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THE DUAL IMPACT OF REGULATORY SANDBOXES ON FINTECH INNOVATION AND REGULATORY PRACTICES: A COMPREHENSIVE ANALYSIS

Dissertation to obtain a Master´s Degree in Law – Specialization in Law and Financial Markets

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ABSTRACT

This study investigates the implementation and impact of regulatory sandboxes within the financial technology (FinTech) sector and the primary regulatory obstacles that have prompted global regulatory authorities to establish this innovative tool. It explores the historical development, benefits, and limitations of sandboxes as tools for fostering innovation while maintaining regulatory oversight. Optimal strategies for sandbox implementation are analyzed, including the rationale for adoption, identification of barriers to innovation, and design considerations. The key findings highlight the potential of sandboxes to reduce costs, mitigate agency problems, and facilitate knowledge exchange between regulators and firms. However, challenges such as regulatory capture and forum shopping are also discussed in this paper. The study concludes by outlining the best practices for sandbox execution, emphasizing the importance of clear eligibility criteria, stakeholder engagement, risk management, and continuous monitoring while promoting innovation and consumer protection.

RESUMO

Este estudo investiga a implementação e o impacto dos sandboxes regulatórios no setor de tecnologia financeira (FinTech) e os principais obstáculos regulatórios que levaram as autoridades reguladoras globais a estabelecer essa ferramenta inovadora. Explora o desenvolvimento histórico, os benefícios e as limitações dos sandboxes como instrumentos para fomentar a inovação ao mesmo tempo que mantém a supervisão regulatória. São analisadas estratégias ideais para a implementação dos sandboxes, incluindo a justificativa para sua adoção, a identificação de barreiras à inovação e considerações sobre o seu design. As principais conclusões destacam o potencial dos sandboxes para reduzir custos, mitigar problemas de agência e facilitar a troca de conhecimento entre reguladores e empresas. No entanto, desafios como captura regulatória e arbitragem regulatória também são discutidos neste trabalho. O estudo conclui delineando as melhores práticas para a execução dos sandboxes, ressaltando a importância de critérios claros de elegibilidade, engajamento das partes interessadas, gestão de riscos e monitoramento contínuo, promovendo simultaneamente a inovação e a proteção do consumidor.

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1. INTRODUCTION

1.1. Context of the Topic

New technologies have emerged in the context of globalization, and the use of digital tools has intensified over time, especially after the Covid-19 pandemic.[1] The demand for efficiency and inclusion benefits has intensified over time, and the application of technological solutions in the financial industry (FinTech) has become more widespread. As financial services continue to adopt these new technologies, regulators must adapt and move away from their traditional roles to keep pace with the new reality of a globalized world.

In contrast, new surveillance and regulatory tools have been developed to address new risks and ensure an adequate response. Supervisory technologies (SupTech) have emerged as a direct result of these technological trends in financial services, providing regulators with a new set of instruments to help them deal with these challenges. SupTech refers to advanced technologies used by supervisors for oversight.[2] This is a response to the evolving nature of the financial sector and the need for advanced regulations.

Moreover, SupTech offers great potential for improving regulatory oversight and creating new challenges that must be addressed with care. The pace of change in technology and digital solutions, including data analytics and artificial intelligence (AI), has had a profound effect across all industries, including financial services. These technological developments have changed the way financial institutions operate and have introduced new issues that regulators must address.

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[1] Iñaki Aldasoro and others, "Covid-19 and Cyber Risk in the Financial Sector" (January 14, 2021) <https://www.bis.org/publ/bisbull37.htm> accessed December 20, 2024.

[2] Gérard Hertig, "Financial Supervision and AI (Chapter 19) - The Cambridge Handbook of Private Law and Artificial Intelligence" (Ernest Lim and Philip Morgan eds, *Cambridge Core*, 2024) <https://www.cambridge.org/core/books/abs/cambridge-handbook-of-private-law-and-artificial-intelligence/financial-supervision-and-ai/F7BC20D8C1199531F8DE71C7D2A725A9> accessed December 14, 2024.

Given these technological developments and their implications, supervisors should keep pace with these new technical improvements and related impacts, not only to facilitate and increase efficiency in their work, but also to recognize, understand, and address the impact of technology on the continuous transformation of financial markets. This more proactive approach is required, as it will enable regulators to stay ahead of potential problems. In this way, they might mitigate the threats that such developments pose.

SupTech solutions can help supervisors oversee compliance with regulations and identify potential breaches more effectively.[3] This greater monitoring ability not only enhances regulatory supervision but also helps to stabilize the financial system. Automated reporting, compliance checks, and data analysis for regulatory purposes are techniques that aid supervisors in their goal of ensuring that supervised entities meet their legal requirements and manage their businesses soundly. Although the use of SupTech tools presents numerous advantages, it also introduces new risks for regulators and the financial sector.

In this regard, it is important to mention that regulators must strike a balance between the obligation to foster innovation and the utilization of new tools to accomplish their regulatory goals. As soon as these technologies bring about new risks, any regulatory response must be sensitive to these risks and not impede innovation. A promising new approach that has gained popularity over the past decade is the appearance of regulatory sandbox experimentation, defined as a "controlled

[3] Ross P Buckley, Douglas W Arner and Dirk A Zetzsche, "FinTech" (*Cambridge Core*, November 2023) <https://www.cambridge.org/core/books/fintech/D6641E8C867EA0455B5E2F5E7F04D33F> accessed October 17, 2024.

environments for firms to test their innovative propositions on real consumers"[4] or a "dynamic and evidence-based regulatory environment to test emerging technologies."[5]

Regulatory sandboxes are a promising mechanism for encouraging innovation and trying new ideas in a safe space, but they present serious concerns. To address these issues, it is necessary to develop and implement well-designed sandbox frameworks based on the premise that the integrity of the regulation, protection of consumers, and advantages of innovation can be accessed while controlling the stability and fairness of the system. This fine line between innovation and regulation illustrates the challenges posed by the application of sandbox regulatory models. In other words, the evolution and proliferation of these developmental regulatory models can have positive or negative effects on FinTech ecosystems and regulatory practices.

To further consider such impacts, it is worthwhile delineating some of the specific benefits embedded in regulatory sandboxes. As discussed, the regulatory sandbox offers a safe space for FinTech firms to test new products and services without the initial requirement of meeting all regulatory requirements to do so. This experimental setting can serve as a multidimensional vehicle for innovation.[6] Furthermore, by overcoming regulatory obstacles, regulatory sandboxes allow for the accelerated market penetration of FinTech startups' products, promoting agility and competition in the financial landscape.[7]

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[4] Parma Bains and Caroline Wu, "Institutional Arrangements for Fintech Regulation: Supervisory Monitoring" (IMF, June 26, 2023) <https://www.imf.org/en/Publications/fintech-notes/Issues/2023/06/23/Institutional-Arrangements-for-Fintech-Regulation-Supervisory-Monitoring-534291> accessed December 17, 2024.

[5] Consultative Group to Assist the Poor, Ivo Jenik and Schan Duff, "Global Experiences from Regulatory Sandboxes" (2020) <https://documents1.worldbank.org/curated/en/912001605241080935/pdf/Global-Experiences-from-Regulatory-Sandboxes.pdf> accessed January 23, 2025.

[6] Ringa Raudla and others, "Regulatory Sandboxes and Innovation Hubs for FinTech: Experiences of the Baltic States" (2024) 58 European Journal of Law and Economics.

[7] Jayoung James Goo and Joo-Yeun Heo, "The Impact of the Regulatory Sandbox on the Fintech Industry, with a Discussion on the Relation between Regulatory Sandboxes and Open Innovation" (2020) 6 Journal of Open Innovation: Technology, Market, and Complexity 43.

