

After all, what are Regulatory Sandboxes? Key characteristics and a working definition

Después de todo, ¿qué son los sandboxes regulatorios? Características clave y una definición de trabajo

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Resumen:

Este artículo examina cómo se definen los sandboxes regulatorios en la literatura académica y en documentos de política pública, con el objetivo de clarificar las principales características de esta herramienta regulatoria, que ha sido adoptada de manera creciente por formuladores de políticas. El análisis se basa en una revisión cualitativa de más de 40 publicaciones académicas y fuentes de política pública que, en conjunto, examinan más de 100 sandboxes regulatorios, abarcando una amplia variedad de sectores y jurisdicciones, tanto en Europa como fuera de ella. El artículo se estructura en dos partes principales. En primer lugar, revisa y compara las definiciones existentes de sandboxes regulatorios e identifica siete elementos recurrentes. En segundo lugar, examina críticamente cada uno de estos elementos a la luz de los debates académicos y de política pública sobre experimentación regulatoria y gobernanza de la innovación. A partir de este análisis, el artículo propone una definición de los sandboxes regulatorios que refleja los enfoques predominantes en la literatura y destaca sus principales características funcionales.

Palabras clave:

Sandboxes regulatorios; aprendizaje regulatorio; flexibilidad regulatoria; orientación regulatoria; gobernanza colaborativa.

Sumario:

1. Introducción; 2. Definición de los sandboxes regulatorios; 3. Características fundamentales de los sandboxes regulatorios: 3.1. Orientación a la innovación; 3.2. Marco regulatorio controlado (enfoque experimental); 3.3. Carácter temporal; 3.4. Flexibilidad regulatoria; 3.5. Orientación regulatoria; 3.6. Aprendizaje regulatorio; 3.7. Gobernanza colaborativa; 4. Conclusiones.

Abstract:

This paper examines how regulatory sandboxes are defined in academic literature and policy documents, with the aim of clarifying the key characteristics of this regulatory tool, which has been increasingly adopted by policymakers. The assessment is performed on basis of a qualitative review of more than 40 academic publications and policy sources that together assessed more than 100 regulatory sandboxes, covering a broad range of sectors and jurisdictions, within Europe and beyond. The paper is structured in two main parts. First, it reviews and compares existing definitions of regulatory sandboxes and identifies seven recurring elements. Second, it critically examines each of these elements in light of academic and policy discussions on regulatory experimentation and innovation governance. Based on this analysis, the paper proposes a working definition of regulatory sandboxes that reflects prevailing approaches in the literature and highlights their core functional features.

Keywords:

Regulatory sandboxes; regulatory learning; regulatory flexibility; regulatory guidance; collaborative governance.

Summary:

1. Introduction; 2. Defining Regulatory Sandboxes; 3. Core Characteristics of Regulatory Sandboxes: 3.1. Innovation-driven; 3.2. Controlled regulatory framework (experimental approach); 3.3. Time-limited; 3.4. Regulatory flexibility; 3.5. Regulatory guidance; 3.6. Regulatory learning; 3.7. Collaborative governance; 4. Conclusion.

1. Introduction

The term sandbox has been historically used in the information technology ecosystem to describe isolated, controlled environments where products or software can be tested securely¹. ICT industry drew inspiration from the analogy of children's playgrounds, where sandboxes are seen as spaces for safe play². This concept has also been adopted by the social sciences to describe experimental settings in various fields, such as sustainable urban development³ or education⁴. However, these applications do not necessarily involve legal oversight or regulatory involvement and therefore are not considered regulatory sandboxes.

By contrast, regulatory sandboxes – a term increasingly employed in legal and policy contexts – also evoke the idea of a safe and controlled environment, but with a broader meaning of “safety.” On one hand, they are intended to provide innovators with a protected space where regulatory requirements are relaxed to encourage experimentation⁵. On the other hand, they must also ensure safety for third parties, such as safeguarding consumer protection – as addressed by financial sandboxes⁶ or addressing broader societal concerns, including health, safety, and the protection of fundamental rights – as emphasized by the EU AI Act.⁷

Due to the increasing adoption of regulatory sandboxes, it becomes increasingly important to reflect on how this concept is defined and characterised, in order to support their appropriate design and operation. To this end, this paper conducted a qualitative review of more than 40 academic papers and policy documents from the European Union and multilateral organisations such as the Organization for Economic Cooperation and Development – OECD, and the World Bank. The initial corpus comprised highly cited papers available through major academic databases – Springer, ProQuest, and Web of Science – and was subsequently expanded through a snowballing technique, whereby references in the selected texts led to further relevant materials. The reviewed literature includes one systematic literature review on regulatory sandboxes⁸, and sector-specific studies in the financial sector⁹, the energy sector¹⁰, data protection¹¹ and AI-related sandboxes¹².

¹ Sharmista Appaya et al., *Global Experiences from Regulatory Sandboxes*, Fintech Note | No. 8 (World Bank, 2020), 5; Hannah Ruschemeier, “Thinking Outside the Box? Regulatory Sandboxes as a Tool for AI Regulation,” in *Bridging the Gap Between AI and Reality*, ed. Bernhard Steffen (Springer Nature Switzerland, 2024), 321, https://doi.org/10.1007/978-3-031-73741-1_20.

² Francesco Longo et al., “Value-Oriented and Ethical Technology Engineering in Industry 5.0: A Human-Centric Perspective for the Design of the Factory of the Future,” *Applied Sciences* 10, no. 12 (2020): 25, 12, <https://doi.org/10.3390/app10124182>.

³ Ruschemeier, “Thinking Outside the Box? Regulatory Sandboxes as a Tool for AI Regulation.”

⁴ Sergio Sánchez et al., “Augmented Reality Sandbox: A Platform for Educative Experiences,” November 2, 2016, 602, <https://doi.org/10.1145/3012430.3012580>

⁵ L. Bromberg et al., “Fintech Sandboxes: Achieving a Balance between Regulation and Innovation,” *Journal of Banking and Finance Law and Practice* 28, no. 4 (2017), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3090844.

⁶ Hilary J. Allen, “Regulatory Sandboxes,” *George Washington Law Review* 87, no. 3 (2019): 626, <https://doi.org/10.2139/ssrn.3056993>; Jonathan Everhart, “The Fintech Sandbox: An Overview of Regulatory Sandbox Regimes,” *Southern Journal of Business and Ethics* 12 (2020): 64–73.

⁷ See Article 57(6), 57(11) and Recital 140 of the AI Act, all of which refer to risk management of fundamental rights, health and safety within sandbox environments.

⁸ Nova Sky, “Systematic Review of Regulatory Sandboxes : Implications for the European Union’s Artificial Intelligence Act” (Diplomityö, N. Sky, 2024), <https://oulurepo.oulu.fi/handle/10024/50797>.

⁹ Appaya et al., *Global Experiences from Regulatory Sandboxes*; European Securities and Markets Authority et al., *FinTech: Regulatory Sandboxes and Innovation Hubs* (Brussels, 2018), https://www.esma.europa.eu/sites/default/files/library/jc_2018_74_joint_report_on_regulatory_sandboxes_and_innovation_hubs.pdf; Dirk Zetzsche et al., “Regulating a Revolution: From Regulatory Sandboxes to Smart Regulation,” *Fordham Journal of Corporate & Financial Law* 23, no. 1 (2017): 31.

¹⁰ F. Gangale et al., *Making Energy Regulation Fit for Purpose: State of Play of Regulatory Experimentation in the EU : Insights from Running Regulatory Sandboxes*. (European Commission – Joint Research Centre, 2023), DOI.org (CSL JSON), <https://data.europa.eu/doi/10.2760/32253>.

¹¹ Business at OECD, *Regulatory Sandboxes for Privacy – Analytical Report.Pdf* (BIAC, 2020), <https://25159535.fsl.hubspotusercontent-eu1.net/hubfs/25159535/website/documents/pdf/Digital%20Economy/Regulatory%20Sandboxes%20for%20Privacy%20-%20Analytical%20Report.pdf>; Nathan Genicot, *From Blueprint to Reality: Implementing AI Regulatory Sandboxes under the AI Act* (FARI, 2024).

¹² Organization for Economic Cooperation and Development, *Regulatory Sandboxes in Artificial Intelligence* (OECD, 2023), <https://doi.org/10.1787/8f80a0e6-en>

Altogether, these works analyse more than 100 regulatory sandboxes in all regions of the globe, and some of those references cover regulatory sandbox cases from 2015, while the most recent report assessed has been published in 2026. Through cross-referencing and comparative analysis, the review enabled the identification of recurring definitions, core features, and emerging classifications, as well as key points of debate surrounding the role of regulatory sandboxes in governance and innovation policy.

Thus, the current paper is structured into two main sections. First, seven key characteristics of regulatory sandboxes are extracted from the definitions identified in the reviewed literature. Second, these core features are critically examined in light of the broader scholarly and policy discussions on regulatory experimentation and innovation governance.

2. Defining Regulatory Sandboxes

As the concept progressed into the regulatory landscape, different definitions have been proposed by a variety of entities, from the private sector, the public sector, academia and civil society. In Table 1, a non-exhaustive list of definitions for regulatory sandbox is presented as identified in literature. The table is provided in chronological order.

