectations may shift as exposure to AVs increases and familiarity breeds acceptance. Just as early resistance to elevators without operators eventually gave way to trust in automation, so too may public discomfort with driverless vehicles decline over time. But such shifts are not guaranteed, and they depend on a regulatory environment that both protects the public and respects their moral sensibilities. If the law fails to recognize the moral dimension of public attitudes, it

risks delegitimizing itself and undermining the social fabric it seeks to uphold.

Zhai et al.'s findings underscore the need for an interdisciplinary approach to AV regulation, one that combines legal analysis, psychological research, and ethical theory. Legal responsibility must not be decoupled from social legitimacy. Assigning blame in a way that is procedurally correct but morally unintelligible to the public may satisfy formal requirements without achieving justice. Conversely, aligning legal standards too closely with fluctuating public sentiment may jeopardize consistency and predictability. The challenge is to find a balance that honors both democratic accountability and principled legal reasoning.

This balance is especially delicate in transitional stages of automation, where partial autonomy coexists with residual human oversight. In these contexts, moral expectations become even more confused. Is the human driver expected to intervene instantly if the system errs? Is inaction tantamount to negligence, even when reaction time is insufficient? Should designers be held responsible for fostering false confidence in automation, or should users bear responsibility for misunderstanding the system's limits? Each of these questions implicates different layers of moral and legal judgment, none of which admit easy answers.

The psychological phenomenon of moral distancing also plays a role. When harm results from the actions of a machine, observers often experience a weakened sense of empathic engagement. The victim may be real, but the perpetrator is faceless. This emotional gap can lead to under-reaction or misdirected blame, distorting both public discourse and legal interpretation. Addressing this requires cultivating new forms of moral vocabulary capable of articulating responsibility in human-machine collectives.

Autonomous vehicles present a powerful test case for the integration of ethics, law, and technology. They force society to ask not just what can be automated but what should be. They challenge the assumption that legal responsibility can be cleanly assigned in systems characterized by distributed agency and emergent behavior. They demand new models of justice that can accommodate the absence of human intent and the presence of machine decision-making. Above all, they call for a recalibration of moral expectations to match the hybrid realities of 21st-century mobility.

5. Ethical and Philosophical Dilemmas

The ethical implications of autonomous vehicles challenge not only conventional legal categories but also foundational philosophical concepts related to agency, responsibility, and moral judgment. While law focuses on compliance, deterrence, and liability, ethics demands an account of what *ought* to be done, even in scenarios that fall outside the reach of statutory definitions. The automation of moral choice in AVs demands scrutiny because it represents a delegation of human judgment to non-human systems. In this delegation, the questions of accountability, intention, and the meaning of harm become increasingly opaque.

The classic illustration of this ethical opacity is the so-called "trolley problem," which forces a decision between harming one person or allowing harm to come to many. When transposed to the context of AVs, this dilemma becomes more than a thought experiment—it becomes a design decision encoded into the vehicle's decision-making architecture. An AV's programming may determine, for instance, whether to prioritize the safety of its occupants or that of pedestrians in unavoidable crash scenarios. Such decisions carry profound moral weight, yet are made preemptively, not in the heat of the moment, and by engineers and ethicists removed from the situation. The ethical accountability of these actors becomes a key concern, as they shape the normative framework within which machines will act.

Philosophical inquiry into responsibility has long emphasized the importance of intent, autonomy, and moral agency. Machines possess none of these qualities in the conventional sense. They do not have intentions, cannot reflect on their actions, and are not moral subjects. This creates a vacuum in moral responsibility. When an AV causes harm, society instinctively searches for an agent to blame, yet no such agent exists within the machine. The

responsibility must therefore be distributed across the socio-technical network that produced and deployed the system. This includes software developers, data scientists, corporate executives, regulators, and legislators. The ethical dilemma lies in the absence of a clear locus of intent, and the diffusion of agency across non-human actors and institutional structures.

Hevelke and Nida-Rümelin (2015) argue that traditional models of moral responsibility are inadequate in this context. They suggest that placing the burden of responsibility on end-users—those riding in or overseeing AVs—is morally unjustified when those users have no meaningful control over the vehicle's real-time decisions. Instead, responsibility should be understood collectively, grounded in institutional and systemic contributions to the decision-making framework (Hevelke & Nida-Rümelin). This ethical shift aligns with contemporary theories of distributed agency, which reject the idea that only individual actors can be moral agents. It also reflects a pragmatic recognition that harm can be the result of cumulative design choices made across different domains.

Designing moral behavior into AVs also raises questions about whose morality is encoded and whether that moral code is universally acceptable. Cultural variation in moral reasoning complicates any attempt to establish a standardized ethical protocol. A utilitarian logic of maximizing lives saved may be accepted in one jurisdiction but rejected in another where rights-based deontological ethics are dominant. Engineers are therefore tasked not just with technical implementation but with navigating the pluralism of moral worldviews. This burden is both philosophical and political, requiring legitimacy and public deliberation in how AVs are programmed to act.

Ethical dilemmas intensify as AVs begin to function within increasingly complex social environments. Decisions about lane changes, merging behavior, and pedestrian interaction all involve implicit moral norms. These micro-interactions, while less dramatic than trolley-like choices, shape public perceptions of fairness, empathy, and respect. A vehicle that always asserts right-of-way may be legally compliant but ethically hostile. A vehicle that is overly deferential may be seen as weak or unpredictable. Balancing assertiveness and caution requires moral sensitivity that machines cannot achieve autonomously. Designers and policymakers must fill this ethical gap with rules that are not only safe but socially intelligible.

Philosophy also plays a role in evaluating the broader societal effects of automation. There is an ethical question about the justice of replacing human labor and decision-making with machine alternatives. The deployment of AVs will affect millions of professional drivers, reshape public space, and redefine mobility access. Ethical analysis must ask not only what decisions AVs should make in emergencies, but what kind of society is being built through their adoption. The dilemmas are not limited to split-second crashes but extend to questions of equity, dignity, and collective risk distribution.

Addressing these dilemmas requires interdisciplinary engagement. Legal reasoning alone is insufficient. Philosophical ethics must inform regulatory frameworks, public consultations must supplement technical design, and educational programs must equip engineers with the tools to reflect on their normative responsibilities. The goal is not to eliminate all ethical risk—such a standard is impossible—but to ensure that decisions involving harm, fairness, and responsibility are made with transparency and justification. The moral legitimacy of AVs will depend not only on their safety records but on the public's confidence that their actions are grounded in values that reflect democratic deliberation and ethical reasoning.

6. Path Forward

Addressing the legal, ethical, and technical complexities associated with autonomous vehicles requires a coordinated, multi-actor effort. No single discipline or institution possesses the full capacity to define responsibility, ensure public safety, and preserve innovation within the rapidly shifting context of machine-driven mobility. The challenges involved cannot be solved by adapting existing

liability doctrines alone; they demand the construction of new legal frameworks that distribute accountability, define safety obligations, and incorporate public values.

One foundational step is the development of hybrid liability regimes. These models recognize that harm involving autonomous vehicles often results not from individual misconduct but from systemic and distributed causes. Under such regimes, responsibility can be shared among developers, manufacturers, platform operators, and possibly public infrastructure providers. Product liability may apply when harm results from flawed software design, hardware malfunction, or inadequate warnings. Enterprise liability is appropriate where a corporate entity oversees deployment and control, even if it delegates design to third-party suppliers. These overlapping liability layers shift the focus from pinpointing a singular guilty party to assigning responsibility across the network of actors who contribute to the operation of autonomous vehicles.

Legal clarity requires not just conceptual reform but enforceable technical standards. Regulatory authorities must define operational benchmarks—such as system reaction times, minimum fail-safe conditions, real-time override capabilities, and environmental adaptability thresholds. These standards should reflect engineering realities without locking innovation into outdated criteria. Legal definitions of system failure must also distinguish between reasonable limitations inherent in probabilistic learning models and negligence in design, training, or maintenance. Without such nuance, liability decisions risk being arbitrary or technologically incoherent.