In addition to market-based benefits, regulatory sandboxes provide advantages to regulators. By establishing regulatory sandboxes, authorities can gain substantial understanding of the operational aspects of innovative technologies and develop better and more flexible regulatory arrangements.[8] Furthermore, because sandbox participants are monitored closely, regulators can check whether new financial products and services comply with established safety and protection standards, keeping consumers safe from negative effects. However, negative outcomes associated with technological development in financial markets have been identified.

First, it has been stated that companies could benefit from more relaxed regulations in sandboxes and distort market competitiveness. Considering the controlled sandbox context, unregulated entities can apply for an exemption in the same way as regulated entities, thereby putting them at the same level, regardless of their regulatory status outside the sandbox.[9]

Beyond competition problems, the absence of standardization can pose challenges for cross-border implementation.[10] In this context, it has been suggested that innovation facilitators, such as regulatory sandboxes, might carry the risk of market fragmentation when the conditions for testing in a regulatory sandbox (such as eligibility criteria, regulatory relief, and testing parameters) vary significantly between countries. Consequently, successful sandboxes implemented in one country may face systemic problems when attempting to scale across borders.[11] Similarly, the support that entities receive in their countries within an innovation hub may differ, which may impede cross-border implementation of a product or business model. Meeting these challenges requires close cooperation and communication among supervisors, as well as greater

[8] Mark Brnovich, "Regulatory Sandboxes Can Help States Advance Fintech" *American Banker* (September 5, 2017) <https://www.americanbanker.com/opinion/regulatory-sandboxes-can-help-states-advance-fintech> accessed January 23, 2025.

[9] *Consultative Group to Assist the Poor, Ivo Jenik and Schan Duff*, n.5.

[10] ibid 40.

[11] *Ringa Raudla and others*, n. 6.

participation and oversight by authorities in exercising effective oversight over a cohesive regulatory and supervisory response.

Moreover, the limited availability or scarcity of resources is a critical barrier to the deployment of regulatory sandboxes. This is particularly crucial given the nature of setting up and maintaining sandboxes, which include substantial resources, such as skilled experts to manage programs (who can be difficult to find) and financial investments to create and maintain a sandbox environment.[12] Consequently, regulatory sandboxes may face challenges concerning resource capacity, and not all innovative firms can benefit from the sandbox environment.

Overcoming the discussion on resource constraints, another critical issue is the phenomenon of 'regulatory capture' or ‘cognitive capture,’ wherein regulators’ decisions can be influenced by lobbying and industry interests, considering the close collaboration between these entities. In such cases, regulatory agencies should rely on providers of sophisticated financial products and services to explain how they work, which ultimately represents the views of that segment of the financial industry rather than the objectives of the broader society.[13]

In conclusion, technological development in financial markets has progressed at a pace requiring the adaptation of regulatory responses, with SupTech and regulatory sandboxes as examples of these responses. While these tools have substantial advantages for better coordination, efficiency, and innovation, they also have pitfalls, such as market distortions, cross-border discrepancies, and resource limitations. For the effective operationalization of these regulatory systems, a fine balance between encouraging innovation and ensuring market stability must be maintained. Therefore, regulatory authorities should work closely with each other, harmonize practices internationally, and guard against possible pitfalls such as regulatory capture. By

[12] OECD, “The Role of Sandboxes in Promoting Flexibility and Innovation in the Digital Age” (*OECD*, June 12, 2020) <https://www.oecd.org/en/publications/the-role-of-sandboxes-in-promoting-flexibility-and-innovation-in-the-digital-age_cdf5ed45-en.html> accessed November 6, 2024.

[13] Hilary J Allen, “Regulatory Sandboxes” (2019) 87 SSRN Electronic Journal.

meeting these challenges and taking advantage of the opportunities provided by SupTech and regulatory sandboxes, supervisory authorities can play an important role in developing a strong, flexible, and innovative financial landscape that can better serve industry players and consumers.

1.2. Research Justification

The proliferation of regulatory sandboxes has created a complex landscape with significant opportunities and challenges. In this multifaceted environment, such instruments are essential for promoting innovation and improving regulations. Careful stewardship and ongoing monitoring are essential to avoid risks and ensure that the FinTech ecosystem and society, in general, view the upside of the equation.

To approach these dimensions more thoroughly, this study seeks to evaluate the simultaneous influence of regulatory sandboxes on the behavior of both FinTech ecosystems and regulatory strategies, as both their strengths and weaknesses will be identified. This study provides an understanding of how sandboxes can be used to accelerate development and market access, as well as their benefits and challenges.

1.3. Research Questions and Methodology

Given this background, this study aims to answer the following research question:

1. What is the impact of regulatory sandboxes on FinTech innovation, and how can these frameworks be designed and implemented to balance innovation, consumer protection and financial stability?

This question involves a critical analysis of the regulatory concerns and challenges that regulatory sandboxes are designed to address, such as how to regulate more effectively in an environment of swift technological development in financial products and services, as well as the tension between the need to promote innovation and the need to ensure consumer protection.

The primary question is supplemented by several sub-questions that investigate various dimensions of regulatory sandboxes in the realm of financial services and FinTech innovation. Collectively, these questions aim to furnish a comprehensive understanding of regulatory sandboxes, elucidating their function in overcoming regulatory obstacles and influencing FinTech innovation and the regulation of financial services. These sub-questions address topics such as the following:

- *What are the main regulatory barriers in financial services that have led global regulatory authorities to establish and implement regulatory sandboxes*? Regulatory barriers within the financial services sector can hinder innovation and restrict market entry for emerging FinTech companies by presenting compliance challenges and increasing operational costs. Therefore, it is essential to analyze these barriers and assess the critical factors that prompted regulators to establish sandbox experiments.

- *What are the various types of regulatory sandboxes, and how have they evolved since their establishment?* A regulatory sandbox, as its name suggests, is a testing environment in which businesses, especially FinTech, can experiment with new products, services, or business models for a limited period under loosened regulatory conditions but in collaboration with a regulator. Several forms of regulatory sandboxes are used in various sectors to achieve specific needs and goals, and a comprehensive evaluation of these different types is fundamental, knowing that none should be applied in isolation by different jurisdictions.

- *How important are the key factors in improving the effectiveness of regulatory sandboxes in promoting innovation in FinTech?* Key elements are critical for the effective functioning of regulatory sandboxes in promoting innovation in the FinTech sector. These considerations are critically assessed, ranging from the regulatory environment, stakeholder

partnership, risk control, and technological platform to the market maturity level.

- *What are the risks and challenges related to regulatory sandboxes, such as regulatory arbitrage, resource constraints, and the risk of regulatory capture, and how can these risks be identified and addressed?* Regulatory arbitrage, that is, firms leveraging varying regulatory regimes to their advantage, may be mitigated by setting the borders of the sandbox and close communication between regulators in different countries. Resource constraints, both for regulators and participating businesses, can be addressed by prioritizing high-impact projects, setting timeframes, and potentially using cost-sharing schemes for sandbox operations. There is a risk of regulatory capture; that is, regulators could be captured by the firms they monitor, which requires strong governance arrangements and a high level of transparency.

- *In what ways does the development and enhancement of regulatory bodies' competencies improve their capacity to manage sandboxes effectively and facilitate FinTech innovation? What is the impact of regulatory sandboxes on venture capital investment in FinTech enterprises?* Enhancing the capacity of regulatory bodies and formulating appropriate regulations are crucial for the effective management of regulatory sandboxes and the advancement of the FinTech industry. The primary advantages of regulatory sandboxes include their capacity to promote innovation, facilitate ongoing regulatory oversight, mitigate regulatory uncertainty, and demonstrate the viability of novel financial-service solutions. It is essential to investigate the extent to which sandboxes impact venture capital investments in the FinTech sector, whether positively or negatively.

- *To what extent does the collaborative nature of regulatory sandboxes facilitate knowledge exchange between regulatory bodies and innovators?* Building capacity within regulatory authorities is frequently achieved through collaboration between academia, industry, and international organizations. This cooperative relationship enables regulators to learn the best practices globally, share learning, and gain better knowledge of the finer nuances of the FinTech space. However, there are problems associated with this close relationship that need to be examined.