Table 1: Proposed definitions of “regulatory sandbox” found in the reviewed literature

Source	Definition
Zetzsche et al. ¹³	“In finance, a regulatory sandbox refers to a regulatory “safe space” for innovative financial institutions and activities underpinned by technology. At the most basic level, the sandbox creates an environment for businesses to test products with less risk of being “punished” by the regulator for non-compliance. In return, regulators require applicants to incorporate appropriate safeguards to insulate the market from risks of their innovative business.”
European Financial Supervisory Authorities ¹⁴	“Schemes to enable firms to test, pursuant to a specific testing plan agreed and monitored by a dedicated function of the competent authority, innovative financial products, financial services or business models.”
Council of the European Union ¹⁵	“Concrete frameworks that, by providing a structured context for experimentation, enable, where appropriate, in a real world environment, the testing of innovative technologies, products, services or approaches – especially in the context of digitalization – for a limited time and in a limited part of a sector or area under regulatory supervision, ensuring that appropriate safeguards are in place.”
World Bank Group – WBG ¹⁶	“[A] controlled, time-bound, live testing environment, which may feature regulatory waivers at regulators’ discretion. The testing environment may involve limits or parameters within which firms must operate.”
OECD ¹⁷	“A limited form of regulatory waiver or flexibility for firms, enabling them to test new business models with reduced regulatory requirement.”
Business at OECD – BIAC ¹⁸	“A controlled environment wherein for some predetermined period of time and for a defined use case, a close collaboration between firms and a regulator enables firms to test new data uses, technologies and applications while receiving regulatory guidance.”
Didenko ¹⁹	A standing (or at least long-term) regulatory strategy that facilitates the development of innovative technology-driven solutions in the financial sector and (i) involves actual on-market testing involving real customers, (ii) is conducted under regulatory supervision and (iii) provides limited exceptions from the otherwise applicable regulatory framework (but regardless of specific regulatory tools used to administer such exceptions).”

¹³ Zetzsche et al., “Regulating a Revolution.”

¹⁴ European Securities and Markets Authority et al., *FinTech: Regulatory Sandboxes and Innovation Hubs*.

¹⁵ Council of the European Union, *Regulatory Sandboxes and Experimentation Clauses as Tools for Better Regulation: Council Adopts Conclusions* (EU Council, 2020)

¹⁶ Appaya et al., *Global Experiences from Regulatory Sandboxes*

¹⁷ Angela Attrey et al., *The Role of Sandboxes in Promoting Flexibility and Innovation in the Digital Age*, OECD Going Digital Toolkit Notes (OECD, 2020), <https://doi.org/10.1787/cdf5ed45-en>.

¹⁸ Business at OECD, *Regulatory Sandboxes for Privacy – Analytical Report.Pdf*

The Future Society ²⁰	"Time-bound programmes administered by authorities. They enable entrepreneurs to test new products and services in the market, but with increased oversight from authorities".
European Parliament Research Service ²¹	"[R]egulatory tools allowing businesses to test and experiment with new and innovative products, services or businesses under supervision of a regulator for a limited period of time."
Agência Nacional de Proteção de Dados – ANPD ²²	"A regulatory sandbox is a collaborative experimentation between the regulator, the regulated entity and other stakeholders with the aim to test innovations against the regulatory framework by adopting a structured methodology."
European Commission ²³	"Schemes that enable firms to test innovations in a controlled real-world environment, under a specific plan developed and monitored by a competent authority" and which are "usually organised on a case-by-case basis, include a temporary loosening of applicable rules, and feature safeguards to preserve overarching regulatory objectives, such as safety and consumer protection."
Undheim et al. ²⁴	"A regulatory sandbox is an example of a 'soft law' mechanism in emerging technologies, introduced in highly regulated industries such as finance and energy, or related to specific spheres or regulations, such as AI or GDPR, with the goal of promoting responsible innovation/and or competition, addressing regulatory barriers to innovation and advancing regulatory learning".
Ranchordás and Vinci ²⁵	"Collaborative regulatory instruments where regulators interact closely with a selected group of market actors (usually startups) to create a safe testbed to understand how to best regulate new types of services or products."
The Datasphere Initiative ²⁶	"Controlled learning environment designed for structured experimentation under defined governance frameworks, timeframes, and built-in safeguards to support iterative, multi-actor collaboration and evidence-based decision-making"

While the plethora of definitions may reveal some different interpretations of this concept, it also allows to identify points of convergence. One widely shared element is the idea of regulatory sandboxes as *controlled environments for the temporary testing of innovations*. This notion brings together three core characteristics: (i) they are *innovation-driven* – as several definitions associate them with the testing of new services or products, or new business models; (ii) they operate within a *controlled regulatory framework*, implying the presence of a structured methodology (which also highlights the relevance on the leading role of regulators on setting up and monitoring these schemes)²⁷; and (iii) they are *time-limited*. These features closely align with traditional experimental

¹⁹ Anton Didenko, "A Better Model for Australia's Enhanced Fintech Sandbox," *University of New South Wales Law Journal* 44, no. 3 (2021).

²⁰ The Future Society, *Sandboxes without the Quicksand: Making EU AI Sandboxing Work for Regulators, Entrepreneurs and Society* (TFS, 2022).

²¹ Tambiana Madiega and Anne Louise Van de Pol, *Artificial Intelligence Act and Regulatory Sandboxes* (European Parliament Research Service, 2022).

²² Agência Nacional de Proteção de Dados, *Consulta à Sociedade – Sandbox Regulatório de IA* (ANPD, 2023), <https://www.gov.br/anpd/pt-br/documentos-e-publicacoes/anpd-sandbox-regulatorio-consulta-bilingue.pdf>.

²³ European Commission, *Regulatory Learning in the EU. Guidance on Regulatory Sandboxes, Testbeds, and Living Labs in the EU, with a Focus Section on Energy – (Commission Staff Working Document) – SWD(2023) 277 Final* (European Commission, 2023), <https://data.consilium.europa.eu/doc/document/ST-12199-2023-INIT/en/pdf>

²⁴ Kristin Undheim et al., "True Uncertainty and Ethical AI: Regulatory Sandboxes as a Policy Tool for Moral Imagination," *AI and Ethics* 3, no. 3 (2023): 997–1002, <https://doi.org/10.1007/s43681-022-00240-x>

²⁵ Sofia Ranchordás and Valeria Vinci, "Regulatory Sandboxes and Innovation-Friendly Regulation: Between Collaboration and Capture," *Italian Journal of Public Law*, March 14, 2024, <https://www.ijpl.eu/regulatory-sandboxes-and-innovation-friendly-regulation-between-collaboration-and-capture/>

²⁶ The Datasphere Initiative, *Sandboxes for DPI* (The Datasphere Initiative, 2026), <https://www.thedatasphere.org/wp-content/uploads/2026/02/Report-Sandboxes-for-DPI-Datasphere-Intiative-2026.pdf>

²⁷ European Commission, *Regulatory Learning in the EU. Guidance on Regulatory Sandboxes, Testbeds, and Living Labs in the EU, with a Focus Section on Energy – (Commission Staff Working Document) – SWD(2023) 277 Final*, 15. "A Better Model for Australia's Enhanced Fintech Sandbox." The Future Society *Sandboxes without the Quicksand: Making EU AI Sandboxing Work for Regulators, Entrepreneurs and Society*.

approaches, supporting the classification of regulatory sandboxes as a form of regulatory experimentation tool²⁸.

Another key element present across several definitions is (iv) *regulatory flexibility*. Once again, the central role of the regulator is emphasized, due to its legitimate role to apply flexible rules, within the limits of existing law. A clear example of this is the use of temporary regulatory waivers, explicitly mentioned in the OECD's definition. However, most definitions do not explicitly refer to waivers. For instance, the European Commission refers instead to the "loosening of applicable rules," a broader and more ambiguous concept, while Undheim et al. mention that regulatory sandboxes address "regulatory barriers to innovation."

The fifth element is (v) *regulatory guidance*, explicitly mentioned by BIAC. This concept emphasizes the role of the regulator in informing and supporting innovators on how to better address legal obligations. It connects to the "soft law" approach, where administrative bodies provide non-binding recommendations – typically through guidelines – but under an interactive, experimental setting²⁹. Undheim et al.³⁰ explicitly associate regulatory sandboxes with soft law. However, regulatory sandboxes differ from typical soft law tools: besides guidance, they enable temporary relaxation of binding rules, a feature soft law is not known for.

Ranchordás and Vinci highlight the notion of (vi) *regulatory learning*, defining regulatory sandboxes as mechanisms to help regulators understand how best to regulate new types of services and products. This function is primarily directed at the regulator, who gains insight into how abstract legal norms apply in specific socio-technical contexts³¹. Nonetheless, this learning process also benefits regulatees, as both parties can gather practical insights, identify good practices, and generate lessons that guide future legal and policy development³². This aligns with the "test and learn" philosophy, which suggests that the best way to evaluate innovative ideas is through experimentation³³. Moreover, this approach can extend to evaluating regulatory effectiveness itself through a process known as evidence-based learning³⁴.

Finally, several definitions imply that regulatory sandboxes are (vii) *collaboration oriented*. This highlights an expectation of close cooperation between regulators and innovators, with the former adopting a supportive rather than enforcement-focused role during experimentation. The objective is not to audit participants but to jointly explore and discuss the regulatory landscape. Therefore, trust is critical to this collaborative model, enabling transparency and the open sharing of information – particularly in areas of emerging risk³⁵. At the same time, such trust must be balanced with accountability and independent oversight to prevent regulatory capture and ensure that sandbox experimentation serves the public interest³⁶.