Fairness to accident victims requires reforms that extend beyond tort litigation. In cases where fault is ambiguous or legally diffused, traditional court processes may delay compensation or leave claimants without effective remedies. Establishing **accident compensation schemes** tailored to AV-related harm could provide a reliable and impartial safety net. These schemes, supported through pooled industry contributions or public-private arrangements, would allow for timely compensation while preserving the option for parties to seek judicial resolution in cases of gross fault or systemic negligence.

No single regulatory body can cover the technical, ethical, and legal dimensions of autonomous mobility. Institutional coordination is necessary across transportation, consumer safety, insurance, and cybersecurity sectors. Inter-agency regulatory frameworks should share data, co-develop standards, and avoid conflicting mandates that create legal uncertainty for developers and users. Independent technical certification entities, responsible for verifying compliance with safety protocols and transparency obligations, should function autonomously from commercial stakeholders to avoid conflicts of interest.

Autonomous vehicles also raise questions that extend beyond national borders. International regulatory convergence is essential for global safety, trade interoperability, and legal predictability. Variations in liability rules, data-sharing norms, and safety verification standards can create incentives for jurisdiction shopping and technological evasion. Regional treaties or frameworks under multilateral institutions could establish shared minimum requirements, encouraging best practices while respecting domestic legal diversity.

Legal reform efforts must also remain sensitive to public values. Technocratic policy instruments will not be effective unless they are accepted as legitimate by the populations they affect. Structured public engagement mechanisms, such as ethics panels, consultative forums, and citizen advisory boards, provide spaces where ordinary people can deliberate on issues such as moral decision-making by machines, privacy in data collection, and expectations of human oversight. These engagements not only generate democratic legitimacy but help align technical priorities with evolving social norms.

Progress on AV governance requires more than legal innovation. It involves sustained effort among legislators, regulators, engineers, insurers, ethicists, and the public. Responsibility in a technologically mediated environment can no longer be assigned

along linear or individualistic lines. It must be redefined as a collective endeavor, embedded in institutional architecture and capable of adapting as autonomous systems become more embedded in everyday life. Only by building this kind of multi-stakeholder foundation can law and policy retain their relevance in an increasingly automated world.

7. Conclusion

The arrival of autonomous vehicles represents not just a technological inflection point but a profound legal and moral challenge. The very structure of responsibility, long rooted in human agency and intent, is being destabilized by the emergence of systems that operate without consciousness, that learn from data rather than instruction, and that often behave in ways opaque even to their creators. This transformation does not occur in a legal vacuum. It collides directly with centuries-old doctrines of fault, liability, and causation—doctrines that were designed to adjudicate conflicts between individuals, not between a person and a machine learning model embedded in a multilayered supply chain.

The fragmentation of responsibility across manufacturers, developers, data providers, operators, and end-users leaves existing legal frameworks stretched beyond their limits. Traditional tort and product liability doctrines rely on clear chains of causation and the presence of a culpable actor. AV accidents, by contrast, often emerge from diffuse system interactions. A software misjudgment, a failure in sensor calibration, or a gap in training data may result in harm, yet no individual actor may be provably negligent in a conventional sense. As technical complexity increases, the ability of courts to reconstruct fault using analog tools diminishes.

The conceptual vacuum this creates is not merely procedural—it is normative. A society must decide not just how responsibility can be assigned, but how it should be assigned. Law must balance the imperative to provide compensation and deterrence with the need to maintain technological progress and social trust. When the public perceives legal outcomes that are technically accurate but morally dissatisfying, the legitimacy of the entire framework begins to erode. Responsibility is as much about justice as it is about liability, and both must remain visible and comprehensible in the public sphere.

In response to this complexity, reform cannot be isolated to statute books or courtroom procedures. It must be structural. Legal frameworks must evolve to reflect systemic causality rather than individual failure. Hybrid liability regimes that combine aspects of fault-based and strict liability offer one pathway. Compensation mechanisms that bypass prolonged litigation in ambiguous cases can restore fairness to victims. Clear safety standards embedded in technical regulation, not legal abstractions, are needed to make responsibility tangible and enforceable. These reforms must also be designed with institutional infrastructure in mind: expert regulators, interdisciplinary courts, and international harmonization mechanisms are all prerequisites for a legal order capable of responding to autonomous mobility.

Yet legal reform alone is insufficient. Moral and psychological expectations shape how laws are received and obeyed. Public discomfort with machines making irreversible decisions, even if statistically optimal, cannot be dismissed as irrational. It must be met with design transparency, participatory rulemaking, and accountability structures that reflect collective values. Ethical questions about who programs decisions, how data is governed, and whose safety is prioritized must not be deferred to technical experts alone. Law must reclaim its place as the space in which these choices are openly debated and socially resolved.

A path forward requires shared responsibility. No single actor—not the manufacturer, not the regulator, not the user—can carry the weight of judgment alone. Responsibility must be shared, structured, and situated within a legal system flexible enough to adapt yet principled enough to preserve fairness. If law is to retain its relevance in the age of automation, it must not retreat in the face of complexity. It must respond with clarity, with moral seriousness, and with institutional imagination equal to the task.

References

Hevelke, A., Nida-Rümelin, J. (2015). Responsibility for Crashes of Autonomous Vehicles: An Ethical Analysis. *Sci Eng Ethics*, *21*, 619–630. https://doi.org/10.1007/s11948-014-9565-5

Li, J., Zhao, X., Cho, M., Ju, W. et al. (2016). From Trolley to Autonomous Vehicle: Perceptions of Responsibility and Moral Norms in Traffic Accidents with Self-Driving Cars. *SAE Technical Paper 2016-01-0164*, https://doi.org/10.4271/2016-01-0164

Liu, P., Du, M. & Li, T. (2021). Psychological consequences of legal responsibility misattribution associated with automated vehicles. *Ethics Inf Technol*, *23*, 763–776 https://doi.org/10.1007/s10676-021-09613-y

Wei, X., & Guo C. (2025). A Comparative Legal Study on the Attribution of Liability for Autonomous Driving Accidents in China and Germany. *Country, Area and Advanced Technology*, *1*(1). https://doi.org/10.37420/j.caatj.2025.003

Zhai, S., Wang, L., & Liu, P. (2024). Not in control, but liable? Attributing human responsibility for fully automated vehicle accidents. *Engineering*, *33*, 121-132. https://doi.org/10.1016/j.eng.2023.10.008

The Legal Nature of Digital Collectibles and the Adaptive Challenges of the Civil Law Property System

Zefan Jiang[1]*

[1] Hefei University, China
* Correspondence: jiangjiangzf@163.com

https://doi.org/10.53104/curr.res.law.pract.2025.07005

Abstract: This paper explores the evolving legal nature of digital collectibles, particularly non-fungible tokens (NFTs), and the systemic challenges they pose to civil law property regimes. Within civil law traditions, the concept of property is bound by codified categories and the principle of *numerus clausus*, which restricts recognition to a limited set of property forms. Digital collectibles, by contrast, are decentralized, programmable, and technologically mediated, defying conventional classifications such as tangible movables or intangible rights. This disconnect generates uncertainty regarding their ownership, transferability, inheritance, and enforceability under traditional legal frameworks. The analysis addresses how digital assets undermine the foundational assumptions of possession, registration, and state-backed enforcement. Particular attention is given to the problems of inheritance continuity, token fragmentation, cross-border legal conflicts, and the role of private key control in lieu of legal title. Drawing from emerging theoretical debates and comparative jurisprudence, the paper proposes a trajectory of adaptive legal reform that includes doctrinal reinterpretation, statutory innovation, and the development of interoperable legal-technical standards. The study concludes that civil law systems must reconceptualize the legal object and embrace a pluralistic approach to digital property to ensure institutional relevance in the era of algorithmic ownership.