- *How can the effectiveness of financial service regulatory sandboxes be assessed and evaluated in relation to the development of FinTech innovation and regulatory results?* One such indicator is the number of quality innovative products and services developed in the sandbox that have managed to make the leap into the mainstream. This can be measured by monitoring the journey of participating firms from sandbox-through to full regulatory compliance and market entry. Additionally, the speed of adoption and acceptability of these innovations can provide useful data on their field outcomes and true worth. In addition, the sandbox's effects on the overall FinTech ecosystem can be estimated by tracking the direction of the investment fund, the number of new jobs within the industry, and the degree of competition between incumbent financial institutions and FinTech startups.

- *What are the factors and good practices conducive to the successful design and implementation of regulatory sandboxes that stimulate FinTech innovation while upholding sound consumer protection and financial stability?* To be successfully utilized for targeted supervisory intervention, consumer protection, and safeguarding financial stability, building regulatory sandboxes requires targeted factors and best practices, such as risk management, regulatory supervision, and stakeholder involvement.

2. TECHNOLOGICAL DEVELOPMENT AND SANDBOXES

2.1. Regulating Technology

2.1.1. Data Analytics and Artificial Intelligence

In October 2024, the International Monetary Fund (IMF) released a version of the Global Financial Stability Report (GFSR), a publication that provides a public analysis of the state of international banking and financial markets. The GFSR focuses on providing timely and relevant analyses of structural and long-term developments in global financial markets, such as the newest systemic risk assessment, emerging economic markets, global debt management, and current economic crises that may have global financial implications. It is published biannually in April and October.[14]

This report is structured into three sections. Section 1 demonstrates that whereas some financial stability risks persist in the short run, medium-term downside risks may have become stronger, primarily due to the widening gap between high economic instability and low financial volatility. The report does have policy prescriptions, including the need for clear central bank communication, rising fiscal buffers, and strengthening non-bank leverage policies.

The second section provides evidence that high levels of macroeconomic uncertainty can undermine macroeconomic stability by increasing downside-tail risks to financial price indices, credit availability, and GDP expansion. These relationships are exacerbated when debt vulnerabilities accumulate or financial market volatility is repressed (i.e., during periods of macro-market disconnection). The report recommends strengthening policy frameworks, creating fiscal and macroprudential buffers, and bolstering international reserves to achieve this.

[14] International Monetary Fund, "Global Financial Stability Report, October 2024; Steadying the Course: Uncertainty, Artificial Intelligence, and Financial Stability" (International Monetary Fund 2024).

Recent developments in artificial intelligence (AI) and generative AI[15] are provided in Section 3, and what they mean for capital markets. The regulatory business issues addressed in this report will be elaborated in the following master's thesis. Section 3 includes new analysis and information from a global survey with market participants and regulators, describes the potential benefits and risks to systemic safety if these new technologies are widely adopted, and outlines policy options in response. For example, the IMF states that the use of AI and Generative AI has positive implications for financial stability, and many monetary market actors, such as investment managers, expect an increase in their use.[16] The advantages resulting from the application of applying these new technologies include efficiency gains, productivity increases, and an advanced investor portfolio structure.[17] However, new technologies that promise to revolutionize the structure of financial markets will create the potential for serious risks that must be carefully managed. Although the GFSR provides a global view of financial stability, it is important to consider the technological innovations reshaping finance, including the emergence of financial technology (FinTech) firms.

The financial market has significantly transformed with the emergence of FinTech startups, which have provided new ways to interact with financial services while increasing their accessibility to financial services. Modern technologies such as AI, blockchain, and mobile apps are used to offer simpler and more convenient financial products and services. This new market has created more competition, greater efficiency, and lower prices for consumers. Furthermore, many FinTech companies attract underserved portions of the population, contributing to financial inclusion and making financial tools available to all. However, the rapid development and widespread

[15] As reported in a publication by Cole Stryker on the IBM website, generative AI, or Gen AI, is an 'artificial intelligence (AI) that can create original content—such as text, images, video, audio or software code—in response to a user's prompt or request'. < https://www.ibm.com/think/topics/generative-ai> accessed February 7, 2025.

[16] Mercer Investments, "AI in Investment Management Survey" (https://www.mercer.com/?site=global, 2024) <https://www.mercer.com/insights/investments/portfolio-strategies/ai-in-investment-management-survey/> accessed February 7, 2025.

[17] Peter S Park and others, "AI Deception: A Survey of Examples, Risks, and Potential Solutions" (arXiv.org, August 28, 2023) <https://arxiv.org/abs/2308.14752>.

adoption of FinTech solutions have also introduced new risks, particularly in the technology sphere, such as cybersecurity and data protection.[18]

Because the volumes of high-value, sensitive financial data that they store are so high, these companies have become highly regarded targets for cybercriminals. The dangers of data breaches, identity theft, and financial fraud have increased, reinforcing the need for strong defenses against such cyberthreats. Moreover, the use of advanced algorithms and algorithmically driven decisions presents challenges in terms of data privacy, algorithmic bias, and the creation of systemic financial risks. The challenge for regulators is to develop appropriate architecture to manage these new risks and innovations within the context of FinTech. Among the different technological risks of FinTech, cyber risk constitutes a relevant risk, given its systemic implications for the threat to financial stability.

In this regard, cyber risk, as defined by the Financial Stability Board (FSB) Cyber Lexicon (2023)[19], encompasses the "likelihood of cyber incidents occurring and their subsequent effects." In the context of cyber security, cyber incidents are events that, based on their severity, can affect the security of an information system and generate destruction or damage to an information system or the information that it processes, stores, or transmits. According to a recent bulletin released by the Bank of International Settlements (BIS)[20], cyberattacks have more than doubled since the pandemic, with the financial sector being a prime target owing to the sensitive data and large transactions it handles.

The International Monetary Fund (IMF) has raised concerns that these attacks could cause bank runs and drive companies into bankruptcy, thus exposing systemic

[18] Ross P Buckley and others, "The Dark Side of Digital Financial Transformation: The New Risks of FinTech and the Rise of TechRisk" (Elsevier BV 2019) <https://doi.org/10.2139/ssrn.3478640> accessed February 21, 2025.

[19] Financial Stability Board, "Cyber Lexicon: Updated in 2023" (*Financial Stability Board*, April 13, 2023) <https://www.fsb.org/2023/04/cyber-lexicon-updated-in-2023/> accessed February 21, 2025.

[20] Iñaki Aldasoro and others, 'Covid-19 and Cyber Risk in the Financial Sector' <https://www.bis.org/publ/bisbull37.htm> accessed 26 April 2024.

issues that cyber threats can inflame. [21] Thus, owing to the continuous development of technological instruments in the financial industry, the question of potential weakening of cybersecurity has been raised, and governments have recognized the importance of progress in the field of information security. Cybersecurity and risks represent a serious threat to financial institutions and their customers, but they are not the only technological issues they deal with. As mentioned, the large collection and analysis of data is a feature of many AI-based financial technologies, which raises important issues of data privacy and security.

Artificial intelligence technologies frequently collect and analyze extensive quantities of personal data (Big Data), raising issues regarding data privacy, surveillance, and the possibility of data misuse.[22] Protecting data and ensuring security and privacy are core requirements for the development and operation of AI technologies, which is a fundamental right established by the General Data Protection Regulation (GDPR).[23] These privacy considerations are one of several troubling challenges that AI's expanding role in finance brings, according to the GFSR's analysis of AI and generative AI consequences for capital markets.

