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COMPLIANCE & ENFORCEMENT TECHNOLOGIES

The present issue of the Journal of Law, Market & Innovation covers a set of strategic topics that can be traced to the role that emerging technologies can play for compliance and enforcement, and to the subsequent regulatory challenges they raise.

This theme emerges from the acknowledgement that the rapid evolution of digital technologies has fundamentally transformed the landscape of regulatory compliance and enforcement, creating both unprecedented opportunities and complex challenges for legal systems worldwide.

The digital transformation of regulatory frameworks has accelerated dramatically in recent years, particularly within the European Union's expanding digital governance ecosystem. As new technologies like artificial intelligence, blockchain, and automated data analytics become increasingly integrated into compliance and enforcement mechanisms, they promise to bridge traditional enforcement gaps while simultaneously introducing novel regulatory complexities. This technological convergence is particularly evident in the implementation of the EU Digital Acquis, where emerging regulations form an interconnected web of digital governance requirements.

Hence, the concept of compliance and enforcement technologies encompasses a broad spectrum of digital tools designed to promote *ex-ante* compliance with legal frameworks and enhance *ex-post* enforcement capabilities.

These technologies leverage automation, artificial intelligence, and sophisticated data analytics to address enforcement challenges across different jurisdictions, offering the potential to create more consistent, effective, and scalable regulatory oversight. However, their implementation also raises fundamental questions about the balance between technological efficiency and legal certainty, the preservation of due process rights, and the maintenance of democratic accountability in regulatory enforcement.

Accordingly, the contributions to this special issue reflect the multifaceted nature of enforcement and compliance technologies, spanning from environmental regulation to digital market governance, from supply chain transparency to decentralised enforcement mechanisms.

Each article addresses different aspects of how technology can enhance regulatory compliance while grappling with the inherent tensions between innovation and legal stability.

The issue opens with Benjamin Amram, Yehuda Leibler, Romi Listenberg, and Dov Greenbaum's examination of compliance and ethical challenges in carbon trading, defending how technology can strengthen global frameworks for market integrity and sustainability. This contribution illustrates the critical role that digital tools play in environmental governance, where traditional enforcement mechanisms often struggle with the scale and complexity of global carbon markets. Then, Gianluca Sisto's contribution on blockchain applications in agrifood supply chains provides a compelling case study of how distributed ledger technology can achieve sustainability and traceability objectives under the UN 2030 Agenda. This work exemplifies the potential of blockchain technology to create immutable records of supply chain activities, enabling more effective enforcement of food safety regulations and environmental standards.

The third contribution encompasses a legal analysis by Gianfranco Alfano and Ludovica Vairo, focused on digital tools and their role in ensuring compliance with the Digital Markets Act (DMA), drawing from gatekeepers' reports to provide practical insights into regulatory implementation. As major technology companies are adapting their practices to comply with new digital market regulations, both technological and conventional approaches are to be integrated to achieve effective compliance. Alessandro Piovano, Cristina Poncibò, and Carlo Federico Vescovo examine the effective enforcement of the DSA's provisions, addressing one of the most significant challenges in contemporary digital regulation. Their analysis explores how enforcement mechanisms can be designed to address the unique characteristics of digital services while maintaining proportionality and effectiveness across different market contexts. Following, contribution by Balázs Bodó and Stefanie Boss presents a fascinating case study of decentralised law enforcement through Ethereum's proof of stake mechanism for moderation practices. This analysis explores how blockchain-based governance systems can serve as models for regulatory enforcement, offering insights into how decentralised technologies might reshape traditional approaches to legal compliance and enforcement, raising relevant questions about the relationship between technological governance and non-state-based regulatory systems.

Finally, Valeria Comegna's examination of AI and blockchain integration for transparent and secure regulatory compliance and enforcement cooperation addresses the convergence of multiple emerging technologies. This contribution explores how the combination of artificial intelligence and blockchain technology can create more robust and transparent enforcement mechanisms, while addressing the challenges of ensuring accountability and preventing technological lock-in in regulatory systems.

The contributions presented in the issue collectively demonstrate that enforcement and compliance technologies should not be understood as mere procedural tools but,



rather, as strategic and structural components of evolving regulatory architectures, highlighting the need for legal frameworks that can accommodate technological innovation while preserving core principles of rule of law, democratic accountability, and individual rights protection.

Looking forward, the variety and relevance of the different contributions presented exemplifies how the intersection of compliance and enforcement technologies with fundamental legal principles constitutes - and will be even more, in the future - a pivotal standpoint for scholarly attention and policy development. In such sense, the articles in this issue provide valuable insights into both the opportunities and challenges that lie ahead, offering a foundation for future research and policy development in this rapidly evolving field.

The editors believe that this collection of contributions will serve as a valuable resource for scholars, policymakers, and practitioners seeking to understand the complex dynamics of technological enforcement and compliance in contemporary legal systems. As digital technologies continue to transform the landscape of regulatory governance, the insights provided by these authors will be relevant for addressing the ongoing challenges of maintaining effective, fair, and accountable enforcement mechanisms in an increasingly digital world.

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