Keywords: digital collectibles; NFTs; civil law property; numerus clausus; legal object; smart contracts

Received: 11 July 2025

Revised: 5 August 2025

Accepted: 8 August 2025

Published: 15 August 2025

Citation: Jiang, Z. (2025). The Legal Nature of Digital Collectibles and the Adaptive Challenges of the Civil Law Property System. *Current Research in Law & Practice, 3*(1), 55-70.

1. Introduction

Digital collectibles, especially non-fungible tokens (NFTs), signal a transformative shift in the conceptual infrastructure of property law. This transformation is not merely a question of integrating new technologies into existing legal frameworks; it necessitates the recalibration of legal concepts that have been relatively stable for centuries. The civil law tradition—grounded in the primacy of codification, the rigidity of the *numerus clausus*, and the ontological clarity of things (*res*)—is particularly strained by the emergence of assets that are neither tangible nor reducible to traditional legal categories.

Civil law systems have historically relied on the physicality of property to define possession and

ownership. The traditional civil notion of possession as factual control of a tangible item breaks down in the face of blockchain technologies. A private cryptographic key grants access and transferability, but not through spatial control or factual custody in the Roman-law sense. NFTs exist as unique entries on a distributed ledger, verifiable through cryptographic hashing and consensus protocols, but fundamentally detached from material referents. Unlike a deed to land, which points to a registrable asset in the real world, an NFT might merely represent a metadata pointer to a digital file stored on an external server, with no guarantee of permanent linkage or legal stability (Hutson et al., 2023).

This detachment produces friction within legal systems where "property" is bound to physical or at least well-defined intangible forms such as intellectual property rights or debt instruments. A core ambiguity lies in whether NFTs themselves constitute the object of property rights, or whether they merely serve as a digital representation of something else—such as a license, a contractual right, or a pointer to an off-chain resource. The question is not merely theoretical; it determines whether NFTs fall within the scope of proprietary protection or must be adjudicated through adjacent legal frameworks such as contract law or intellectual property law. If NFTs are to be treated as legal objects (*corpora*), they pose a challenge to the numerus clausus principle that restricts recognized property forms in civil law. If, instead, they are treated merely as technical instruments or tokens signifying access or usage rights, then the enforceability of associated claims must be anchored in auxiliary legal regimes, and not in the proprietary framework itself.

Blockchain as a technological substrate further complicates the matter. Its decentralized, immutable, and pseudonymous nature introduces new challenges for legal enforcement and regulatory design. The legal order traditionally identifies ownership through registration, contracts, or physical control. But with NFTs, ownership is entirely mediated through a blockchain wallet address—control is code-based, not contract-based. Wyczik notes that while common law systems have begun to recognize digital assets as personal property through judicial interpretation, civil law systems struggle due to the lack of legislative and conceptual infrastructure for recognizing programmable ownership as legally operative property rights (Wyczik, 2025).

Another dimension of difficulty lies in the multi-jurisdictional and platform-dependent reality of NFTs. Smart contracts can be coded with complex transfer restrictions, royalty mechanisms, or usage conditions. These may be enforceable in code, but not necessarily aligned with legal enforceability in civil courts. Roman observes that this divergence between code-based logic and law-based logic threatens the coherence of civil law systems built on predictability and transparency. In practice, the enforcement of property rights over NFTs may depend more on platform governance and digital infrastructure than on judicial or statutory authority.

Intellectual property law introduces additional ambiguity. Many NFTs purport to transfer "ownership" of digital artworks or content, but without any actual assignment of copyright or moral rights. This leads to a bifurcation of ownership: one party owns the NFT (the token), another retains IP over the referenced content. Blandino explores how French private law struggles with this dualism, as the principle of unity in ownership is destabilized when control over access is divorced from legal authorship (Blandino, 2025).

The legal implications deepen when NFTs intersect with fractional ownership, securitization, or derivative financial products. Jiménez & Jiménez document how decentralized platforms have begun offering tokens that represent fractions of a larger NFT or pooled assets. This blurs the line between property and securities law. The traditional concept of indivisibility in unique property is technologically undermined by smart contracts that allow near-infinite divisibility, altering the economic and legal nature of the asset (Jiménez & Jiménez, 2023).

Even where civil law systems acknowledge these assets, regulatory regimes often fall back on analogies that fail to grasp the distinctiveness of blockchain-based ownership. The analogy to traditional chattels

or titles remains inadequate. Soares and Kauffman show how legal challenges in Europe and Latin America highlight the failure of analogical reasoning to fully capture the logic of decentralized digital property (Soares & Kauffman, 2024).

Judicial systems in civil law jurisdictions are beginning to tentatively engage with these questions, but mostly through fragmented, issue-specific rulings. A broader theoretical response demands a re-imagining of the ontology of legal objects, the decoupling of ownership from physical possession, and a reconstruction of property doctrines to accommodate assets whose persistence, transferability, and identity are governed by code rather than legal fiat.

The deeper question remains whether civil law property systems can adapt incrementally, or whether they require foundational rearticulation. Moringiello and Odinet argue that civil law systems have historically redefined property categories during periods of major technological and economic change—printing presses, industrial assets, dematerialized securities—suggesting a latent capacity for transformation (Moringiello & Odinet, 2022). Whether NFTs will catalyze such a transformation depends on whether legislators and scholars can forge new taxonomies of property that reflect the ontological shift from things to data.

2. Conceptualizing Digital Collectibles as Legal Objects

Civil law property theory is predicated on the notion of the "thing" (*res*) as a precondition for ownership. Ownership in this context is not an abstract claim but a structured legal relationship rooted in the nature of a legally recognized object. Traditionally, these objects are categorized either as corporeal (tangible) or incorporeal (intangible), with legal recognition contingent upon their capacity to be bounded, possessed, transferred, and subjected to exclusive control. In this framework, the "thingness" of property is both a metaphysical and legal prerequisite. Digital collectibles, particularly non-fungible tokens (NFTs), challenge the foundations of this classification, presenting new forms of existence that resist assimilation into conventional categories.

Digital collectibles are fundamentally informational constructs. They are encoded representations of uniqueness, embedded on decentralized ledgers, and operationalized through smart contracts. Unlike intangible rights such as debts or intellectual property, which are historically recognized as rights in personam or rights in rem derived from statutory frameworks, digital collectibles exist natively on technological platforms. Their existence and functionality are defined not by law but by code. This technological ontology defies the object-subject division that underlies classical property law. As Michael Madison argues, digital objects are not "things" in the traditional sense, but functional constructs whose design is determined by code, infrastructure, and institutional interpretation (Madison, 2005).

The classical civil law system begins with the assumption that legal things exist independently of the law itself. The law merely recognizes and assigns legal consequences to things that are materially real. Civil codes often define things in terms of spatial occupation and tangibility. For instance, the German Civil Code (BGB) defines "thing" (*Sache*) under §90 as a corporeal object, excluding digital entities entirely. This excludes digital collectibles from the outset, barring any attempt at their legal classification unless new legislative or doctrinal mechanisms are introduced. The French Code Civil similarly roots ownership in physical possession or material representations of rights, leaving no space for natively digital constructs whose function and persistence are technologically rather than legally determined (Blandino, 2025).

The categorization problem is exacerbated by the semiotic nature of digital collectibles. An NFT is not the digital artwork or media it references; it is a ledger entry that points, usually via a metadata hash, to a location where the media is stored. This separation between token and referent introduces ontological instability into the legal classification. Is the object of ownership the token, the metadata, the referenced file,

or the conceptual package they form together? None of these layers is sufficient to constitute a legal object under traditional property definitions. The token cannot be possessed in a physical sense; the file is usually not stored on-chain; the reference may decay as servers go offline; the linkage between token and asset is frequently governed only by informal norms or platform-level agreements.

This instability demands a reassessment of what constitutes a "thing" in law. Contemporary legal theory has proposed several pathways. One is the functionalist redefinition of things based on exclusionary control. Thomas Merrill and Henry Smith's theory of the numerus clausus posits that legal property must enable standardized exclusionary rights to ensure clarity and transactional efficiency. In their framework, a property right is legally sustainable if it allows a defined subject to exclude others from a resource. Applying this to digital collectibles, one could argue that control over the private key associated with an NFT wallet constitutes exclusionary control over the token. However, this analogy is strained. Control in blockchain systems is a function of cryptography and consensus protocols, not legal enforcement. Possession is not a factual state but a mathematical condition governed by access credentials. The law plays no active role in maintaining or validating that possession.