Data analytics and artificial intelligence (AI) have emerged as powerful technological solutions for addressing complex challenges across various industries. Data management tools help companies obtain actionable insights from large datasets, make data-driven decisions, and automate several processes with high efficiency. The process of examining raw data to draw conclusions about the information, patterns, correlations, and trends enables companies to make informed business decisions that improve the customer experience, simplify operations, and create new products or

[21] International Monetary Fund, "Global Financial Stability Report, April 2024" (International Monetary Fund 2024) <https://doi.org/10.5089/9798400257704.082> accessed February 21, 2025.

[22] Changwu Huang and others, "An Overview of Artificial Intelligence Ethics" (2023) 4 IEEE Transactions on Artificial Intelligence 799.

[23] Council Regulation (EU) 2016/679 of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data (GDPR - General Data Protection Regulation) [2016] OJ L119/1.

services.[24] AI involves the use of machine learning algorithms and neural networks to mimic human intelligence, learn from experiences, and complete tasks that typically require human intervention.

The integration of data analytics and AI has revolutionized healthcare, finance, manufacturing, and marketing. In healthcare, they are employed to analyze patient information, forecast disease outbreaks and personalize treatment.[25] Banking institutions can use AI algorithms to detect fraud, assess risk, and conduct algorithmic trading.[26] The use of predictive maintenance solutions helps reduce equipment downtime and improve production efficiency for manufacturers. IA-based recommendation engines and customized advertising campaigns have changed the way organizations engage with customers.[27] While these technologies are still developing, their potential uses are growing, heralding increased efficiency, innovation, and problem-solving in many fields. Although data analytics and artificial intelligence provide effective mechanisms for tackling complex challenges in different fields, their adoption poses challenges, including data privacy, ethical concerns, and employment displacement in traditional industries.

One of these challenges is data privacy issues. As companies collect and analyze increasing amounts of personal and sensitive data, concerns are rising about how these data are stored, used, and protected. With the risks of data breaches and the misuse of private data, there is a demand for more stringent regulations and better protection against external risks. Data privacy concerns individuals' privacy and the protective use

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[24] IBM, "Artificial Intelligence" (*IBM*, 2024) <https://www.ibm.com/think/topics/artificial-intelligence> accessed April 30, 2025.

[25] Health Data Research UK, "Call for Applications to Test New £37.5M UK Health Data Research Services" (*HDR UK*, July 19, 2019) <https://www.hdruk.ac.uk/news/call-for-applications-to-test-37-5m-new-uk-health-data-research-services/> accessed March 6, 2025.

[26] Dimple Patil, "Artificial Intelligence in Financial Services: Advancements In Fraud Detection, Risk Management, And Algorithmic Trading Optimization" (Elsevier BV 2025) <https://doi.org/10.2139/ssrn.5057412> accessed May 7, 2025.

[27] Thomas H. Davenport, Abhijit Guha and Dhruv Grewal, "How to Design an AI Marketing Strategy" *Harvard Business Review* (July 1, 2021) <https://hbr.org/2021/07/how-to-design-an-ai-marketing-strategy> accessed May 7, 2025.

of personal information, as well as the implications of AI and data analytics in decision-making processes.[28]

The ethical implications of AI and data analysis are challenging. Algorithms have been scrutinized for bias and opacity, especially in weight applications such as loan decisions, employment practices, and criminal justice determinations.[29] People are concerned that AI systems may have biases and worsen social inequalities. Additionally, the use of AI in surveillance and predictive policing has promoted serious debate about individual privacy rights and potential abuse of power.[30]

Another major issue regarding the use of AI is job displacement in traditional sectors as these technologies mature. Although these technologies create new job opportunities in fields such as data science and AI development, they have the potential to automate many tasks and cause major shifts in the workforce in industries such as manufacturing, customer service, and transport. This raises significant questions regarding the responsibility of job-training programs to retrain workers in a dynamic labor market. Aside from direct employment implications, the surge in AI and automation presents a series of further complications.

Similar to the employment sector, rapid advancements in artificial intelligence and data analytics present significant challenges to regulatory frameworks and governance. Policymakers and legislators frequently encounter difficulties in keeping pace with the evolving landscape, resulting in gaps in oversight and protection. There is

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[28] Saharnaz Dilmaghani and others, "Privacy and Security of Big Data in AI Systems: A Research and Standards Perspective," *2019 IEEE International Conference on Big Data (Big Data)* (IEEE 2019) <https://doi.org/10.1109/bigdata47090.2019.9006283> accessed April 30, 2025.

[29] Moses Alabi, "Ethical Implications of AI: Bias, Fairness, and Transparency" (*unknown*, November 11, 2024) https://www.researchgate.net/publication/385782076_Ethical_Implications_of_AI_Bias_Fairness_and_Transparency>.

[30] The Economic Times, "AI and Privacy: The Privacy Concerns Surrounding AI, Its Potential Impact on Personal Data" *Economic Times* (April 25, 2023) <https://economictimes.indiatimes.com/news/how-to/ai-and-privacy-the-privacy-concerns-surrounding-ai-its-potential-impact-on-personal-data/articleshow/99738234.cms?from=mdr> accessed April 30, 2025.

a debate about how to balance the need to innovate and move forward with the need to responsibly develop and deploy this technology.[31]

Nevertheless, the promise of data analytics and AI continues to push these technologies into numerous industries. However, the challenges and risks that emerge when artificial intelligence systems are employed in the supervisory sector must be addressed. The lack of transparency and explainability of these systems poses challenges to supervisory bodies. Explainability in AI systems refers to the capacity of a company or model developer to comprehend the rationale behind a model's outputs or the process by which it arrives at its conclusions.[32] Moreover, AI systems, particularly those based on machine learning, can reflect the biases present in the training data or design choices of the models. The biased outcomes of AI systems can lead to discriminatory decisions, perpetuate inequalities, and violate fundamental rights of individuals.

Furthermore, the integration of automated technologies into decision-making activities can generate an accountability deficit, impeding human supervisors from discharging their legal obligations, particularly their duty to provide reasons for their decisions. The consequences of these problems could be substantial for the auditability of AI-supported supervisory judgments, potentially compromising their legality and effectiveness.

To mitigate these fears, increased focus is being placed on appropriate AI ethics frameworks, the introduction of strong data protection strategies, and the encouragement of multidisciplinary engagement to ensure that such powerful technologies are applied appropriately. The regulatory framework in the European Union, comprising the AI Act[33] and the General Data Protection Regulation (GDPR), holds considerable

[31] Financial Stability Board, "Financial Stability Implications from FinTech - Supervisory and Regulatory Issues That Merit Authorities' Attention" (2017) <https://www.fsb.org/2017/06/financial-stability-implications-from-fintech/> accessed April 27, 2025.

[32] Paul Tierno, "Artificial Intelligence and Machine Learning in Financial Services" (Congressional Research Service 2024) <https://crsreports.congress.gov/> accessed June 4, 2025.

[33] Regulation of the European Parliament and of the Council laying down harmonised rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain union legislative acts) 2024.

importance in defining the legal boundaries of AI-driven supervisory instruments. Adherence to these regulations, particularly with respect to transparency, accountability, and safeguarding fundamental rights, is vital to guarantee the legitimacy and efficacy of AI applications. Nevertheless, as the use of data analytics and AI has grown, regulators are increasingly turning to new techniques to balance innovation with responsible regulation. One such method involves the use of regulatory sandboxes, which are described in the following section.

2.2. Regulatory Sandboxes

2.2.1. Definition and Objectives

Regulatory sandboxes are environments in which entities are authorized by regulatory bodies to test innovative projects in the financial or payment areas for a specified period, observing a specific set of regulatory provisions that support the controlled and delimited performance of their activities. It is described as "an environment in which FinTech entrepreneurs can conduct limited tests of their innovations with fewer regulatory constraints, real customers, less risk of enforcement action, and ongoing guidance from regulators."[34]

The experimentation facilitated by regulatory sandboxes enables authorities to analyze the interaction between technological innovations and existing regulations[35], as well as to assess the feasibility and necessity of approaching them differently to promote innovation models while safeguarding fundamental rights. This is attributed to the fact that sandboxes provide controlled market environments for small-scale testing and foster collaboration and trust between the regulated entity and the regulator. Typically implemented in scenarios where emerging technologies possess disruptive potential[36],

[34] Dirk A Zetzsche and others, "Regulating a Revolution: From Regulatory Sandboxes to Smart Regulation" (2017) 11 SSRN Electronic Journal.