In most definitions, the collaborative aspect focus narrowly on the interaction between regulators and businesses, overlooking scenarios in which the public sector itself may be a source of innovation, or yet failing to acknowledge the potential contributions of other stakeholders within innovation ecosystems, such as academia and civil society. A notable exception is the definition proposed by the Brazilian Data Protection Authority (ANPD), which describes regulatory sandboxes as "collaborative experimentation between the regulator, the regulated entity, and other stakeholders." The term "regulated entity" is deliberately broad, opening the possibility for experimentation within the public sector. In fact, France's *Commission nationale de l'informatique et des libertés*, held one

²⁸ Sofia Ranchordás, "Experimental Regulations and Regulatory Sandboxes – Law Without Order?," *Law and Method*, 2021, <https://www.boomportaal.nl/tijdschrift/LaM/lawandmethod-D-21-00012>.

²⁹ Walter G. Johnson, "Caught in Quicksand? Compliance and Legitimacy Challenges in Using Regulatory Sandboxes to Manage Emerging Technologies," *Regulation & Governance* 17, no. 3 (2023): 709–25, <https://doi.org/10.1111/rego.12487>.

³⁰ Undheim et al., "True Uncertainty and Ethical AI," 998.

³¹ Jonathan McCarthy, "From Childish Things: The Evolving Sandbox Approach in the EU's Regulation of Financial Technology," *Law, Innovation and Technology* 15, no. 1 (2023): 1–24, <https://doi.org/10.1080/17579961.2023.2184131>.

³² European Commission, *Regulatory Learning in the EU. Guidance on Regulatory Sandboxes, Testbeds, and Living Labs in the EU, with a Focus Section on Energy – (Commission Staff Working Document) – SWD(2023) 277 Final*; Sofia Ranchordás, "Experimental Regulations for AI: Sandboxes for Morals and Mores," *Morals & Machines* 1, no. 1 (2021): 86.

³³ Nils O. Fonstad and Jeanne W. Ross, "Learning How to Test and Learn | MIT CISR," *MIT Center for Information Systems Research*, February 15, 2018, https://c isr.mit.edu/publication/2018_0201_TestAndLearn_FonstadRoss

³⁴ Business at OECD, *Regulatory Sandboxes for Privacy – Analytical Report.Pdf*.

³⁵ Johnson, "Caught in Quicksand?"

³⁶ Ranchordás and Vinci, "Regulatory sandboxes and innovation-friendly regulation."

sandbox edition which targeted public sector innovation³⁷. The inclusion of “other stakeholders” in ANPD’s definition also signals an openness to wider participation, although it doesn’t make clear who they could be.

3. Regulatory Sandboxes core characteristics

Fostering innovation is often cited as the primary goal of regulatory sandboxes and is widely understood as a shared objective between regulators and innovator³⁸. Regulatory sandboxes are portrayed as a potential solution to the longstanding regulation versus innovation conundrum, where regulation is frequently perceived as a barrier to technological development³⁹. However, this claiming is highly debatable. The State plays a fundamental role in enabling innovation when providing legal certainty and actively supporting innovation through well-designed policies and incentives. In this context, regulatory sandboxes can be viewed as one of these key policy instruments. Nevertheless, relying solely on innovation to justify the establishment of regulatory sandboxes – without a proper plan for their operationalization – can introduce significant risks, including harm to competition and, more critically, to individuals and groups impacted by the technologies being tested⁴⁰.

Moreover, defining “innovation” is a challenge itself. As seen in the proposed definitions for regulatory sandboxes, innovation is often associated with the introduction of “new products and services” or “new business models.” Yet, these notions offer little practical guidance on how to assess the innovative character of a given technology. The OECD’s *Oslo Manual defines innovation as “a new or improved product or process (or combination thereof) that differs significantly from the unit’s previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process).”*⁴¹ The manual also provides a useful framework for measuring business innovation. However, in practice, regulators rarely possess the necessary resources to conduct a thorough assessment of “innovativeness.” Instead, project selection decisions are often made subjectively by the teams managing the sandbox⁴².

It is important to consider that innovations tested in regulatory sandboxes may involve different levels of technology maturity. In Norway, Datatilsynet’s privacy sandbox has supported projects in different stages of development – ranging from initiatives still in the conceptual design phase⁴³, to those testing high-fidelity prototypes under simulated or real-world conditions⁴⁴. In Singapore, the

³⁷ Commission Nationale de l’Informatique et des Libertés, “Sandbox: CNIL Launches Call for Projects on Artificial Intelligence in Public Services,” CNIL, July 28, 2023, <https://www.cnil.fr/en/sandbox-cnil-launches-call-projects-artificial-intelligence-public-services>.

³⁸ Davide Baldini and Kate Francis, “AI Regulatory Sandboxes between the AI Act and the GDPR,” *CEUR Workshop Proceedings* 3731 (January 2024), <https://ceur-ws.org/Vol-3731/paper07.pdf>; Fabio Seferi, “A Comparative Analysis of Regulatory Sandboxes from Selected Use Cases: Insights from Recurring Operational Practices,” in *Regulatory Sandboxes for AI and Cybersecurity. Questions and Answers for Stakeholders* (Cybersecurity National Lab, 2025), Zotero, <https://cybersecnatlab.it/white-paper-on-regulatory-sandboxes/>; Sky, “Systematic Review of Regulatory Sandboxes”; Katerina Yordanova, “The Shifting Sands of Regulatory Sandboxes for AI,” *CITIP Blog*, July 18, 2019, <https://www.law.kuleuven.be/citip/blog/the-shifting-sands-of-regulatory-sandboxes-for-ai/>.

³⁹ Sofia Ranchordás, “Innovation Experimentalism in the Age of the Sharing Economy,” *Lewis & Law Clark Review* 19 (2015), Zotero, <https://law.lclark.edu/live/files/21702-lcb194art1ranchordaspdf>.

⁴⁰ Anastasiia Dardykina, “Is There Enough Sand in the Sandbox?,” SSRN Scholarly Paper no. 5126862 (Social Science Research Network, October 1, 2024), <https://doi.org/10.2139/ssrn.5126862>; Erik Longo and Filippo Bagni, “From Legal Experimentation to Regulatory Sandboxes: The EU’s Pioneering Approach to Digital Innovation and Regulation,” in *Regulatory Sandboxes for AI and Cybersecurity. Questions and Answers for Stakeholders* (Cybersecurity National Lab, 2025), <https://cybersecnatlab.it/white-paper-on-regulatory-sandboxes/>; Ruschemeier, “Thinking Outside the Box? Regulatory Sandboxes as a Tool for AI Regulation.”

⁴¹ Organization for Economic Cooperation and Development, *Oslo Manual 2018 – Guidelines for Collecting, Reporting, and Using Data on Innovation* (OECD, 2018)

⁴² McCarthy, “From Childish Things,” 14.

⁴³ See for instance: Datatilsynet, “Ruter: On Track with Artificial Intelligence,” Datatilsynet, 2023, <https://www.datatilsynet.no/en/regulations-and-tools/reports-on-specific-subjects/reports/ruter-on-track-with-artificial-intelligence/>; Datatilsynet, “Simplifai and NVE: Digital Employee,” Datatilsynet, 2023, <https://www.datatilsynet.no/en/regulations-and-tools/reports-on-specific-subjects/reports/simplifai-and-nve-digital-employee/>.

⁴⁴ Some examples: Datatilsynet, “The AVT Project: Activity Data for Assessment and Adaptation,” Datatilsynet, 2022, <https://www.datatilsynet.no/en/regulations-and-tools/reports-on-specific-subjects/reports/the-avt-project-activity-data-for-assessment-and-adaptation/>; Datatilsynet, “NAV: Prediction of the Development of Sick Leave,” Datatilsynet, 2022, <https://www.datatilsynet.no/en/regulations-and-tools/reports-on-specific-subjects/reports/nav-prediction-of-the-development-of-sick-leave/>.

Infocomm Media Development Authority – IMDA, has established a Privacy-Enhancing Technology (PET) Sandbox, where most cases focus on testing proof of concepts within a shared data infrastructure⁴⁵. By its turn, the UK Financial Conduct Authority – FCA, requires a certain degree of market readiness as an eligibility criteria for assessing its regulatory sandbox⁴⁶, but offers the Digital Sandbox as an alternative tool for firms into earlier stages of development, where they can assess data sets to build and experiment prototype solutions⁴⁷.

The EU Digital Europe EUSAIr project, which has been supporting the implementation of AI regulatory sandboxes across the EU, has suggested adopting the Technology Readiness Level (TRL) scale to assess the technology maturity⁴⁸. This scale has been adopted by the European Commission since 2020. TRL 1–2 represent those technologies in the conceptual and planning stages of development; TRL 3–7 progress to functional prototypes, including proofs of concept (TRL 3), laboratory validation (TRL 4), real environment validation (TRL 5), relevant environment validation (TRL 6), and prototype validation (TRL 7). Finally, TRL 8–9 represent the final stages of development, where technology is mature enough to be applied in real-world contexts using real-life data and interacting with end users.

According to EUSAIr, a regulatory sandbox may engage with technologies at different TRLs. Earlier TRLs (2–3) may primarily involve regulatory guidance, clarification of compliance expectations and preliminary risk assessments. Later stages would be necessary for testing in real world conditions (at least TRL 4) and for preparing conformity assessments (at least TRL 5). In the context of the AI Act, regulators may prefer to establish testing environments focusing on innovations at more advanced stages of maturity, since this facilitates access to market after the sandbox exit. However, doing so also requires more robust safeguards, since under these circumstances, end-users, consumers and other rightsholders may already be impacted by the technologies being tested, even before their formal market deployment.