The legal ambiguity is compounded by the lack of uniformity in what NFTs represent. Some NFTs are used as tickets, others as keys to exclusive digital communities, and still others as financial instruments or identity markers in metaverse platforms. The variability of function undermines the possibility of defining NFTs as a coherent class of legal objects. If the legal system treats all NFTs identically, it ignores the substantive differences in their use. If it distinguishes among them by function, it risks fracturing the legal concept of digital property into incompatible micro-categories. This tension has led some scholars to propose that digital objects should be classified not by ontology but by affordance—what they allow users to do and how they are used within a broader technological and social context.

Ownership in civil law is tied to concepts of control, benefit, and risk. In digital systems, control is operationalized via smart contracts and platforms. Benefit is frequently realized through monetization, resale, or access to gated services. Risk is borne not through natural degradation or theft in the traditional sense but through loss of access credentials, platform deprecation, or regulatory interventions. These shifts in how control and risk manifest call into question whether legal ownership in the classical sense can be meaningfully applied. If losing a password results in irreversible loss of access, does this constitute legal alienation? If a platform discontinues support for an NFT standard, does that constitute destruction of the object? Legal definitions lack the vocabulary to engage with such questions because they assume a world in which property is stable, persistent, and enforceable by courts and institutions.

There is also a distinction between metaphysical and institutional recognition of objects. Something may exist ontologically as an object but lack institutional recognition as a legal thing. Digital collectibles exist and are traded, assigned value, and used in complex financial and cultural transactions. They are ontologically robust but legally invisible or only partially visible. Law's failure to classify them is not an indication of their insignificance but of its epistemic lag. As Peter Goodrich has written, the law often functions through "juridical signs" that trail the objects and practices they attempt to order. The legal system's inability to name or classify digital collectibles renders them formally ambiguous even as they are economically and socially significant.

Attempts to resolve this through analogy—by treating digital collectibles like dematerialized securities, intellectual property licenses, or contractual rights—inevitably run into conceptual limits. Securities are backed by legal entities and subject to disclosure regimes. Licenses depend on intellectual property statutes and entail limited-use rights. Contractual rights are enforceable against named counterparties. NFTs often lack identifiable issuers, rely on open access, and involve platforms that disclaim responsibility for governance. Their legal status is

therefore decentered, existing in a liminal zone between property, code, and community norms.

The application of private law principles to digital assets is emerging as a contested site of doctrinal innovation. Some courts have begun to treat cryptocurrencies as property capable of being held in trust, seized, or subjected to restitution. The Singapore International Commercial Court in *B2C2 Ltd v Quoine Pte Ltd* recognized that contractual obligations involving digital tokens could be enforced under common law principles. However, this approach has not been widely replicated in civil law jurisdictions, where the recognition of property hinges on codified definitions. The German Federal Court of Justice (BGH) has not yet ruled definitively on whether NFTs qualify as things or rights. Legal uncertainty persists, leaving users and institutions in a state of interpretive flux.

One possible doctrinal avenue lies in the concept of *immaterialgüterrecht*, or the law of intangible goods. Swiss and German law have developed limited frameworks for recognizing data and digital signals as potential legal interests, particularly in the context of data protection or software licensing. These could be extended to accommodate digital collectibles, not as things per se but as rights encoded in a new technological form. This would require substantial legislative reform, but it is theoretically plausible. A less ambitious path would be to create a sui generis category for blockchain-based tokens, similar to how some jurisdictions have carved out special rules for electronic money or digital signatures.

Any comprehensive reclassification must also grapple with the normative consequences of treating digital collectibles as legal objects. Doing so would vest owners with enforceable rights and impose correlative duties on third parties. It would require the state to recognize blockchain-based transactions as constitutive of legal transfer. It would invite the courts to adjudicate disputes over smart contract execution, digital theft, and token fraud. These changes are not merely technical; they implicate deep questions about the scope of state authority, the legitimacy of code as law, and the autonomy of decentralized systems.

The political economy of digital collectibles further complicates their legal recognition. These tokens often function within platform ecosystems where control is exercised by corporations or decentralized autonomous organizations (DAOs). Legal recognition of the tokens might empower platform users but also expose them to regulatory burdens. Legislators must weigh the risks of legitimizing speculative instruments against the need to provide legal certainty. Some jurisdictions, such as the United Kingdom, have begun to explore the idea of recognizing digital tokens as a new form of personal property, building on the 2019 UK Jurisdiction Taskforce Legal Statement on Cryptoassets and Smart Contracts. Yet these statements remain advisory, lacking the force of codified law.

Conceptualizing digital collectibles as legal objects demands a paradigm shift. It is not enough to force new technologies into old conceptual boxes. The law must develop new categories that reflect the realities of digital existence: modularity, programmability, conditionality, and platform dependence. This will require sustained theoretical engagement and legislative creativity. As law has adapted in the past to encompass railroads, telegraphs, and dematerialized shares, so too must it evolve to accommodate assets that exist entirely in the space of code, networks, and user interaction.

3. Property Law and Numerus Clausus Constraints

The civil law tradition is underpinned by structural coherence, doctrinal rigidity, and formal certainty. Among its defining features is the principle of *numerus clausus*, which limits the forms of property rights that individuals can create and transfer. This principle operates as a safeguard for third-party expectations and market efficiency, by ensuring that legal systems only recognize a fixed number of property rights that are publicly knowable and predictable in content. While this rigidity promotes legal security and transactional clarity in traditional economies, it becomes a constraint in the digital age, where new forms of value, particularly digital collectibles such as non-fungible tokens (NFTs), emerge beyond the established taxonomy of property.

The principle of *numerus clausus* is a doctrinal commitment that not only defines which property interests are valid but also prohibits the private creation of novel property forms outside those recognized by law. In civil law systems such as those of France, Germany, and many East Asian jurisdictions, this doctrine is entrenched in both statute and jurisprudence. The justification for this constraint is twofold: to prevent fragmentation of property rights that could impair marketability, and to maintain a legal order that facilitates efficient dispute resolution. The assumption underlying this justification is that legal certainty requires limitation. By constraining legal innovation in property relations to the legislature, civil law systems discourage ad hoc contractual invention of hybrid or sui generis property interests.

Digital collectibles expose the limitations of this constraint. NFTs are inherently multifaceted; they can represent digital artworks, identity credentials, gaming assets, virtual real estate, or access rights. Their use cases transcend the fixed forms of property traditionally recognized by civil codes. Yet under the principle of *numerus clausus*, legal systems cannot easily accommodate assets that do not fit into predefined categories such as movables (*res mobilis*), immovables (*res immobilis*), or intangible rights like claims, shares, or intellectual property. This creates a legal void. NFTs exist in an ambiguous zone between data and property, between technological function and legal form. Civil law frameworks, designed around clear typologies of things and rights, are often ill-equipped to classify or govern such hybrid entities without significant conceptual and legislative adaptation.

The classification problem arises not merely from conceptual unfamiliarity but from doctrinal design. NFTs, as tokens recorded on a blockchain ledger, do not occupy space, cannot be possessed in the traditional sense, and lack inherent economic function. Their value derives from social consensus and platform infrastructure. Civil law typically requires that property objects be clearly defined, rivalrous, and susceptible to exclusion or appropriation. NFTs fail on multiple counts under this definition. Their existence is predicated on technological conditions, and their utility and identity are often governed by smart contracts, which are autonomous and self-executing, not traditional legal instruments.