[35] Jenik I and Lauer K, "Working-Paper-Regulatory-Sandboxes-Oct-2017.Pdf" (2017) <https://www.cgap.org/sites/default/files/Working-Paper-Regulatory-Sandboxes-Oct-2017.pdf>

[36] Freddy Fachler, "Regulatory Sandboxes: A Safe Space for Disruptive Innovation" (Https://iitos.net/en/home/, September 18, 2024) <https://iitos.net/en/regulatory-sandboxes-a-safe-

these sandboxes permit the experimentation of innovative technologies and business models in situations where there is uncertainty regarding their compliance with applicable laws and regulations.

The objectives of regulatory sandboxes vary. The implementation of such sandboxes is generally defined in the context of innovation, market growth, competition and economic development.[37] Regulatory sandboxes are typically categorized into four distinct types that are not mutually exclusive according to their objectives.[38]

The first type is *a policy-focused sandbox*. This approach is based on the assessment and formulation of specific regulations or policies, particularly in sectors that experience rapid technological advancements. This enables regulators to experiment with new regulatory processes within a controlled setting prior to their broader implementation. Regulatory sandboxes have positively impacted investment growth in FinTech ventures by mitigating regulatory uncertainty.[39] By offering a more defined regulatory framework, sandboxes facilitate investors' comprehension of rules and associated risks.[40] Consequently, this enhanced clarity and reduced uncertainty have led to increased financial investment in FinTech companies and their innovations. Fundamentally, these sandboxes establish a secure environment for experimentation in financial technology, thereby attracting more investors and fostering sector growth. Although policy-focused sandboxes primarily address regulatory frameworks, another approach focuses on fostering product-level innovation.

Product- or innovation-focused sandboxes are a type of regulatory sandbox that aims to encourage innovation by lowering barriers to entry for firms testing new financial products or business models. These sandboxes allow companies to conduct

space-for-disruptive-innovation/> accessed February 25, 2025.

[37] *Zetzsche and others*, n. 34.

[38] *Consultative Group to Assist the Poor, Ivo Jenik and Schan Duff*, n. 5.

[39] Giulio Cornelli and others, "Regulatory Sandboxes and Fintech Funding: Evidence from the UK" (2023) 28 Review of Finance 203.

[40] *Jayoung James Goo and Joo-Yeun Heo*, n. 7.

limited trials of innovative offerings in a controlled environment with real customers but with reduced regulatory constraints and continuous guidance from regulators. The key objectives are to enable firms to assess the market viability of novel ideas, reduce the time and costs of bringing innovations to the market, and provide insights into emerging technologies and business approaches.[41] By creating a safe space for experimentation, product-focused sandboxes can help accelerate the development and adoption of beneficial financial innovations while maintaining the appropriate safeguards. Regulators can use the sandbox process to evaluate how new products interact with existing rules and consider whether regulatory adjustments are needed to accommodate promising innovations.[42] Building on the concept of product-focused sandboxes, regulators have refined their approach by developing more specialized environments known as *thematic sandboxes*.

Thematic sandboxes are specialized regulatory sandboxes that focus on specific themes, policy areas, or sectors. They aim to accelerate the adoption of innovations or support the development of targeted products or services, often for specific population segments.[43] The key features of thematic sandboxes include (i) a narrow focus on a defined theme or policy objective, (ii) tailored testing parameters aligned with the chosen theme, (iii) targeted participation from firms working on relevant innovations, (iv) collaboration between regulators and industry on thematic challenges, and (v) the potential for faster policy insights in priority areas.[44]

Thematic sandboxes enable regulators to allocate resources effectively to innovations that address specific regulatory or market priorities. The establishment of a controlled environment for thematic experimentation is expected to facilitate more rapid advancement towards targeted policy objectives or emerging technologies. This

[41] Wolf-Georg Ringe and Christopher Ruof, "Regulating Fintech in the EU: The Case for a Guided Sandbox" (2020) 11 European Journal of Risjenikk Regulation 604.

[42] Emily Leckenby and others, "The Sandbox Approach and Its Potential for Use in Health Technology Assessment: A Literature Review" (2021) 19 Applied Health Economics and Health Policy 857.

[43] *Consultative Group to Assist the Poor, Ivo Jenik and Schan Duff*, n. 5.

[44] *Jenik I and Lauer K*, n. 35.

approach allows regulators to acquire deeper insights into areas of innovation while ensuring the maintenance of appropriate safeguards.[45] As regulatory sandboxes evolve to address specific themes and policy areas, there is a growing recognition of the need for international cooperation in financial innovation, leading to the development of cross-border solutions.

Cross-border or multi-jurisdictional sandboxes aim to support firms' cross-border operations and encourage regulatory cooperation across jurisdictions. These sandboxes allow companies to simultaneously test innovative financial products or services in multiple countries under a coordinated regulatory framework, thereby reducing regulatory fragmentation and arbitrage between different jurisdictions.[46] Cross-border sandboxes facilitate knowledge sharing among regulators in different countries and can lead to more harmonized approaches to regulating emerging technologies and business models in the financial sector.

For instance, the Financial Stability Board, an international entity responsible for monitoring the global financial system, has raised concerns regarding restrictions on data transfer for cross-border payments.[47] These concerns highlight the growing tension between financial innovation and regulatory oversight. As global financial transactions increasingly rely on digital infrastructure, the free flow of data across borders has become crucial for efficient and secure payment processing.[48] However, many countries have implemented data localization laws and other restrictions on cross-border data

[45] Michael Wechsler, Leon Perlman and Nora Gurung, "The State of Regulatory Sandboxes in Developing Countries" [2018] SSRN Electronic Journal.

[46] Ross P Buckley and others, "Building FinTech Ecosystems: Regulatory Sandboxes, Innovation Hubs and Beyond" [2019] SSRN Electronic Journal.

[47] Financial Stability Board, "Recommendations to Promote Alignment and Interoperability Across Data Frameworks Related to Cross-Border Payments: Final Report" (2024) <https://www.fsb.org/2024/12/recommendations-to-promote-alignment-and-interoperability-across-data-frameworks-related-to-cross-border-payments-final-report/>.

[48] Andrew M Dahdal, Jon M Truby and Imad Antoine Ibrahim, "Sandboxes in the Desert: Is a Cross-Border 'Gulf-Box' Feasible?" [2021] SSRN Electronic Journal.

transfers, citing national security, privacy protection, and regulatory control as primary motivations.[49]

These restrictions can significantly affect the efficiency and cost-effectiveness of cross-border payments, potentially hindering financial inclusion and economic growth in the region. Financial institutions may face increased compliance costs and operational complexities while navigating diverse regulatory frameworks. Moreover, such restrictions can impede the development of innovative financial technologies that rely on global data networks to function. The Financial Stability Board's focus on this issue underscores the need for a balanced approach that addresses regulatory concerns while fostering technological advancement and global financial integration.[50] While these restrictions pose significant challenges, they also present opportunities for collaborative regulatory frameworks, such as cross-border sandboxes. However, implementing cross-border sandboxes requires overcoming challenges, such as aligning different regulatory regimes and establishing mechanisms for joint oversight and information exchange among authorities.

Against this backdrop, these regulatory sandboxes—policy-focused, product-focused, thematic, and cross-border—represent a spectrum of approaches designed to address different aspects of financial innovation and its regulation. Each model serves a unique purpose in the evolving landscape of FinTech regulations. This progression highlights the evolution of regulatory sandboxes from policy-focused to cross-border approaches, reflecting the increasing complexity and global nature of financial innovation and regulators' efforts to keep pace with rapid technological advancements.