Given the inherently subjective nature of innovation, fostering it should not be the sole purpose of establishing a regulatory sandbox. Ranchordás⁴⁹ highlights that innovation is, by its very nature, a risky endeavour, characterized by uncertainty and potential societal impacts, both positive and negative. It is therefore the regulator's role to mitigate – or, in extreme cases, prevent – developments that could harm society. When properly established, regulatory sandboxes can contribute to the lawful, sustainable, and ethical development of technologies such as AI systems⁵⁰.

3.2. Controlled regulatory framework (experimental approach)

The second key characteristic of regulatory sandboxes is their experimental nature. Sandboxes are one of several experimentation tools adopted in recent years to assess emerging technologies across both technical and legal dimensions. As testing environments, they must offer a structured methodology that reinforces their role as a “safe space”, on a twofold perspective: for the innovator, the sandbox should reduce the risk of sanctions when exploring certain uncharted areas; for society, it must identify and address potential risks to individuals and groups⁵¹.

Even within the financial sector, authorities have incorporated considerations of consumer protection into both the entry criteria and the testing processes conducted within sandboxes⁵². For instance, the UK FCA – widely recognized as a pioneer in the development of regulatory sandboxes – has emphasized both the potential benefits to consumers and the need for risk management to

⁴⁵ Infocomm Media Development Authority, “Privacy Enhancing Technology Sandboxes,” Infocomm Media Development Authority, accessed March 9, 2026, <https://www.imda.gov.sg/how-we-can-help/data-innovation/privacy-enhancing-technology-sandboxes>.

⁴⁶ Financial Conduct Authority, “Regulatory Sandbox,” FCA, United Kingdom, 2026, <https://www.fca.org.uk/firms/innovation/regulatory-sandbox>

⁴⁷ Financial Conduct Authority, “Digital Sandbox,” FCA, 2025, <https://www.fca.org.uk/firms/innovation/digital-sandbox>.

⁴⁸ EUSAIr, *The EU AI Ecosystem and AI Regulatory Sandboxes: Potential Synergies (Preliminary Assessment)* (EUSAIr, 2025), https://eusair-project.eu/app/uploads/2025/08/EUSAIr_Report_InnovationEcosystem.pdf.

⁴⁹ Ranchordás, “Innovation Experimentalism in the Age of the Sharing Economy.”

⁵⁰ Baldini and Francis, “AI Regulatory Sandboxes between the AI Act and the GDPR.”

⁵¹ Genicot, *From Blueprint to Reality*, 10.

⁵² Everhart, “The fintech sandbox.”

ensure their protection as integral parts of its sandbox methodology⁵³. However, the concept of the “consumer” in the financial sector tends to be narrowly defined, typically referring to retail clients, investors and depositors⁵⁴. When considering the diverse contexts of AI applications, societal protection needs a broader scope, to address the rights of stakeholders who may fall outside consumer legal frameworks. Take for instance, data subject rights that encompasses situations such as employment relationships and state–citizens interactions regarding public services⁵⁵.

Understanding regulatory sandboxes as controlled frameworks highlights the crucial role of the regulator on coordinating the sandbox. This marks a significant distinction from other experimentation tools such as testbeds and living labs, where regulator involvement is optional and, when present, typically not in a leading role⁵⁶. By contrast, in a regulatory sandbox, the regulator plays a pivotal role in establishing and supervising the framework in which innovations are developed and tested: it is responsible for setting the parameters of the sandbox, overseeing the experimentation process, evaluating its implementation, and assessing the outcomes. This leadership role is also essential to enabling three additional core features of regulatory sandboxes: regulatory flexibility, regulatory guidance, and regulatory learning, which are discussed in further sections.

3.3. Time-limited

The temporary nature of regulatory sandboxes is also understood as one of their key features. Testing periods typically range 6 months to 2 years,⁵⁷ although there are exceptional cases in which they have operated for 5 or even 20 years.⁵⁸ Seferi notes that testing durations longer than 12 months usually happen in sectors which involve larger-scale trials and infrastructure assessments, such as telecommunications (12 to 24 months), energy (24 to 48 months), and transportation (12 to 60 months)⁵⁹. A regulatory sandbox needs to be time-bound, as it imposes limits on the duration and resources that regulators dedicate to a specific innovation⁶⁰. This helps mitigate the risk of preferential treatment toward a narrow group of regulatees and confines the period during which sandbox participants may operate under lighter regulatory conditions, limiting potential risks of regulatory capture⁶¹.

3.4. Regulatory flexibility

The relaxation of rules is a core characteristic of regulatory sandboxes, designed to foster an innovation-friendly environment and offered as an incentive for innovators to engage in testing in collaboration with regulators⁶². This flexibility is arguably the most controversial feature of sandboxes, as it can introduce risks for stakeholders affected by the technologies being tested, and may create imbalances between those operating within the sandbox and those outside it.

Contrary to common sense, regulatory flexibility does not mean exemptions from liability. Since the launch of its regulatory sandbox, the FCA has never exempted participants from liability for harm

⁵³ Allen, “Regulatory Sandboxes.”

⁵⁴ Zetsche et al., “Regulating a Revolution,” 7.

⁵⁵ Natali Helberger et al., “The Perfect Match? A Closer Look at the Relationship between Eu Consumer Law and Data Protection Law,” *Common Market Law Review* 54, no. 5 (2017), <https://kluwerlawonline.com/api/Product/CitationPDFURL?file=Journals\COLA\COLA2017118.pdf>.

⁵⁶ European Commission, *Regulatory Learning in the EU. Guidance on Regulatory Sandboxes, Testbeds, and Living Labs in the EU, with a Focus Section on Energy – (Commission Staff Working Document) – SWD(2023) 277 Final*.

⁵⁷ 73 of 99 fintech sandbox projects assessed by the World Bank had their testing periods ranging from 6 months to 2 years, with almost half of those (33) with 1 year duration. See Appaya et al., *Global Experiences from Regulatory Sandboxes*, 22.

⁵⁸ While Sky came to a similar conclusion as the World Bank, she also identified cases in which testing last 5 to 20 years. See: Sky, “Systematic Review of Regulatory Sandboxes,” 32.

⁵⁹ “A Comparative Analysis of Regulatory Sandboxes from Selected Use Cases: Insights from Recurring Operational Practices,” 157.

⁶⁰ Allen, “Regulatory Sandboxes,” 638.

⁶¹ Ranchordás and Vinci, “Regulatory sandboxes and innovation-friendly regulation.”137.

⁶² Bromberg et al., “Fintech Sandboxes: Achieving a Balance between Regulation and Innovation”; Dardykina, “Is There Enough Sand in the Sandbox?”; Ruth Plato-Shinar and Andrew Godwin, “Regulatory Cooperation in AI Sandboxes: Insights from Fintech,” *SSRN Scholarly Paper* no. 5199887 (Social Science Research Network, April 1, 2025), <https://doi.org/10.2139/ssrn.5199887>.

caused during the testing phase⁶³. The WBG study also reveals that most jurisdictions explicitly require applicants to demonstrate sufficient resources to cover potential liabilities, particularly for customer-related harms⁶⁴. These findings suggest that regulatory sandboxes are not mechanisms to evade responsibility or legal consequences for third-party harms. In the EU, Regulations enacting provisions on regulatory sandboxes state that these environments should not result on liability exemptions neither affect the supervisory and corrective powers of competent authorities⁶⁵.

Rather, the regulatory leeway provided by regulatory sandboxes typically involves a temporary easing of specific regulatory requirements. Based on the reviewed literature, three common methods have been identified. The first one is the issuance of “no-enforcement letters” (or “no-action letters”), whereby regulators commit to refraining from enforcement actions under certain conditions⁶⁶. These commitments are usually tailored to each case⁶⁷. However, offering such letters entails a degree of risk for the regulator: if it later revokes its position, the letter could be used as evidence in legal proceedings. Moreover, going back on such commitments could damage the regulator’s credibility and jeopardize future participation in the sandbox. In any case, while these letters can serve as strong incentives for innovators, they may also weaken the effectiveness of legal protections intended to safeguard third-party interests⁶⁸. As such, their use must be carefully weighed to avoid undermining public trust and regulatory legitimacy.

A second option involves *restricted authorization*, such as *temporary licenses*, which allow innovators to engage in certain activities within the sandbox⁶⁹. This approach is particularly suited to legal frameworks based on authorization regimes, which are common in sectors like finance, energy, telecommunications, and healthcare⁷⁰. However, other legal regimes, such as data protection, do not rely on a licensing model. Instead, data protection law adopts a risk-based approach, where entities (e.g., data controllers and processors) assess their own compliance by conducting risk management evaluations⁷¹. These assessments ensure that data processing activities comply with legal requirements, with obligations tailored to the risk level involved.

Third, instead of a temporary licence, regulators may establish specific legal exemptions (i.e. legal derogations), allowing innovators to temporarily deviate from certain legal obligations during the testing phase⁷². These exemptions are typically tailored to the needs of the experimentation process and vary depending on what regulators wish to facilitate. For instance, the Monetary Authority of Singapore (MAS) offers flexible rules in standardization processes for sandbox participation but still enforces strict requirements on customer confidentiality and financial handling; while Canada’s Ontario Securities Commission has granted relief on audit and certain disclosure and reporting requirements, but only for services prioritized in their sandbox⁷³. These exemptions are generally narrower than temporary licenses, as they waive specific legal duties based on the regulator’s risk appetite within the sandbox⁷⁴. Blanket exemptions, however, are highly criticized

⁶³ Financial Conduct Authority, *Regulatory Sandbox Guide* (FCA, 2022), <https://www.fca.org.uk/publication/fca/fca-regulatory-sandbox-guide.pdf>.