Attempts to analogize NFTs to recognized property forms have been unsatisfactory. One approach is to treat them as dematerialized movable goods, akin to digital files or electronically transferable instruments. Another is to frame them as bearer instruments, where control of the cryptographic key is equated with legal possession. A third is to associate them with intellectual property licenses. Each analogy captures a facet of NFTs but fails to reflect their composite nature. Unlike digital files, NFTs do not store content; they reference it. Unlike bearer instruments, NFTs cannot be destroyed or physically transferred; their existence is inscribed on a public ledger that is immutable. Unlike licenses, NFTs often lack express legal terms defining scope, duration, and enforceability. None of these analogies provides a fully satisfactory doctrinal foundation for treating NFTs as legal property under a *numerus clausus* system.

The risk of overextension also looms large. If civil law jurisdictions begin to treat NFTs as property without a clear framework, they risk destabilizing the coherence of property doctrine. Doctrines such as transfer formalities, publicity of rights, and succession mechanisms are designed for well-defined property forms. Applying them to NFTs without adaptation could generate inconsistencies and legal uncertainty. At the same time, refusal to recognize NFTs as property at all leaves their holders without recourse to fundamental legal protections, such as enforcement of ownership, restitution of unjust enrichment, or liability for wrongful interference. This limbo is both doctrinally problematic and economically destabilizing in markets where NFTs are traded with significant monetary and symbolic value.

Some jurisdictions have sought to mitigate these tensions through legislative experimentation. Liechtenstein's 2019 Blockchain Act (Token and TT Service Provider Act) is a notable example. It introduced the legal concept of the "token container

model," whereby tokens can represent rights or claims linked to assets, enabling their recognition as property-like entities. While not a civil law jurisdiction in the strict sense, Liechtenstein's approach is influential because it demonstrates a pathway for reconciling digital innovation with structured legal categories. The Act does not expand the *numerus clausus* per se, but it creates a legislative wrapper that permits tokens to function within the existing taxonomy.

Other scholars have argued for a rethinking of the *numerus clausus* principle itself. Alexandra Braun notes that *numerus clausus* is often justified on grounds that assume static and paper-based property regimes, and that its rigidity is increasingly at odds with the modular and programmable nature of digital assets (Braun, 2020). The digital economy, she argues, operates through a different logic—where value is created through interoperability, composability, and networked utility—none of which aligns with the closed and hierarchical structure of classical property law.

The adaptability of *numerus clausus* also differs across legal systems. In common law jurisdictions, while property forms are also limited, courts have greater latitude to recognize new categories through case law. Civil law systems, by contrast, rely on legislative enumeration. This structural difference explains why common law courts have been quicker to recognize cryptocurrencies and NFTs as species of personal property, as seen in cases like *AA v Persons Unknown* in England. Civil law systems, such as those in Germany or Japan, face more substantial doctrinal barriers. The legislative process is slow, and the required revisions implicate foundational concepts like *Besitz* (possession) and *Eigentum* (ownership).

Civil law systems may need to reconsider whether *numerus clausus* should remain a gatekeeping mechanism in an era of algorithmic governance and platform-based economies. The practical realities of digital ownership have already overtaken legal doctrine. NFTs are bought, sold, inherited, and used as collateral. Platforms implement quasi-legal mechanisms such as dispute resolution and revocation policies. These practices amount to a kind of de facto property regime that operates outside formal law. Ignoring this regime risks alienating law from the economic and social practices it is meant to regulate.

One way forward is to introduce statutory recognition of NFTs as legal objects without necessarily labeling them as full property rights. They could be recognized as *digital tokens with enforceable use claims* or *platform-native quasi-things*, akin to how financial derivatives or electronic money are regulated under bespoke regimes. This would preserve the integrity of *numerus clausus* while providing a legal hook for enforcement, taxation, and inheritance. Such a move would echo earlier legal evolutions, such as the treatment of dematerialized securities in the 20th century or the emergence of *immaterialgüterrecht* in the realm of intellectual property.

Property law has historically evolved by absorbing innovations into its conceptual framework when economic necessity and social practice demanded it. The recognition of corporate shares, patents, and digital money all required departures from strict interpretations of legal objects. Digital collectibles represent a new frontier in this tradition. They call for a recalibration of the relationship between formal constraints and functional utility. The *numerus clausus* principle has served an important role in limiting complexity, protecting third-party interests, and preserving legal order. But its preservation must not come at the cost of excluding entire classes of socially and economically significant assets from legal recognition.

4. Ownership and Transferability in a Decentralized Digital Context

The foundational concepts of ownership and transferability in civil law property systems have historically been defined through materiality, possession, and state-backed registries. Ownership has traditionally relied on visible, physical control over an object and the possibility of asserting one's rights through legally recognized mechanisms of possession, transfer, or inheritance. The digitalization

of assets presents a radical shift in this structure, particularly with the introduction of blockchain-based tokens such as cryptocurrencies and non-fungible tokens (NFTs). These assets displace the center of gravity of ownership away from tangible control and legal title toward access credentials and cryptographic authority.

Aksoy has argued that the legal nature of crypto assets challenges classical property regimes because these assets are not "objects" in the traditional legal sense (Aksoy, 2023). They are not physical, cannot be perceived through sensory experience, and lack a centralized registry. Ownership over such assets is determined by control over private cryptographic keys and is executed through code rather than institutional intermediation. This creates a divergence between de facto control and legal recognition. Someone may hold exclusive control over a digital collectible, but that control is not equivalent to legally protected ownership unless the law recognizes the asset as an object of property and the form of transfer as valid under the legal regime.

In civil law systems, possession and ownership are conceptually distinct but deeply interrelated. Possession is typically defined as factual control with intent to possess, and it often serves as the basis for the presumption of ownership. The concept of possession is rooted in tangible reality and assumes that a person can physically exclude others from the use of an object. In a decentralized blockchain context, the absence of tangibility and the presence of global, immutable ledgers upend this conceptual apparatus. Control is not a physical condition but a mathematical one, verified by consensus algorithms and dependent on key management. If the private key is lost, control is irretrievable. There is no central authority to reset ownership or resolve disputes. As a result, the civil law concept of possession lacks traction in this environment.

The act of transfer within a blockchain network is similarly decoupled from traditional legal paradigms. Transfer of an NFT or cryptocurrency token is executed through the signing of a transaction using a private key, which then gets validated and recorded on a public ledger. This process bears resemblance to delivery in classical property law, but it is devoid of legal formalities such as notarization or registration. In many civil law systems, especially with regard to immovables or valuable movables, transfer of ownership requires compliance with specific procedural and evidentiary requirements. These are designed to provide legal certainty, prevent fraud, and ensure public visibility of transactions. Blockchain transactions bypass these mechanisms entirely, raising the question of whether such a transfer can have proprietary effects under the law.

A related complication arises in cases of disputed ownership or wrongful dispossession. In traditional civil law systems, mechanisms such as rei vindicatio enable the recovery of property by the rightful owner. These mechanisms assume a centralized judiciary and a legal framework that can enforce rights against specific persons. On the blockchain, the system is both anonymous and autonomous. The platform does not recognize legal ownership; it only recognizes control of the key. If a token is transferred fraudulently, the transaction is usually irreversible. There is no legal backstop embedded into the technology. Aksoy notes that while some common law jurisdictions have begun treating digital tokens as property interests capable of supporting proprietary remedies, civil law jurisdictions have yet to develop equivalent doctrines (Aksoy, 2023).

Another area of conceptual friction is the absence of a central registry. Traditional property systems rely on public registers—of land, securities, or intellectual property—to identify ownership and resolve conflicts. Blockchain replaces the registry with a distributed ledger, which is theoretically more secure and transparent, but lacks a mechanism for recognizing legal status or rectifying errors. The ledger records what the code executes, not what the law commands. This disjuncture creates complications for legal institutions attempting to interface with decentralized systems. Courts cannot easily enforce orders to revert transactions. Legislators cannot require compliance from platforms that operate without geographic jurisdiction. Property law, which evolved in tandem with the territorial authority of the state, faces an

unprecedented challenge in the form of borderless, stateless digital assets.