2.2.2. Historical Evolution

The sandbox concept is well established. It originated in the IT industry to refer to a segregated, isolated environment for testing products or software, thus mitigating

[49] *Financial Stability Board*, n. 47.

[50] ibid 20.

risks before products are introduced to the market.[51] Software developers utilize information technology sandboxes to execute potentially malicious codes, conduct covert attacks, or evaluate security software for vulnerabilities without jeopardizing the integrity of the host device or network. For instance, widely used browser engines (e.g., Google Chrome and Internet Explorer), productivity software (e.g., Microsoft Word and Adobe Reader), and operating system kernels (e.g., Windows 8) have all been subjected to sandboxing to varying degrees.[52] Although sandboxes originated in the IT sector, their applications have expanded to other industries, including the healthcare sector.

Sandboxes have been used in the health industry to identify and experiment with innovative tests and services in the health industry.[53] Research findings indicate that the implementation of regulatory sandboxes in healthcare is a relatively recent phenomenon, predominantly observed in high-income nations to facilitate the adoption of novel technologies, particularly those associated with digital health. For instance, Health Data Research UK and the United Kingdom's National Institute for Health Data Services used a sandbox environment to virtually test services and innovations for the early detection of neurodegenerative diseases, antidepressant treatment responses, and rare disease scanning, among other medical uses.[54] Healthcare has not only been an early adopter of regulatory sandboxes, but their application has also extended to various other sectors, including energy and utilities.

Several studies have investigated the development of sandboxes in various sectors. Research focusing on the efficacy of sandboxes in the context of sustainable electricity has yielded significant findings. These findings indicate that while regulators

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[51] *Jenik and Lauer*, n.35.

[52] Michael Maass and others, "A Systematic Analysis of the Science of Sandboxing" (2016) 2 PeerJ Computer Science e43.

[53] *Emily Leckenby and others*, n. 42.

[54] Health Data Research UK, "Call for Applications to Test New £37.5M UK Health Data Research Services" (*HDR UK*, July 19, 2019) <https://www.hdruk.ac.uk/news/call-for-applications-to-test-37-5m-new-uk-health-data-research-services/> accessed March 6, 2025.

are willing to engage with emerging technologies, sandboxes should be implemented as an interactive process that requires ongoing evaluation.[55] Furthermore, the implementation of novel tools in the gas and renewable energy sectors has been investigated in several European countries. The analysis identified anticipated outcomes for regulatory sandboxes, including the accelerated development and deployment of new business models and an enhanced capacity to test and refine innovations within a real-world context.[56] Moreover, the transportation sector advocates the implementation of regulatory sandboxes to enhance accessibility, diversity, and inclusion.[57] Notwithstanding these considerations, regulatory sandboxes have become prominent in the financial sectors.

Since 2012, financial institutions and payment systems have consistently engaged in the exploration of innovative products and services, with regulatory sandboxes being introduced to the financial sector through Project Catalyst, launched by the Consumer Financial Protection Bureau (CFPB) in the United States, with the sole intention of promoting consumer-friendly innovation solutions.[58] The primary objective of the project was the bureau's recognition of the necessity to facilitate advancements in consumer benefits while simultaneously acknowledging the concomitant increase in risk that accompanies these advancements. Comprehending and equilibrating these benefits and risks in a manner that safeguards consumers while fostering a fair, competitive, and transparent market was one of the primary aims of this study.

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[55] Esther C van der Waal, Alexandra M Das and Tineke van der Schoor, "Participatory Experimentation with Energy Law: Digging in a 'Regulatory Sandbox' for Local Energy Initiatives in the Netherlands" (2020) 13 Energies 458.

[56] Ellen Beckstedde and others, "Regulatory Sandboxes: Do They Speed up Innovation in Energy?" (2023) 180 Energy Policy 113656.

[57] OLA Mobility Institute, "Bridging Policy and Innovation: Using Regulatory Sandbox to Drive New Mobility Innovations" (2021) <https://olawebcdn.com/ola-institute/OMI_Issue_Brief_Bridging_Policy_and_Innovation.pdf> accessed March 25, 2025.

[58] "CFPB Launches Project Catalyst to Spur Consumer-Friendly Innovation" (*Consumer Financial Protection Bureau*, 2012) <https://www.consumerfinance.gov/about-us/newsroom/consumer-financial-protection-bureau-launches-project-catalyst-to-spur-consumer-friendly-innovation/> accessed March 6, 2025.

One of the initiatives described in this project was the establishment of pilot programs to evaluate innovative product or service concepts. Experimentation is intrinsic to innovation and may yield greater benefits to consumers than maintaining the *status quo*, where numerous individuals are underserved or unserved in the financial marketplace. Through collaboration with entities testing financial products or services, the Bureau could acquire insights into consumers' financial decision-making processes and product utilization, thereby enhancing its understanding of how innovations affect policy considerations.[59]

The term "regulatory sandbox" was popularized within financial sector by the U.K.'s Financial Conduct Authority (FCA) through its Project Innovate, which in October 2014 initially promoted the "innovation in the interests of consumers in a way that advances all FCA objectives."[60] As experience and understanding increased, the FCA recognized the clear necessity of providing regulatory support to firms seeking to test their innovations in real-world market conditions with actual consumers, albeit in a controlled environment. Consequently, the "Regulatory Sandbox" concept was established in 2015 to support and facilitate the ecosystem for FinTech firms.

The establishment of a regulatory sandbox was implemented in response to a recommendation provided by the Government Office for Science[61] which concluded that a regulatory sandbox possesses the potential to facilitate more effective competition in the interests of consumers by reducing time and financial costs associated with the introduction of novel ideas to the market, providing enhanced access to financial resources for innovative firms, and improving the environment for testing a greater

[59] ibid.

[60] Financial Conduct Authority, "Financial Conduct Authority's Project Innovate Celebrates First Anniversary with Plans for 'Regulatory Sandbox'" (*FCA*, November 10, 2015) <https://www.fca.org.uk/news/press-releases/financial-conduct-authority%E2%80%98s-project-innovate-celebrates-first-anniversary> accessed March 7, 2025.

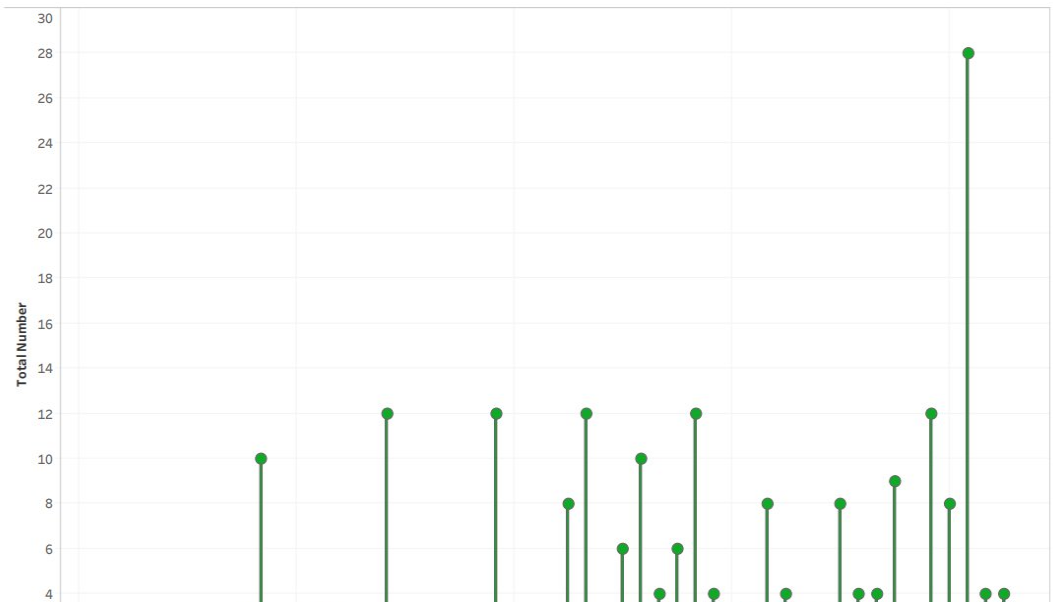
[61] Government Office for Science, "FinTech Futures: The UK as a World Leader in Financial Technologies" (2015) <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/413095/gs-15-3-fintech-futures.pdf> accessed March 7, 2025.