⁶⁴ Appaya et al., *Global Experiences from Regulatory Sandboxes*, 25.

⁶⁵ See Article 12(4) and (5) of the Interoperable Europe Act, Article 33(2) of the Cyber Resilience Act, Article 33(4) and (6) of the Net-Zero Industry Act and Article 57(11) and (12) of the EU AI Act.

⁶⁶ Thomas Buocz et al., “Regulatory Sandboxes in the AI Act: Reconciling Innovation and Safety?,” *Law, Innovation and Technology* 15, no. 2 (2023): 363, <https://doi.org/10.1080/17579961.2023.2245678>.

⁶⁷ Zetsche et al., “Regulating a Revolution.”

⁶⁸ Buocz et al., “Regulatory Sandboxes in the AI Act.”

⁶⁹ Sky, “Systematic Review of Regulatory Sandboxes,” 39.

⁷⁰ Thiago Moraes, “Regulatory Sandboxes as Tools for Ethical and Responsible Innovation of Artificial Intelligence and Their Synergies with Responsive Regulation,” in *The Quest for AI Sovereignty, Transparency and Accountability*, ed. Luca Belli and Walter B. Gaspar (Springer Nature Switzerland, 2025), https://doi.org/10.1007/978-3-032-02762-7_18.

⁷¹ Raphaël Gellert, “Meta Regulation in Data Protection Law: The Risk-Based Approach,” in *The Risk-Based Approach to Data Protection*, ed. Raphaël Gellert (Oxford University Press, 2020), 21, <https://doi.org/10.1093/oso/9780198837718.003.0006>.

⁷² Buocz et al., “Regulatory Sandboxes in the AI Act,” 363; Giuseppe Mobilio and Matteo Giannelli, “Legal Basis for Regulatory Sandboxes: Key Aspects for a Coherent Theoretical and Practical Framework,” in *Regulatory Sandboxes for AI and Cybersecurity. Questions and Answers for Stakeholders* (Cybersecurity National Lab, 2025), 40, Zotero, <https://cybersecnatlab.it/white-paper-on-regulatory-sandboxes/>.

⁷³ Zetsche et al., “Regulating a Revolution,” 36–37.

⁷⁴ Sky, “Systematic Review of Regulatory Sandboxes,” 34.

by academics due to the potential risks they introduce, and regulatory sandboxes should not be treated as “regulatory holidays”⁷⁵: the Australian Securities and Investments Commission (ASIC) approach has faced significant criticism and has even been dismissed by some academics as a proper regulatory sandbox.⁷⁶ A 2018 report by the European Supervisory Authorities for the EU financial sector concluded that, at the time, fintech sandboxes in the region still required firms to obtain a licence before beginning testing.⁷⁷ Flexibility was granted in how supervisory powers were exercised: occasionally through measures like no-enforcement letters, or through proportionality levers related to national rules implementing EU Directives (e.g. where those rules exceeded the EU’s minimum requirements), or otherwise where those levers were already embedded in EU legislation.

Two final considerations must be made regarding the flexibility of regulatory sandboxes. First, this leeway requires a statutory basis for its legitimacy,⁷⁸ and to be in accordance with the legality principle under the rule of law⁷⁹. These are usually experimental clauses in legislation, which permit temporary deviations from specific legal requirements⁸⁰. These clauses also provide the legal framework for regulators to initiate a sandbox program⁸¹. In the EU AI Act, Article 57 outlines the general rules for AI regulatory sandboxes and can be understood as the experimental clause which legitimizes these tools to operate and govern how regulators should experiment within these controlled environments. Additional rules may complement the AI Act’s provisions, including the Commission’s implementing acts, national legislation and government regulations or decisions.⁸² Aside from flexibility, these statutory bases also play essential roles for defining scope (legal and technical), type of settings (such as laboratory or real-world conditions), powers and tasks of the regulators in this context⁸³. Second, it is important to note that derogatory provisions in a specific sector or regulation do not automatically imply derogations across all applicable legal frameworks⁸⁴. This is particularly relevant in contexts where technologies being tested, such as AI, may impact multiple legal regimes simultaneously, and it is debatable if an experimentation clause can limit supervisory powers of multiple legal domains at once.⁸⁵

3.5. Regulatory guidance

Participating in a regulatory sandbox can offer innovators a unique opportunity to engage in direct dialogue with regulators and receive guidance on regulatory expectations and how to meet legal obligations⁸⁶, and some regulatory sandboxes environments have been framed as “regulatory

⁷⁵ Allen, “Regulatory Sandboxes”; Didenko, “A Better Model for Australia’s Enhanced Fintech Sandbox.”

⁷⁶ Bromberg et al. argue that ASIC’s blanket exemption is inconsistent with the logic that underpins regulatory sandboxes, since this kind of leeway doesn’t provide safe spaces designed by the regulator to prevent (or mitigate) consumer harm. See: Bromberg et al., “Fintech Sandboxes: Achieving a Balance between Regulation and Innovation,” 17.

⁷⁷ European Securities and Markets Authority et al., *FinTech: Regulatory Sandboxes and Innovation Hubs*.

⁷⁸ Buocz et al., “Regulatory Sandboxes in the AI Act”; Longo and Bagni, “From Legal Experimentation to Regulatory Sandboxes: The EU’s Pioneering Approach to Digital Innovation and Regulation”; Mobilio and Giannelli, “Legal Basis for Regulatory Sandboxes: Key Aspects for a Coherent Theoretical and Practical Framework.”

⁷⁹ Stefan Philipsen et al., “Legal Enclaves as a Test Environment for Innovative Products: Toward Legally Resilient Experimentation Policies,” *Regulation & Governance* 15, no. 4 (2021): 1135, <https://doi.org/10.1111/rego.12375>.

⁸⁰ Genicot, *From Blueprint to Reality*, 36.

⁸¹ Johnson, “Caught in Quicksand?,” 712.

⁸² Article 58 of the AI Act requires the Commission to enact implementing acts on further rules of EU AI regulatory sandboxes.

⁸³ Mobilio and Giannelli, “Legal Basis for Regulatory Sandboxes: Key Aspects for a Coherent Theoretical and Practical Framework.”

⁸⁴ Esther C. Van Der Waal et al., “Participatory Experimentation with Energy Law: Digging in a ‘Regulatory Sandbox’ for Local Energy Initiatives in the Netherlands,” *Energies* 13, no. 2 (2020): 10, <https://doi.org/10.3390/en13020458>.

⁸⁵ Nathan Genicot and Thiago Guimaraes Moraes, “Exploring the Boundaries of AI Regulatory Sandboxes under the AI Act: Flexibility and Real-World Testing,” *Cambridge Forum on AI: Law and Governance* 1 (January 2025): 8, <https://doi.org/10.1017/cfi.2025.10013>.

⁸⁶ Ahmad Alaassar et al., “Exploring How Social Interactions Influence Regulators and Innovators: The Case of Regulatory Sandboxes,” *Technological Forecasting and Social Change* 160 (November 2020): 120257, <https://doi.org/10.1016/j.techfore.2020.120257>; Sofia Ranchordás, “Experimental Lawmaking in the EU: Regulatory Sandboxes,” preprint, October 22, 2021, <https://doi.org/10.2139/ssrn.3963810>; Jon Truby et al., “A Sandbox Approach to Regulating High-Risk Artificial Intelligence Applications,” *European Journal of Risk Regulation* 13, no. 2 (2022): 270–94, <https://doi.org/10.1017/err.2021.52>;

dialogues⁸⁷. When assessing the UK fintech ecosystem, Fahy found that the most common motivation for companies to join the FCA regulatory sandbox was to “make sure they were following the law.”⁸⁸ The sandbox was perceived as an expedited route to market entry, offering a form of legal shelter for product testing and commercialisation. Similarly, Alaassar et al.⁸⁹ conducted interviews with regulators and firms and observed a shared understanding that the former could support sandbox participants by identifying regulatory gaps and offering early-stage guidance.

The pursuit of legal certainty is thus widely recognised as a central motivation for firms to participate in regulatory sandboxes. However, while sandboxes may enhance legal certainty for participating firms, they may simultaneously reduce it for those outside the sandbox.⁹⁰ In the absence of mechanisms to disseminate lessons learned, competitors may perceive the regulatory flexibility and tailor-made guidance granted to sandbox participants as unfair, potentially leading to legal disputes. Additionally, without adequate risk management, regulatory experimentation may cause severe interferences with the fundamental rights of individuals, and there is also a risk that products exiting the sandbox could be misinterpreted by the public as having been officially endorsed by authorities⁹¹.

To mitigate these risks, Ranchordás argues that regulators should be transparent about the experimental nature of the sandbox⁹². This includes clearly communicating the scope and duration of the experimentation, the evaluation criteria, and the mechanisms for exit. Furthermore, citizens must be able to understand the societal benefits of these experimental regimes.