The tension between code and law also manifests in the concept of intent. Civil law attaches importance to the subjective intention behind a legal act. Ownership and transfer are not only factual but volitional: they must reflect the will of the owner. Smart contracts, by contrast, are self-executing scripts that operate without reference to subjective intention. Once triggered, they complete transactions automatically. If an error occurs in the code, the law may not recognize that the parties intended something different. The gap between what the code does and what the law would have done in a comparable situation leads to uncertainty and potential injustice. Some scholars have described this as a shift from "law in action" to "code as law," where formalism replaces discretion and automation supplants interpretation.

This automation has implications for transferability. In traditional property systems, transferability is a function of the nature of the object, the will of the parties, and compliance with formal requirements. In blockchain-based systems, tokens are, by design, easily transferable. This high fluidity resembles fungible commodities or bearer instruments. Yet, in the case of NFTs, which are unique and sometimes linked to valuable content or functionality, transferability raises questions of legal consequences, such as taxation, consumer protection, and regulatory compliance. The simplicity of code-based transfer masks the complexity of real-world legal obligations.

The problem of interoperability adds another layer. NFTs and other digital collectibles often operate within specific platforms or ecosystems. Ownership may grant access to services, communities, or content that is platform-dependent. If the platform ceases to operate, or changes its terms, the utility of the NFT may disappear, despite continued control over the token itself. In classical property theory, ownership confers stable and independent rights. Here, ownership is contingent on the persistence of external technological structures. Legal systems are not yet equipped to handle this conditional and modular nature of digital ownership.

Cross-border issues further complicate the picture. Blockchain networks are global, but property law is national. Determining the applicable law in a dispute involving a digital asset is difficult. Conflict of laws rules are based on the location of the object or the parties, both of which may be indeterminate in blockchain contexts. Some jurisdictions may view a token as property, others as a contractual right, and others as data. The same asset may be treated differently depending on where the dispute arises, who is involved, and what legal theories are advanced. The absence of harmonized rules leads to legal arbitrage and forum shopping, undermining coherence and predictability.

Attempts to address these problems have included judicial recognition of digital assets as property, the creation of legal categories such as "digital things," and legislative proposals to regulate blockchain assets within national frameworks. Some proposals suggest adapting the concept of *control* to serve as a proxy for possession. Others recommend creating statutory registers for digital assets or embedding legal terms into smart contracts to ensure enforceability. These efforts reflect a recognition that traditional doctrines need modification, not abandonment. The goal is not to discard the concept of ownership but to reimagine it in a context where control, identity, and transactionality are redefined by code.

Ownership in a decentralized digital context is best understood as a hybrid construct. It consists of cryptographic control, platform governance, and social recognition, none of which maps neatly onto classical legal categories. Legal systems must grapple with the reality that ownership can exist without state recognition, transfer can occur without legal formality, and value can be created and destroyed without physical movement or human intention. Civil law traditions, with their emphasis on codification and formalism, face significant hurdles in adapting to this paradigm. But they also possess conceptual resources—such as abstraction, doctrinal systematization, and legislative precision—that can be mobilized to meet the challenge.

Ownership in the digital age requires a reconceptualization that integrates technological architecture with legal principle. It demands a theory of transferability that accounts for self-executing systems, irreversible operations, and jurisdictional indeterminacy. It calls for legal tools that recognize control not as a physical fact but as a digital function. The challenge is to maintain the integrity of property law while acknowledging the transformations brought about by decentralized technology. The opportunity is to build a legal framework that is both grounded in tradition and responsive to innovation.

5. Inheritance and Continuity of Digital Ownership

The law of succession is traditionally rooted in the assumption that property, whether tangible or intangible, can be clearly identified, classified, and transferred through mechanisms embedded in the legal apparatus of the state. Wills, intestacy rules, probate proceedings, and civil registries have historically enabled the orderly transmission of rights and obligations from one generation to the next. The emergence of digital property, particularly in the form of blockchain-based collectibles and assets such as non-fungible tokens (NFTs), disrupts this system in foundational ways. These assets are not only novel in their technical structure but also in the manner in which they are controlled, accessed, and valued. Their decentralization, programmability, and dependence on private keys generate tensions with traditional legal expectations around death, succession, and continuity of ownership.

The core issue lies in the disjunction between control and legal title. Ownership of a digital collectible is determined by control of a private cryptographic key, not by registry entries, probate orders, or testamentary documents. If the key is lost, access to the asset is irretrievably gone. If the key is held by someone else, legal remedies may be unavailable or ineffective. This presents a challenge for heirs, courts, and legal professionals. In the traditional model, executors or administrators are empowered to collect, manage, and distribute the estate, relying on public registries, financial institutions, or court mandates. With digital collectibles, there is often no institution to contact, no court-enforceable record, and no practical way to recover the asset without prior access to the relevant keys or wallets.

Anyama et al. identify the failure of conventional inheritance mechanisms to adequately accommodate blockchain-based assets as a source of significant legal risk (Anyama et al., 2024). They suggest that AI-driven estate planning tools and smart contracts may offer solutions, but these require a rethinking of inheritance frameworks at the legislative level. The key insight from their analysis is that intent and access must be simultaneously preserved. The law must ensure that an individual's wishes regarding digital property can be fulfilled, while also providing heirs with the technological and legal means to exercise control over inherited assets.

The principle of transferability on death, deeply embedded in civil law systems, presumes that property does not extinguish upon the death of the owner. Instead, it vests in the heirs or beneficiaries, subject to formalities. This presumption collapses in the case of digital assets where access cannot be forcibly transferred. The asset may persist on the blockchain, but in the absence of access credentials, it becomes a stranded value—existing but unusable. The traditional remedies of inheritance law, such as substitution, seizure, or liquidation, are inapplicable. Legal recognition of the heir's right is irrelevant if the asset is inaccessible.

Daulay and Cahyono argue that legal systems must provide for statutory recognition of digital tokens as part of the estate and require asset holders to disclose or escrow access credentials in a legally binding manner (Daulay & Cahyono, 2025). Their proposal rests on two pillars: legal classification and procedural enforcement. First, digital collectibles must be classified as heritable property under civil law, regardless of their technological origin. Second, procedural rules must be reformed to include obligations to register, disclose, or safeguard access mechanisms in anticipation of death. Without such reforms, succession law fails to achieve its purpose in the digital domain.

The question of classification is particularly complex. NFTs and other blockchain assets do not neatly fall into existing property categories. They are neither corporeal things nor traditional rights such as debts or shares. Their value lies in their uniqueness, traceability, and association with digital communities or functionalities. Some are used as symbols of status, others as tools of governance in decentralized platforms. Inheritance law struggles to treat such multifaceted, mutable assets as static elements of an estate. Their volatility, coupled with their technological dependence, renders them resistant to traditional valuation, registration, or management.

Compounding this is the problem of formal requirements. Many civil law systems impose strict requirements for the creation of valid wills and the transfer of certain assets. These include notarization, signatures, and official registration. In the context of digital collectibles, such formalities may be unworkable. The assets may reside on decentralized platforms with no legal entity, may be accessible only through multi-signature wallets, or may be governed by smart contracts that preclude external interference. In some cases, a testator may intend to pass an NFT to an heir, but without appropriate access arrangements, the asset remains out of reach. Even a valid will cannot override the logic of a smart contract that requires specific cryptographic authorization.

The rise of "dead wallets" illustrates the urgency of the issue. These are blockchain addresses that hold assets but are no longer accessible because the private keys have been lost or destroyed. The assets cannot be moved, sold, or transferred. They continue to exist, but they are functionally inert. From a legal perspective, they represent a kind of lost property, but without the possibility of recovery through possession or adverse claims. The law has no current tools to address this phenomenon, which is likely to become more widespread as digital assets become a more common part of personal estates.

Solutions proposed in the legal literature include custodial inheritance services, where trusted third parties hold backup access credentials in escrow, to be released upon proof of death. Other models propose the use of smart contracts that automatically transfer access rights upon receipt of a death certificate or after a period of inactivity. These technological solutions are promising, but they raise concerns about privacy, security, and regulatory compliance. If not carefully designed, they may expose assets to theft or misuse. They may also conflict with legal prohibitions against conditional transfers or self-executing inheritance devices in some jurisdictions.