number of products with potential for market debut.[62] In this regard, Project Innovate has supported nearly 700 firms, assisting them in navigating regulatory challenges and facilitating a more efficient introduction of innovative products and services to the market, according to a study published five years after its launch in 2014.[63]

The success of the UK regulatory sandbox model inspired its adoption and adaptation in numerous countries. Regulators worldwide have adopted a regulatory sandbox as a mechanism for creating a dynamic, evidence-based regulatory environment for testing emerging technologies. A report conducted in 2020 by the World Bank Group, which meticulously compiled a comprehensive list of all existing sandboxes, both announced and operational, indicated that 76 FinTech-related sandboxes had been announced since 2016.[64] Although the data collected for this research date back to November 2020, they provide a comprehensive analysis of the experiences of all known sandboxes to date. Despite the recent surge in regulatory sandbox implementation, understanding the historical context that led to their development is important.

As illustrated in Figure 1, over half of the FinTech sandboxes were established between 2018 and 2019, with five being developed in 2020. This trend suggests that, as previously mentioned, the utilization of digital tools has increased over time, particularly after the Covid-19 pandemic.[65]

Figure 1 Timeline of regulatory sandboxes created since 2015



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However, financial innovations such as regulatory sandboxes emerged significantly earlier than often acknowledged. The 2008 Global Financial Crisis prompted a reevaluation of the role played by innovations, such as credit default swaps and collateralized debt obligations, alongside deregulation, in precipitating the crisis.[66] Pre-crisis studies indicate that the risks associated with technological innovations outweigh their benefits.[67] This perspective was encapsulated in well-known statements, such as "credit default swaps as *financial weapons of mass destruction*."[68] In the aftermath of the crisis, regulatory bodies were primarily concerned with consumer protection and financial stability, particularly within the macro-prudential framework. Consequently, during the peak of the post-crisis period, discussions centered on the re-regulation of the market to address the deficiencies identified prior to the crisis.[69]

[66] Ross Buckley and Douglas Arner, *From Crisis to Crisis: The Global Financial System and Regulatory Failure* (Kluwer Law International BV 2011).

[67] Douglas W Arner, *Financial Stability, Economic Growth, and the Role of Law* (Cambridge University Press 2007).

[68] René Stulz M, "Financial Derivatives Lessons From the Subprime Crisis" [2009] *Milken Institute Review* 58.

[69] Dirk A Zetzsche, "Investment Law as Financial Law: From Fund Governance over Market Governance to Stakeholder Governance?" [2013] SSRN Electronic Journal.

Regulatory developments have emerged in this challenging context, such as the introduction of FinTech and regulatory sandboxes. Despite the increasing advocacy for re-regulation following the issues encountered during the 2008 financial crisis, there has been concurrent pressure to stimulate economic growth, including formulating an agenda aimed at promoting financial inclusion. Consequently, there has been an increasing initiative among regulatory bodies to enable financial inclusion through innovation while maintaining consumer protection and financial stability. Four approaches to achieve these objectives have been described in the literature.[70]

Initially, the *do-nothing approach* (*laissez-faire* or permissive regime), whether intentional or otherwise, constitutes a non-interventionist strategy in which regulators opt not to engage or establish specific frameworks for innovative financial technologies. This is also known as the 'wait-and-see' approach.[71]

This strategy allows market forces to drive innovation and competition without regulatory constraints.[72] Moreover, it can facilitate rapid technological advancement and the emergence of new business models. These benefits are evident in certain economic conditions. Empirical observations indicate that the formation of FinTech startups is more prevalent in countries with well-developed economies, readily accessible supporting infrastructure and flexible market regulations.[73] Among these, regulatory flexibility is particularly noteworthy.

Flexible market regulations foster an environment conducive to innovation and experimentation in the energy sector.[74] Regulations play a pivotal role in shaping the

[70] *Dirk A Zetzsche and others*, n. 34.

[71] World Bank Group, "How Regulators Respond To FinTech : Evaluating the Different Approaches – Sandboxes and Beyond" (*World Bank*, 2020) https://documents.worldbank.org/en/publication/documents-reports/documentdetail/579101587660589857/how-regulators-respond-to-fintech-evaluating-the-different-approaches-sandboxes-and-beyond>.

[72] ibid, p. 44.

[73] Christian Haddad and Lars Hornuf, "The Emergence of the Global Fintech Market: Economic and Technological Determinants" (2018) 53 Small Business Economics 81.

[74] Jacques Pelkmans and Andrea Renda, "Does EU Regulation Hinder or Stimulate Innovation?" (2014)

entrepreneurial landscape. On the one hand, it can provide a stable framework that encourages business creation and innovation by establishing clear rules, protecting intellectual property, and ensuring competition. Well-designed regulations can create opportunities for entrepreneurs to develop solutions that meet compliance requirements or address newly identified needs. This is the so-called Porter Hypothesis, defined as 'regulation could potentially enhance productivity and/or competitiveness by generating substantial innovation offsets'.[75] Recent studies have demonstrated that government policies foster innovation in environmental regulation.[76] Additionally, regulations foster consumer trust and market stability, which are essential for the growth of new ventures.

On the other hand, when regulations become overly burdensome or inflexible, they can inhibit entrepreneurial activities and innovation. Excessive compliance costs, lengthy approval processes, and rigid standards may affect small businesses and startups, which often lack the resources to navigate complex regulatory environments. This can lead to reduced market entry, decreased competition, and slow development of new products and services.[77]

In the financial market context, synergy between economic strength, technological readiness, and regulatory support cultivates an ecosystem in which FinTech startups can prosper and contribute to the ongoing digital transformation of the financial sector. An illustrative case can be observed in China, where a permissive regulatory approach enhanced the robustness of the Chinese financial market.[78] However, critics contend that this laissez-faire attitude may expose consumers to potential risks and market instability.

<https://ssrn.com/abstract=2528409>.

[75] Mark A Cohen and Adeline Tubb, "The Impact of Environmental Regulation on Firm and Country Competitiveness: A Meta-Analysis of the Porter Hypothesis" [2015] SSRN Electronic Journal.

[76] Wanli Zhang and others, "Revisiting the Porter Hypothesis: A Multi-Country Meta-Analysis of the Relationship between Environmental Regulation and Green Innovation" (2024) 11 Humanities and Social Sciences Communications.

[77] *Jacques Pelkmans and Andrea Renda*, n. 74.

[78] Shitong Qiao, "Finance against Law: The Case of China" (2022) 64 Harvard International Law Journal.

The absence of regulatory oversight can result in the widespread distribution of detrimental financial products. In the absence of adequate control, financial institutions may prioritize short-term profits over long-term stability by offering complex products that consumers find difficult to understand.[79] However, the effectiveness of regulatory approaches varies depending on market conditions. While mature markets with self-regulatory mechanisms may require less oversight, emerging markets may require more stringent controls. Given these complexities, policymakers must carefully balance innovation promotion with market stability.

Another type of approach can be defined as the *cautious permissiveness approach,* also described as '*test-and-learn'*[80], which involves allowing innovation and new practices but with careful monitoring and specific conditions to manage potential risks on a case-by-case basis.[81] This regulatory approach strikes a delicate balance between fostering innovation and safeguarding public interest. By allowing new practices and technologies to emerge without requiring prior approval, this approach encourages entrepreneurship and rapid advancement in various sectors. Nevertheless, this does not imply a complete lack of oversight; rather, it necessitates vigilant monitoring of these innovations with readiness to intervene if necessary to mitigate the potential risks of adverse consequences.