3.6. Regulatory learning

While regulatory guidance is often seen as the main incentive for innovators to join a sandbox, the primary benefit for regulators lies in gaining a deeper understanding of how new technologies function and how they interact with existing legal frameworks⁹³. Baldini and Francis argue that regulatory sandboxes offer regulators the opportunity to acquire technical insights on emerging technologies and their novel applications well before they reach the market, by establishing a new channel for evidence-based regulatory learning⁹⁴. Similarly, Ranchordás affirms that experimental legal instruments contribute to evidence-based lawmaking and promote the continuous reassessment and adaptation of regulation⁹⁵. This links sandboxes to anticipatory regulation, which develops legal responses iteratively to address the “pacing problem”: the challenge that technological change outpaces the ability of regulatory systems to respond appropriately⁹⁶.

However, the effectiveness of this regulatory learning process is highly dependent on the design and integration of the sandbox in a broader strategy. Without a structured methodology, sandboxes

⁸⁶ [cont.] Katerina Yordanova and Natalie Bertels, “Regulating AI: Challenges and the Way Forward Through Regulatory Sandboxes,” in *Multidisciplinary Perspectives on Artificial Intelligence and the Law*, ed. Henrique Sousa Antunes et al. (Springer International Publishing, 2024), https://doi.org/10.1007/978-3-031-41264-6_23.

⁸⁷ Appaya et al., *Global Experiences from Regulatory Sandboxes*; Genicot, *From Blueprint to Reality*; Ranchordás and Vinci, “Regulatory sandboxes and innovation-friendly regulation.”; Yordanova and Bertels, “Regulating AI.”

⁸⁸ “Regulator Reputation and Stakeholder Participation: A Case Study of the UK’s Regulatory Sandbox for Fintech,” *European Journal of Risk Regulation* 13, no. 1 (2022): 138–57, <https://doi.org/10.1017/err.2021.44>.

⁸⁹ Alaassar et al., “Exploring How Social Interactions Influence Regulators and Innovators.”

⁹⁰ Philipsen et al., “Legal Enclaves as a Test Environment for Innovative Products,” 1135.

⁹¹ Truby et al., “A Sandbox Approach to Regulating High-Risk Artificial Intelligence Applications,” 279.

⁹² Ranchordás, “Experimental Regulations and Regulatory Sandboxes – Law Without Order?” 18.

⁹³ Ana Paula Gonzalez Torres and Nitin Sawhney, “Role of Regulatory Sandboxes and MLOps for AI-Enabled Public Sector Services,” *The Review of Socionetwork Strategies* 17, no. 2 (2023): 297–318, <https://doi.org/10.1007/s12626-023-00146-y>; Johnson, “Caught in Quicksand?”; Longo and Bagni, “From Legal Experimentation to Regulatory Sandboxes: The EU’s Pioneering Approach to Digital Innovation and Regulation”; Ruschemeier, “Thinking Outside the Box? Regulatory Sandboxes as a Tool for AI Regulation”; Sky, “Systematic Review of Regulatory Sandboxes”; Yordanova and Bertels, “Regulating AI.”

⁹⁴ Baldini and Francis, “AI Regulatory Sandboxes between the AI Act and the GDPR,” 5.

⁹⁵ Ranchordás, “Experimental Regulations for AI,” 23.

⁹⁶ Emily Leckenby et al., “The Sandbox Approach and Its Potential for Use in Health Technology Assessment: A Literature Review,” *Applied Health Economics and Health Policy* 19, no. 6 (2021): 857–69; Gary E. Marchant, “Addressing the Pacing Problem,” in *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem*, ed. Gary E. Marchant et al. (Springer Netherlands, 2011), https://doi.org/10.1007/978-94-007-1356-7_13.

may have a limited learning value with a low outreach of its findings⁹⁷. Therefore, sandboxes must be properly integrated into regulatory and policymaking strategies. If lessons learned are not systematically gathered, shared, and considered for regulatory reform – whether through amendments to existing norms or the creation of new legal frameworks – the sandbox’s potential as a tool for evidence-based learning is undermined⁹⁸. A good practice in this regard is the publication of evaluation reports. For example, the UK ICO publishes both individual project exit reports and broader insights reports⁹⁹. These documents contribute to sharing of lessons learned and also work as soft law instruments, providing guidance to the wider community of regulatees beyond the sandbox participants.

Alaassar et al. claim that unwillingness to explore regulatory changes could undermine the potential of sandboxes to work as innovation-friendly regulatory tools¹⁰⁰. Treating sandboxes merely as “conformity assessment” mechanisms limits their transformative potential and risks creating competition imbalances by offering regulatory guidance exclusively to sandbox participants. On the other hand, evidence-based learning on sandboxes should not become a pathway at deregulation or at reducing protection standards. Rather, it should aim to foster the development of adaptive and appropriate regulatory frameworks that bridge the gap between technological innovation and legal oversight – without compromising fundamental rights, safety, and other societal protections¹⁰¹.

3.7. Collaborative governance

Last, but not least, regulatory sandboxes are set up as collaborative environments¹⁰². This means that interactions between regulators and regulatees happen on the common understanding that enforcement is not the order of the day. Of course, for this to be effective all parties engaged in the sandbox must be able to trust each other¹⁰³. Trust is typically built through open, honest, and transparent dialogue: Regulators must demonstrate a genuine interest in identifying and addressing regulatory challenges, rather than focusing on punitive measures¹⁰⁴. At the same time, safeguards must be in place to prevent regulatory capture and ensure that collaboration remains balanced and accountable. Regulatees must understand that if they stop engaging in good faith, disregard regulatory recommendations, or fail to address identified risks, the experimentation may be swiftly suspended, and in serious cases, enforcement action or liability claims may follow¹⁰⁵.

This collaborative nature is another reason why sometimes regulatory sandboxes are framed as “regulatory dialogues”¹⁰⁶. Nevertheless, in many cases, periodic reports have become the primary means of communication between regulators and regulatees¹⁰⁷. While important, relying solely on written reports risks missing out on richer forms of engagement – such as meetings, workshops, and direct interactions – that can significantly enhance evidence-based regulatory learning. The emphasis on dialogue in regulatory sandboxes also requires managing expectations, as innovators may mistakenly assume that regulatory sandboxes always include access to technical infrastructure or financial support. However, this is often not the case. Genicot assessed several privacy sandboxes and found that only Singapore provided financial support or access to data

⁹⁷ Ranchordás, “Experimental Regulations and Regulatory Sandboxes – Law Without Order?”

⁹⁸ Allen, “Regulatory Sandboxes,” 640.

⁹⁹ Information Commissioner’s Office, “Previous Participants,” ICO, November 19, 2024, <https://ico.org.uk/for-organisations/advice-and-services/regulatory-sandbox/previous-participants/>.

¹⁰⁰ Alaassar et al., “Exploring How Social Interactions Influence Regulators and Innovators,” 11.

¹⁰¹ Ruschemeier, “Thinking Outside the Box? Regulatory Sandboxes as a Tool for AI Regulation,” 323.

¹⁰² Dardykina, “Is There Enough Sand in the Sandbox?”; Plato-Shinar and Godwin, “Regulatory Cooperation in AI Sandboxes”; Sky, “Systematic Review of Regulatory Sandboxes”; Truby et al., “A Sandbox Approach to Regulating High-Risk Artificial Intelligence Applications.”

¹⁰³ Alaassar et al., “Exploring How Social Interactions Influence Regulators and Innovators”; Johnson, “Caught in Quicksand?”

¹⁰⁴ Johnson, “Caught in Quicksand?”

¹⁰⁵ RanchRanchordás and Vinci, “Regulatory sandboxes and innovation-friendly regulation.”

¹⁰⁶ Appaya et al., *Global Experiences from Regulatory Sandboxes*; Genicot, *From Blueprint to Reality*; Ranchordás and Vinci, “Regulatory sandboxes and innovation-friendly regulation.”; Yordanova and Bertels, “Regulating AI.”

¹⁰⁷ Sky, “Systematic Review of Regulatory Sandboxes,” 41.

infrastructure.¹⁰⁸ Similarly, the WBG's report on fintech sandboxes highlighted their role in fostering continuous dialogue but was unclear on the extent to which they offer shared infrastructure. Also, the UK FCA explicitly states participants must meet certain resource requirements before joining its sandbox, implying that financial or technical support is not provided¹⁰⁹. Finally, an overview presented by the European Commission on regulatory sandboxes in the energy sector found that only Lithuania's regulatory sandbox offered funding¹¹⁰.

This does not mean, however, that regulatory sandboxes cannot offer financial benefits. Fahy notes that companies often associate participation in a regulator's sandbox with an enhanced corporate reputation, which can increase their attractiveness to investors¹¹¹. This factor can be particularly attractive to SMEs and startups¹¹². McCarthy's shows that participation in fintech sandboxes has led to an average 15% increase in capital raised – especially among smaller and younger firms¹¹³. Likewise, the FCA reported that 40% of companies that successfully completed its 2015 sandbox program secured investment during of afterward testing¹¹⁴. Regulatory sandboxes can also appeal to small businesses and startups, which may lack resources but benefit from facilitated engagement with regulators¹¹⁵. Participation is generally free of charge, and sandboxes may be explicitly designed to support small and medium-sized enterprises (SMEs) and startups¹¹⁶. In the context of the AI Act, there is an unique opportunity to integrate EU's regulatory sandboxes with the AI innovation ecosystem it is developing through its policies.¹¹⁷

A common outcome of this collaborative process is exit reports, usually drafted either by the regulator or by the participating organisation, with the final content mutually agreed upon by both parties¹¹⁸. This document generally summarises the objectives, testing process, regulatory considerations, and key findings of the sandbox participation, and often serves as proof that the entity has successfully completed the sandbox programme. Many privacy sandboxes have publicly disclosed such reports to share lessons learned and support broader regulatory learning among stakeholders¹¹⁹. In license-based regulated sectors, such as finance, energy or telecommunications, sandbox participation may also convert temporary authorisations granted during testing into permanent permissions¹²⁰. Under the EU AI Act, in addition to an exit report, sandbox participants

¹⁰⁸ Genicot assessed 8 privacy regulatory sandboxes from Brazil, Colombia, Denmark, France, Luxembourg, Norway, Singapore and the UK. See: Genicot, *From Blueprint to Reality*.