Public law considerations also enter the picture. Taxation of digital assets on death requires accurate valuation and legal recognition. Many jurisdictions tax estates or inheritances based on fair market value at the time of death. In the case of NFTs, which may fluctuate wildly in value and may lack a transparent market, this requirement becomes nearly impossible to fulfill. Moreover, if the asset cannot be transferred or accessed, the imposition of tax may be both unfair and legally dubious. Legislatures must develop new guidelines for the valuation, reporting, and taxation of digital collectibles in the context of succession.

The rights of co-heirs and legatees are similarly complicated. Where multiple heirs are entitled to a share of an estate that includes indivisible or platform-bound assets, traditional mechanisms of partition or liquidation may not apply. A single NFT cannot be divided physically or legally. Its transfer may require consensus on valuation, platform rules, and potential tax liabilities. If one heir holds the key, others may be excluded. If the key is shared, issues of trust, coordination, and platform functionality arise. Succession law must develop new doctrines for managing digital co-ownership and fiduciary responsibilities over blockchain assets.

Jurisdictional conflicts are inevitable. A person may die domiciled in one country, with assets located on decentralized platforms accessible globally. Conflict of laws rules must determine which jurisdiction's inheritance law applies, and whether that law can be enforced in relation to assets that are not physically located or legally registered anywhere. The traditional reliance on situs—location of the asset—is inapplicable. Some have suggested using the location of the controller or the platform, but this too raises

difficulties, particularly when platforms are governed by decentralized autonomous organizations with no legal domicile.

Some legal systems have begun to grapple with these issues. The United States Internal Revenue Service has issued preliminary guidance on the taxation of digital assets in estates. Switzerland and Liechtenstein have moved to recognize crypto-assets as part of the estate for inheritance purposes. Singaporean courts have addressed ownership disputes over blockchain assets and have hinted at the need to integrate them into estate planning. These developments are tentative and fragmented. They represent early efforts to respond to a problem that is global, urgent, and growing in scale.

The overarching challenge is that inheritance law is premised on state authority, legal formalism, and centralized enforcement. Digital ownership is premised on individual control, technical rules, and decentralized execution. Bridging the gap between these systems requires more than doctrinal adjustment; it demands a reconceptualization of what it means to own, transfer, and inherit in a digital age.

6. Adaptive Legal Reforms and Path Forward

The evolution of digital collectibles and blockchain-based property has exposed deep structural tensions in civil law systems that rely on stable, closed categories of property. These tensions manifest across doctrinal, institutional, and procedural dimensions. They require not only reactive responses to new asset types but also proactive structural adaptations in lawmaking, adjudication, legal theory, and international cooperation. As digital assets become increasingly normalized in economic and social life, a fragmented or hesitant legal response risks disenfranchising holders of such assets, undermining the coherence of the civil law property system, and widening the gap between legal form and technological substance.

The principle of codification in civil law systems traditionally provides clarity and uniformity. Yet the pace of technological change renders static legislative structures inadequate to meet new realities. Yang identifies the need to create standardized legal categories for digital property in civil law codes, emphasizing that unclassified or ambiguously defined property leads to legal uncertainty and risks creating informal legal hierarchies (Yang, 2025). Legal systems must first acknowledge that digital collectibles represent a distinct and autonomous category of property. This category is neither traditional movable property nor a subset of intellectual property but rather a digitally-native, technologically-mediated asset whose existence and value are determined by decentralized infrastructures.

Recognition is not sufficient without tailored legislative frameworks. The codification of digital property must define ownership, transferability, inheritance, and loss in terms that reflect the technical nature of blockchain architecture. A critical element of this codification is the concept of control. In civil law, ownership is supported by the twin pillars of title and possession. In digital systems, control is exercised through private keys and validated by blockchain consensus mechanisms. Civil law must revise its definition of possession to include technological control mechanisms that do not require physical proximity or material substance. The law must treat the secure and exclusive control of a private key as a legally cognizable act of possession with proprietary consequences.

Transfer of digital assets poses another challenge. The traditional requirement of legal formalities—often designed to protect third-party interests or signal legal intent—collides with the technical design of blockchain systems. A transfer on a blockchain is executed through the submission of a transaction signed with a private key. No external witnesses, notaries, or declarations of intent are involved. Legal reform must bridge this divide by accepting blockchain-validated transactions as legally effective, provided they meet specific evidentiary standards. These standards might involve the verification of metadata, timestamps, digital signatures, and blockchain immutability.

Judicial systems in civil law countries must also adapt. Courts traditionally resolve property disputes by analyzing documents, examining witnesses, and

referencing registries. These tools are less effective in digital environments where ownership is recorded on public blockchains and access is determined by cryptographic key control. Judges need technical literacy and doctrinal flexibility to interpret smart contracts, analyze wallet activity, and differentiate between technological and legal indicators of ownership. Comparative law shows that common law jurisdictions have moved faster in this domain. Courts in Singapore and the United Kingdom have issued opinions recognizing crypto-assets as property and allowing injunctions over wallets. Civil law courts must develop similar jurisprudence, either through interpretive analogies or guided legislative mandates.

One of the more promising models of flexible civil law adaptation comes from Brazil, where courts have demonstrated interpretive openness in applying existing property law concepts to digital contexts (Soares & Kauffman, 2024). This interpretive strategy avoids the paralysis of waiting for legislative reform while maintaining fidelity to core civil law doctrines. Brazilian judges have emphasized the functional attributes of digital tokens—excludability, assignability, and valuation—rather than their formal ontological status. This approach provides a template for other civil law jurisdictions to follow, using doctrinal tools such as analogical reasoning, general clauses, and open-ended definitions of patrimonial assets.

Another area requiring reform is inheritance law. As digital assets increasingly become components of personal wealth, legal systems must ensure their effective transmission after death. Traditional inheritance models rely on institutional intermediaries—such as probate courts and asset custodians—to facilitate the orderly transfer of rights. In decentralized systems, there is no institution to compel the release of a digital asset or reassign access. Yang proposes a typological reform model that distinguishes digital assets by their underlying rights—personality-based, property-based, or composite (Yang, 2025). This model supports the creation of tailored inheritance protocols that reflect the diverse nature of digital property. In practice, this could involve default smart contract templates for testamentary transfers or legal mandates for custodians to support inheritance access mechanisms.

Procedurally, reform must address evidentiary burdens. Courts and notaries currently lack tools to authenticate digital asset ownership, validate the content of smart contracts, or determine the last known control of a wallet. Legal reform should mandate the integration of blockchain analytics tools into judicial processes and notarial systems. These tools can trace ownership histories, verify the authenticity of token standards, and establish the transactional integrity of digital assets. Such mechanisms would allow courts to determine ownership without depending solely on testimony or subjective declarations.

Cross-border legal coherence is essential. Digital collectibles operate across jurisdictions, but property law is deeply territorial. Conflicts of law arise over which jurisdiction's property law applies, especially in cases of inheritance, insolvency, or contractual disputes. Existing private international law frameworks are ill-suited to address stateless, decentralized assets. Harmonization initiatives must include provisions specifically targeting digital assets. This may require conventions that define a default applicable law based on the domicile of the wallet controller, the legal seat of the issuing platform, or the jurisdiction of primary economic activity. Absent such clarity, legal uncertainty will persist, particularly in multi-jurisdictional disputes.

The infrastructure of digital ownership must also be integrated into legal frameworks. Platforms that facilitate digital asset trading, storage, and access must be subjected to legal obligations regarding identity verification, asset custodianship, and dispute resolution. These obligations are especially important when dealing with asset freezes, fraud claims, or ownership transfers due to incapacity or death. Regulatory approaches can mandate compliance with access protocols, custodial standards, or judicial intervention orders. In parallel, user rights must be protected against arbitrary platform actions such as deletions, bans, or token delisting, all of which can

erode the value and functionality of digital collectibles.

Public legal education is critical. Users must understand that digital ownership is not equivalent to legal title unless supported by legal infrastructure. Platforms must disclose the limitations of their token systems and the legal risks involved. Legislatures can require warnings or legal disclosures in digital wallets, platforms, and marketplaces. This transparency will mitigate legal disputes and help align public expectations with legal realities.

The role of administrative agencies should be expanded to include supervision of digital asset ecosystems. Just as financial authorities regulate securities, banking, and payment systems, specialized agencies can oversee NFT platforms, token issuers, and decentralized applications. These agencies can monitor compliance with legal standards, investigate abuses, and provide guidance on best practices. Their actions can supplement judicial enforcement and legislative reform by acting quickly and flexibly in response to technological developments.

International cooperation is indispensable. The borderless nature of blockchain assets requires coordinated action among states. Bilateral treaties, international guidelines, and multilateral organizations must develop shared standards for digital asset classification, recognition, and enforcement. The current fragmentation of regulatory approaches hampers legal certainty and enables jurisdictional arbitrage. Global convergence around principles—such as the recognition of digital tokens as assets, the enforceability of smart contracts, and the legal significance of blockchain transactions—will create a coherent global digital property regime.

Adaptive reform is not only a matter of legal technique. It reflects a broader philosophical shift in how property is conceptualized in the digital age. Traditional property law assumes scarcity, tangibility, and static value. Digital collectibles defy these assumptions. They are abundant in format but scarce by design. They are intangible yet possess unique identity. Their value is dynamic, network-dependent, and context-driven. Legal systems must adopt a dynamic theory of property that incorporates modularity, programmability, and interoperability as core legal features.

The future of civil law property doctrine depends on its ability to absorb, translate, and govern new forms of ownership. This requires abandoning the binary between legal and non-legal property and recognizing that property exists wherever control, value, and exclusion intersect—regardless of material form. The challenge is not to preserve tradition for its own sake but to evolve doctrine to meet the needs of a society transformed by digital technology.

7. Conclusion

The rise of digital collectibles has introduced a structural fracture in classical property law, particularly within civil law systems where conceptual clarity and codified categories have historically served as the bedrock of legal certainty. Unlike prior innovations that were eventually absorbed into established frameworks through analogy or incremental reform, digital assets demand a deeper reconsideration of foundational principles. The separation between control and ownership, the abstraction of property from physical form, and the autonomy of code from legal institutions together erode the assumptions that have governed property regimes for centuries.

Digital property challenges not only classification but authority. In a traditional property system, the state certifies ownership, enforces rights, and resolves disputes. In decentralized environments, ownership is validated by consensus protocols, access is enforced by encryption, and disputes are resolved—or left unresolved—by immutable code. The absence of a centralized arbiter of property claims introduces a new legal topology where power is distributed, authority is fragmented, and legal remedies are limited by design. This inversion of control disorients legal systems structured around vertical authority and hierarchical validation of title.

Civil law systems must confront the inadequacy of their current vocabulary. Legal concepts such as possession, registration, alienation, and restitution

were forged in material contexts where objects had location, form, and observable presence. Digital collectibles resist these predicates. They are borderless, incorporeal, and non-rivalrous, yet carry economic weight and social significance. Legal systems that insist on material referents for property risk obsolescence in a world where value circulates without mass and ownership is asserted through lines of code. The challenge is not to redefine property in abstract terms but to rebuild its architecture around the realities of digital existence.

This transformation is not merely technical. It marks a shift in the social contract of ownership. Classical property was grounded in exclusion and permanence. Digital property is grounded in access and mutability. What can be owned can also be reprogrammed, deplatformed, or deprecated. Legal rights must evolve to recognize this volatility without surrendering the protections that property traditionally affords. The law must secure digital ownership against technological failure, contractual overreach, and institutional neglect.

The digital turn in property also reconfigures relationships between private parties. Smart contracts automate transactions without recourse to courts or traditional dispute resolution. Tokenized governance enables collective decisions without legislatures. Platforms become de facto legislators, adjudicators, and enforcers. In this ecosystem, legal systems risk becoming reactive observers unless they assert normative principles that govern how digital property is created, exchanged, and defended. The authority of law must be re-established not by overriding technology but by shaping the terms under which technology operates.

A recalibrated civil law system will need to acknowledge technological control as a legally significant fact. It will need to formalize the evidentiary value of blockchain records, recognize token-based rights as objects of patrimony, and impose obligations on platforms that facilitate digital ownership. These reforms will not dilute legal certainty. They will anchor it in a new ontological context. Law must move from a world of paper, possession, and physicality to one of networks, cryptography, and data.

The path forward is neither conservative preservation nor wholesale abandonment of doctrine. It is a methodical reconstruction of legal categories, procedures, and institutions to accommodate new modes of owning and transferring value. This reconstruction must begin with intellectual clarity, proceed through legislative innovation, and culminate in judicial practice. Only through such a process can the civil law system maintain its legitimacy and efficacy in the age of digital property.

The transformation of property law in response to digital collectibles is not a peripheral adjustment but a core task of contemporary legal theory and practice. It compels a recognition that property is not a fixed concept but a dynamic relationship between persons and objects, mediated by institutions and shaped by technology. The legal future of digital ownership will depend on how effectively this relationship is redefined, not in opposition to the past, but as an extension of it into a new terrain.

References

Anyama, U. F., Opoku, A. S., & Agorye, U. V. (2024). Unlocking the Digital Inheritance: How Artificial Intelligence Can Revolutionize the Transfer of Digital Assets. *International Journal of Law Management & Humanities, 7*(2), 1095-1118.

Blandino, P. (2025, July 30). *The legal framework for NFTs under French private law*. SSRN. https://doi.org/10.2139/ssrn.5377270

Çağlayan Aksoy, P. (2023). The applicability of property law rules for crypto assets: Considerations from civil law and common law perspectives. Law. *Innovation and Technology, 15*(1), 185–221. https://doi.org/10.1080/17579961.2023.2184140

Daulay, E. N. S., & Cahyono, A. B. (2025, March). *Legal protection for heirs with non-fungible token heritage objects*. *Journal of Law, Politic and Humanities, 5*(3), 2216–2227. https://doi.org/10.38035/jlph.v5i3.1198

Hutson, J., Banerjee, G., Kshetri, N., Odenwald, K., & Ratican, J. (2023). Architecting the metaverse: Blockchain and the financial and legal regulatory challenges of virtual real estate. *Faculty Scholarship*, 451. https://digitalcommons.lindenwood.edu/faculty-research-papers/451

Ibáñez Jiménez, J., & Ibáñez Jiménez, E. M. (2023). NFT legal and market challenges in permissioned blockchain networks. In V. Chernyshenko & V. Mkrttchian (Eds.), *Blockchain applications: Transforming industries, enhancing security, and advancing society* (pp. 81–97). IGI Global.

Madison, M. J. (2005). *Law as design: Objects, concepts, and digital things*. *Case Western Reserve Law Review, 56*, 381.

Moringiello, J. M., & Odinet, C. K. (2023). *Blockchain real estate and NFTs*. *William & Mary Law Review, 64*(4), 1131. Retrieved from https://scholarship.law.wm.edu/wmlr/vol64/iss4/7

Soares, M. N., Kauffman, M. E., & Berlanga, K. M. R. N. (2024). Legal challenges in the commercialisation of NFTs: A comparative analysis of Europe and Brazil. *Revista Tecnologia e Sociedade, 20*(61), 359–378. https://doi.org/10.3895/rts.v20n61.17795

Wyczik, J. (2025). Ownership in the 21st century: Property law of digital assets. *Information & Communications Technology Law, 34*(2), 187–206. https://doi.org/10.1080/13600834.2024.2408917

Yang, Q. (2025). Principles for the standardized handling of digital property inheritance. *Humanities and Social Science Research, 8*(3), 29-43. https://doi.org/10.30560/hssr.v8n3p29