¹⁰⁹ Financial Conduct Authority, *Regulatory Sandbox Guide*.

¹¹⁰ The Commission overview included energy-sector regulatory sandboxes of the following Member States: Belgium, Denmark, Spain, France, Italy, Hungary, Lithuania, Netherlands, Portugal and Sweden. See: European Commission, *Regulatory Learning in the EU. Guidance on Regulatory Sandboxes, Testbeds, and Living Labs in the EU, with a Focus Section on Energy – (Commission Staff Working Document) – SWD(2023) 277 Final*, 121.

¹¹¹ Fahy, "Regulator Reputation and Stakeholder Participation," 145.

¹¹² Antonella Zarra, "Operationalizing AI Regulatory Sandboxes: A Look at the Incentives for Participating Start-Ups and SMEs beyond Compliance," in *Regulatory Sandboxes for AI and Cybersecurity. Questions and Answers for Stakeholders* (Cybersecurity National Lab, 2025), <https://cybersecnatlab.it/white-paper-on-regulatory-sandboxes/>.

¹¹³ McCarthy, "From Childish Things," 10.

¹¹⁴ Financial Conduct Authority, *Regulatory Sandbox Lessons Learned Report* (FCA, 2017), <https://www.fca.org.uk/publication/research-and-data/regulatory-sandbox-lessons-learned-report.pdf>.

¹¹⁵ Ranchordás, "Experimental Regulations and Regulatory Sandboxes – Law Without Order?"; Zarra, "Operationalizing AI Regulatory Sandboxes: A Look at the Incentives for Participating Start-Ups and SMEs beyond Compliance."

¹¹⁶ Genicot, *From Blueprint to Reality*; Appaya et al., *Global Experiences from Regulatory Sandboxes*.

¹¹⁷ Examples include the European Digital Innovation Hubs (EDIHs), Test and Experimentation Facilities (TEFs) AI Factories and data spaces. See: Genicot, *From Blueprint to Reality*.

¹¹⁸ Genicot, *From Blueprint to Reality*; Fabio Seferi, *A Working Experimentation Model for Cyber Resilience Regulatory Sandboxes*, 2025, <https://eur-ws.org/Vol-3962/paper67.pdf>; Sky, "Systematic Review of Regulatory Sandboxes."

¹¹⁹ Examples include privacy sandboxes from Norway's Datatilsynet (Datatilsynet, "Sandbox – Reports," 2023, <https://www.datatilsynet.no/en/regulations-and-tools/sandbox-for-artificial-intelligence/reports/>), France's CNIL (Commission Nationale de l'Informatique et des Libertés, "Sandbox," 2025, <https://www.cnil.fr/en/tag/Sandbox>), UK's ICO (Information Commissioner's Office, "Previous Participants.") and Singapore's IMDA (Infocomm Media Development Authority and Personal Data Protection Commission, "Privacy Enhancing Technology Sandboxes," Infocomm Media Development Authority, 2022, <https://www.imda.gov.sg/how-we-can-help/data-innovation/privacy-enhancing-technology-sandboxes>).

¹²⁰ Moraes, "Regulatory Sandboxes as Tools for Ethical and Responsible Innovation of Artificial Intelligence and Their Synergies with Responsive Regulation."

may request written documentation of the activities carried out within the sandbox to support the demonstration of compliance during subsequent conformity assessment procedures¹²¹. This documentation may contribute to a presumption of compliance with certain regulatory requirements; however, it should not be interpreted as proof of full compliance, as sandbox experimentation may not cover all regulatory requirements under the AI Act.

Beyond regulator–regulatee interaction, regulatory sandboxes also offer a valuable opportunity for collaboration between regulators – particularly in contexts where technologies intersect multiple legal frameworks, whether across sectors at the national level or between jurisdictions¹²². Data-driven technologies are inherently cross-cutting in nature, which necessitates coordinated regulatory approaches that present both opportunities and challenges. For example, fintech solutions have long been recognized for their broad impact across multiple areas of public policy. As a result, it has been recommended they adopted a multidisciplinary supervisory cooperation and knowledge sharing on issues such as competition, fraud, anti-money laundering, cybersecurity, consumer protection, and data protection¹²³. In the UK, the financial and data protection authorities – the FCA and the ICO – have been collaborating to facilitate coordinated regulatory support for companies operating across both domains. This cooperation raises firms confidence that they are getting aligned guidance, regardless of which sandbox environment they participate in¹²⁴. The EU AI Act also points into that direction, explicitly stating that national competent authorities should cooperate with other relevant authorities, whenever appropriate, such as when testing involves the processing of personal data or falls within the remit of other sectoral regulators¹²⁵.

Regulatory cooperation can promote greater harmonisation and reduce the risk of forum shopping – where innovators choose to enter sectors or jurisdictions perceived as more flexible or “innovation-friendly”, creating competition or other regulatory imbalances¹²⁶. One strategy to mitigate this risk is the creation of one-stop shops for sandbox participation, such as the arrangements of fintech sandboxes of the UK and Hong Kong¹²⁷. A similar model was proposed for the Dutch model on AI regulatory sandbox: AI developers and providers would submit queries through a single-entry point, which would screen the requests and refer them either to a central coordination team or to the relevant authority¹²⁸. Only questions deemed appropriate for sandbox experimentation would proceed, allowing innovators and regulators to jointly develop a sandbox plan.

At the cross-border level, there are still relatively few examples, though initiatives like the ASEAN Financial Innovation Network stand out¹²⁹. The EU AI Act may stimulate more cross-border experimentation by explicitly allowing for the joint establishment of regulatory sandboxes.¹³⁰ Also, the Interoperable Europe Act requires Union entities and bodies to operate interoperability regulatory sandboxes, with the specific goal of supporting cross-border interoperability of trans-European digital public services¹³¹. Cross-jurisdiction initiatives should mitigate risks of forum shopping¹³².

On the other hand, multi-sector and cross-border sandboxes introduce complexity and can

¹²¹ EU AI Act, Article 57(7)

¹²² Alaassar et al., “Exploring How Social Interactions Influence Regulators and Innovators”; John W. Harris, “NC Regulatory Sandbox Act: Encouraging Innovation despite Missing Some Opportunities,” *North Carolina Banking Institute* 26 (2022): 301.

¹²³ Radostina Parenti, *Regulatory Sandboxes and Innovation Hubs for FinTech: Impact on Innovation, Financial Stability and Supervisory Convergence* (European Parliament, 2020), 10, Zotero, [https://www.europarl.europa.eu/RegData/etudes/STUD/2020/652752/IPOL_ST U\(2020\)652752_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2020/652752/IPOL_ST U(2020)652752_EN.pdf).

¹²⁴ Nikil Rathi, “Tech, Trust and Teamwork: How the FCA and ICO Are Helping Innovation Take Off,” FCA, Financial Conduct Authority, May 28, 2025, <https://www.fca.org.uk/news/blogs/tech-trust-and-teamwork>.

¹²⁵ EU AI Act, Article 57(4) c/c 57(10).

¹²⁶ Zarra, “Operationalizing AI Regulatory Sandboxes: A Look at the Incentives for Participating Start-Ups and SMEs beyond Compliance.”

¹²⁷ Plato–Shinar and Godwin, “Regulatory Cooperation in AI Sandboxes,” 13.

¹²⁸ Autoriteit Persoonsgegevens, *Proposal Dutch Regulatory Sandbox* (Autoriteit Persoonsgegevens, 2025).

¹²⁹ Appaya et al., *Global Experiences from Regulatory Sandboxes*, 34.

¹³⁰ Article 57(1) and Recital 138 of the AI Act.

¹³¹ Articles 3(14) c/c 11 of the Interoperable Europe Act.

¹³² Dardykina, “Is There Enough Sand in the Sandbox?”; Madiaga and Van de Pol, *Artificial Intelligence Act and Regulatory Sandboxes*.

increase the burden on regulators – particularly where participation is frequently required. For example, Article 57(10) of the AI Act states that whenever personal data processing is involved, national data protection authorities (DPAs) must be involved in sandbox activities. This could place significant strain on DPAs, many of which are already under-resourced. Similarly, Article 12 of the Interoperable Europe Act requires DPAs (among other regulators) to be engaged in interoperability regulatory sandboxes. Effective engagement in sandboxes requires regulators to possess not only legal expertise (which is expected) but also a basic level of technical understanding to enable meaningful dialogue with innovators¹³³. If innovators perceive that regulators are not sufficiently prepared to engage in such discussions, they may be discouraged from participating¹³⁴. Despite these challenges, the EU financial authorities have reported that these initiatives have strengthened cooperation with other regulators, including those outside the financial domain, such as DPAs¹³⁵.

Finally, given the collaborative nature of regulatory sandboxes, they appear to offer a suitable environment for engaging a more diverse set of actors. In this regard, the OECD¹³⁶ identifies multistakeholder cooperation as a key element for the success of AI regulatory sandboxes. Such cooperation should involve not only coordination among different public authorities but also active engagement with market participants, academic experts, and civil society representatives. Similarly, the World Economic Forum¹³⁷ emphasizes that a multistakeholder approach enables collaborative assessment of the socio-economic impacts of emerging technologies such as AI. Nevertheless, existing sandbox experiences suggest that this broader multistakeholder approach remains largely underdeveloped. Beyond the interaction between regulators and regulatees, it is often unclear whether and how other stakeholders, particularly from civil society, are meaningfully involved. If their participation is limited to responding to surveys or providing data, civil society actors are relegated to the role of test subjects rather than active contributors. This raises an important reflection, whether civil society can be meaningfully engaged into these experimentation environments.

Participation of impacted stakeholders in AI and data governance is receiving growing attention, driven by calls for stronger democratic participation and participation equity: these actors should participate more directly in the governance of the technologies that impact them, since this improves general democratic values of plurality, participation, equal representation, and non-discrimination.¹³⁸ In this context, approaches such as value sensitive design¹³⁹ and participatory design¹⁴⁰ could bring an added value. They promote several stakeholder engagement methods throughout the development of technological artefacts, such as co-design workshops for value elicitation and system requirement specification, surveys and interviews to gather user feedback and iterative development processes that support critical design thinking.

Furthermore, establishing multistakeholder advisory bodies can help embed the perspectives of rights-holders within experimentation environments. This approach has been promoted by the Brazilian DPA¹⁴¹, the Norwegian DPA¹⁴², and by sandbox initiatives led by civil society organisations (e.g.

¹³³ Plato-Shinar and Godwin, "Regulatory Cooperation in AI Sandboxes," 9.

¹³⁴ Johnson, "Caught in Quicksand?," 718.

¹³⁵ European Securities and Markets Authority et al., *Update on the Functioning of Innovation Facilitators – Innovation Hubs and Regulatory Sandboxes* (2023).

¹³⁶ Organization for Economic Cooperation and Development, *Regulatory Sandboxes in Artificial Intelligence*.

¹³⁷ World Economic Forum, *AI Governance Alliance: Briefing Paper Series 2024* (WEF, 2024), https://www3.weforum.org/docs/WEF_AI_Governance_Alliance_Briefing_Paper_Series_2024.pdf.

¹³⁸ Margot E. Kaminski and Gianclaudio Malgieri, "Impacted Stakeholder Participation in AI and Data Governance," SSRN Scholarly Paper no. 4836460 (Social Science Research Network, May 21, 2024), <https://papers.ssrn.com/abstract=4836460>.

¹³⁹ Batya Friedman et al., "Value Sensitive Design and Information Systems," in *Early Engagement and New Technologies: Opening up the Laboratory*, ed. Neelke Doorn et al. (Springer Netherlands, 2013), https://doi.org/10.1007/978-94-007-7844-3_4.

¹⁴⁰ Susanne Bødker et al., *Participatory Design*, Synthesis Lectures on Human-Centered Informatics (Springer International Publishing, 2022), <https://doi.org/10.1007/978-3-031-02235-7>.

¹⁴¹ Agência Nacional de Proteção de Dados, *Consulta à Sociedade – Sandbox Regulatório de IA*.

¹⁴² Tom E. Markussen and Arild Opheim, *Evaluation of the Norwegian Data Protection Authority's Regulatory Sandbox for Artificial Intelligence* (Datatilsynet, 2023), https://www.datatilsynet.no/contentassets/41e268e72f7c48d6b0a177156a815c5b/agenda-kaupang-evaluation-sandbox_english_ao.pdf.

COR Sandbox¹⁴³, and IFOW Responsible AI Sandbox¹⁴⁴). Such mechanisms can establish structured channels for dialogue and oversight, so that experimentation processes remain attentive to societal impacts and fundamental rights protection.

4. Conclusion

Based on the analysis conducted and the key elements identified in the reviewed literature, this paper proposes the following working definition of regulatory sandboxes:

“Regulatory sandboxes are controlled, time-limited experimentation environments that enable coordinating entities to engage with innovators and other actors on testing innovative products, services, or business models, within existing legal regimes, often relying on incentives such as regulatory flexibility and regulatory guidance, to support mutual learning, and foster collaboration among engaged stakeholders.”

While no single definition can fully capture the diversity of regulatory sandbox models currently in operation, this paper argues that the proposed definition reflects both how they are commonly understood in the literature and how they ought to be conceived for responsible governance practice. In particular, it emphasises that regulatory sandboxes should not merely facilitate innovation through regulatory relief. Rather, they should work as collaborative spaces oriented towards learning, and dialogue between regulators, innovators, and other relevant stakeholders.

In Table 2, three different examples of regulatory sandbox environments are presented to illustrate how these key characteristics can be identified: the UK FCA fintech sandbox¹⁴⁵, the first known regulator to establish a regulatory sandbox framework; the Norwegian Datatilsynet privacy sandbox¹⁴⁶, which has focused on trustworthy AI in the context of data protection from 2021 to 2025; and the Spanish *Secretaría de Estado de Digitalización y Inteligencia Artificial* (SEDIA) AI sandbox¹⁴⁷, a pilot initiative designed to create lessons for the forthcoming AI Regulatory Sandboxes mandated under the EU AI Act¹⁴⁸.

Table 2: The key characteristics of a Regulatory Sandbox in some specific sandbox environments

Core characteristic	FCA Regulatory fintech sandbox (UK)	Datatilsynet Regulatory privacy sandbox (Norway)	SEDIA Pilot AI Sandbox (Spain)
Innovation-driven	Supports testing of innovative financial products, services, or business models in fintech and related sectors.	Foster privacy-enhancing innovation and responsible data governance, including AI systems	Pilot to test AI systems and implement requirements of the upcoming EU AI Act.
Controlled framework	Firms test innovations in a supervised environment with regulatory oversight and consumer protection safeguards.	Selected organisations experiment with AI projects under close supervision of the DPA	Pilot projects are conducted within a structured testing environment supervised by the Spanish State Secretary on Digitalization and AI (SEDIA).
Time-limited	Testing activities last up to 6 months; Application to exit last up to 24 months	Yearly based cohorts	Testing activities last around 12 months, after participants selection

¹⁴³ COR Sandbox, “COR Sandbox,” Sandbox, 2026, <https://www.corsandbox.org>

¹⁴⁴ Institute for the Future of Work, “Responsible AI Sandbox – IFOW,” United Kingdom, 2026, <https://www.ifow.org/landing-page/sandbox>.

¹⁴⁵ Financial Conduct Authority, “Regulatory Sandbox.”

¹⁴⁶ Datatilsynet, “Regulatory Privacy Sandbox,” Datatilsynet, accessed July 20, 2024, <https://www.datatilsynet.no/en/regulations-and-tools/sandbox-for-artificial-intelligence/>.

¹⁴⁷ Secretaria de Estado de Digitalización e Inteligencia Artificial – SEDIA, “Sandbox IA – Home,” 2025, <https://avance.digital.gob.es/sandbox-IA/Paginas/sandbox-IA.aspx>.

¹⁴⁸ European Commission, “First Regulatory Sandbox on Artificial Intelligence Presented | Shaping Europe’s Digital Future,” Brussels, 2022, <https://digital-strategy.ec.europa.eu/en/news/first-regulatory-sandbox-artificial-intelligence-presented>.

Core characteristic	FCA Regulatory fintech sandbox (UK)	Datatilsynet Regulatory privacy sandbox (Norway)	SEDIA Pilot AI Sandbox (Spain)
Regulatory flexibility	Firms may benefit from tools such as restricted authorisation, waivers, or no-enforcement letters.	Focuses less on waivers and more on interpreting GDPR obligations during experimentation.	Allows experimentation with AI Act compliance processes before full regulatory application.
Regulatory guidance	One of the available tools is individual guidance to help firms understand regulatory requirements during testing.	Provides free regulatory guidance and advisory support to all participating organisations.	Participants receive guidance on implementing AI Act obligations and conformity assessment processes.
Regulatory learning	Insights from sandbox tests support FCA policies on emerging financial technologies.	Lessons from projects on data protection and AI governance good practices are shared in public reports.	Outcomes will provide evidence for supporting future AI executive acts and assess the impact of the AI Act.
Collaborative governance	Interaction between firms, regulators, and sometimes consumers in real-market tests.	Cooperation between DPA, participant organisations, and members of an advisory board. Some projects also engaged with end-users and affected stakeholders such as hospital staff and patients; or school staff, students and legal guardians.	Collaboration between the Spanish government, AI providers, and a panel of experts to develop AI regulatory implementation practices.

Importantly, this definition highlights the broader societal role of regulatory sandboxes. Beyond benefits for participating innovators and authorities, sandboxes should also contribute to the public interest by fostering responsible innovation, anticipating risks to fundamental rights, and guiding future regulatory development. When appropriately designed and implemented, regulatory sandboxes can serve as sites for inclusive experimentation, where diverse perspectives are integrated and safeguards for affected third parties – such as consumers, end-users, and other rightsholders – are meaningfully considered. Framing them as learning-oriented and participatory governance tools can support more transparent, and socially responsive approaches to regulatory experimentation in sandbox environments.

Use of Generative AI

This paper used generative AI in a limited manner for spelling, translation and minor stylistic refinements.

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