Notably, this strategy necessitates the establishment of explicit boundaries and conditions for innovators, encompassing transparency, data protection, and safety standards. Regulators can adjust restrictions based on outcomes, thus creating a responsive environment that addresses challenges while promoting growth. It can be said that the cautious permissiveness approach balances regulation and laissez-faire policies to optimize innovation benefits while minimizing societal harm.

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[79] Patrick Jomini, "Effects of Inappropriate Financial Regulation" (*Ecipe*, 2011) <https://ecipe.org/wp-content/uploads/2014/12/Jomini_FinancialRegulation032011.pdf> accessed April 20, 2025.

[80] *World Bank Group*, n. 71.

[81] *Dirk A Zetzsche and others*, n. 34.

Structured experimentalism, or *innovation facilitators,* is a third type of regulatory approach that combines elements of traditional top-down regulation with bottom-up experimentation and learning by creating a structured context for experimentation, such as regulatory sandboxes, innovation hubs, and innovation accelerators.[82] [83] This approach recognizes the complexity and uncertainty inherent in many policy domains and seeks to create a framework for systematic learning and adaptation to changing conditions.

In practice, structured experimentalism involves setting broad goals and performance standards at a central level while allowing local actors the flexibility to achieve those goals. It emphasizes ongoing monitoring, evaluation, and peer learning among implementers. Regulators and regulated entities engage in an iterative process of trying different approaches, measuring outcomes, and adjusting them based on the evidence. This allows context-specific solutions to emerge while maintaining some degree of centralized oversight and coordination. Moreover, it aims to leverage local knowledge and innovation while avoiding the pitfalls of rigid, one-size-fits-all regulations that may be poorly suited to diverse contexts or changing conditions. While structured experimentalism offers a flexible and adaptive approach to regulation, it contrasts with conventional methods.

The *traditional regulatory* approach to developing new regulations for specific forms of new products and institutions in the FinTech sector represents a more comprehensive and targeted strategy than the general approach.[84] It is mentioned in the World Bank document as the '*regulatory laws and reforms'* method[85], which involves creating tailored legislative and regulatory frameworks to address the unique challenges and opportunities presented by various FinTech innovations. As noted by the Financial Stability Board, an increasing number of jurisdictions are adopting this approach,

[82] ibid.

[83] *World Bank Group*, n. 71.

[84] *Dirk A Zetzsche and others*, n. 34.

[85] *World Bank Group*, n. 71.

recognizing the need for more specific and nuanced oversight in a rapidly evolving financial technology landscape.[86]

This regulatory strategy allows for greater precision in addressing the distinct characteristics and risks associated with different FinTech products and services. By developing specialized frameworks, regulators can better account for technological complexities, potential systemic risks, and consumer protection concerns specific to each innovation. This method may also provide clearer guidelines for FinTech companies. This potentially fosters innovation in a well-defined regulatory environment. However, it requires significant resources and expertise from regulatory bodies to keep pace with rapid advancements in financial technology and may result in a more complex regulatory landscape.

In conclusion, the regulatory landscape of financial technology presents a complex interplay of approaches, each with its merits and challenges. Policymakers must navigate a delicate balance between fostering innovation and safeguarding market stability, from the non-interventionist "do-nothing" strategy to more structured and targeted regulatory reforms. The effectiveness of these approaches varies depending on market conditions, the economic environment, and the specific characteristics of FinTech innovations. As the financial sector continues to evolve rapidly, regulators must remain adaptable and employ a mix of strategies that can respond to emerging technologies while protecting consumer interest. The ongoing challenge lies in creating a regulatory framework that encourages entrepreneurship and technological advancement without compromising the integrity and stability of the financial system. Ultimately, the success of any regulatory approach depends on its ability to evolve alongside the dynamic FinTech landscape, promoting innovation while mitigating potential risks.

[86] Financial Stability Board, “Financial Stability Implications from FinTech - Supervisory and Regulatory Issues That Merit Authorities’ Attention” (2017) <https://www.fsb.org/2017/06/financial-stability-implications-from-fintech/> accessed April 27, 2025.

2.2.3. Benefits and Limitations

Experimentation of new products

The use of regulatory sandboxes has increased over the years. Among the various characteristics attributed to sandboxes, one that stands out is their *ability to promote the testing of new technologies to assess their effectiveness and their impact*. As mentioned, this tool creates a regulatory environment in which the regulatory body allows a company to operate under different rules than other companies for a certain period to test some innovations. This exception was created so that participating companies could use new tools that could not be tested under the current rules. However, these exceptions are relative.

In the context of sandboxes, regulatory bodies closely monitor tests to assess the benefits to society and the risks that such innovations may pose. For example, in Brazil, companies operating in regulated markets, such as capital markets, can register for admission to regulatory sandboxes promoted by the Securities and Exchange Commission of Brazil (*Comissão de Valores Mobiliários, CVM*) in areas of interest chosen by the regulatory body. After registration, the CVM preliminarily analyzes whether the applications meet the eligibility criteria for participation in the test; for instance, the applicant must demonstrate sufficient technical and financial capabilities to develop the intended activity in an experimental regulatory environment. Upon evaluating the prerequisites, a special committee will examine the content of the proposals and, if approved, will be assessed by a collegiate body formed by the CVM directors.[87]

At the end of the test, the data and information collected throughout the regulatory environment are used to decide whether the regulations that are part of the experiment's theme should be changed and how this change should occur. In addition,

[87] Resolução CVM nº 29, 11 May 2021 (Brazil).

it is possible to verify whether a project can be fully authorized to operate in the market. However, this limited environment poses a challenge to market innovation.

As mentioned, the criteria established for participation in a regulatory sandbox must be strict and can therefore act as a significant exclusion factor for new entrants in the financial technology sector. The eligibility criteria are designed to ensure that only potentially innovative and beneficial products are granted access to the sandbox environment to protect consumers and market integrity. However, in some cases, it can inadvertently select well-established companies with sufficient resources to meet the standards. For instance, smaller startups or individual entrepreneurs may be excluded because of financial constraints.

Consequently, only firms with sufficient resources will be able to navigate regulatory compliance, which can have a harmful influence on other market players, potentially limiting progress and innovation. This phenomenon is referred to as *regulatory capture* and is considered a market risk. The literature shows that this phenomenon influenced, among other factors, the emergence of the subprime crisis, as banks held a relevant influence over regulatory policies. The permissive actions of regulatory bodies accentuated banks' risky behavior, compromising the entire financial market.[88]

Regarding sandbox environments, it is important to note that the proximity between regulators and participants can exacerbate this risk. The search for technical understanding, common in these spaces, can result in excessive reliance on information provided by companies, creating a scenario in which regulators are inadvertently influenced. Thus, regulators may unconsciously favor closely related companies when establishing future requirements or standard policy.[89]

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[88] Andrew Baker, "Restraining Regulatory Capture? Anglo-America, Crisis Politics and Trajectories of Change in Global Financial Governance" (2010) 86 International Affairs 647.

[89] Daniel Carpenter and David A Moss (eds), *Preventing Regulatory Capture: Special Interest Influence and How to Limit It.* (Cambridge University Press 2013) 25 <https://doi.org/10.1017/cbo9781139565875> accessed June 17, 2025.

To mitigate this risk, it is essential that sandboxes adhere to the principles of transparency and independent review. Publishing selection criteria, progress reports, and trial results allows for greater public and academic scrutiny of the research. In addition, including diverse stakeholders on oversight boards, such as external experts and consumer representatives, can serve as effective counterbalances.[90] Thus, while regulatory sandboxes are promising tools, their success depends on the ability to balance innovation with robust regulatory safeguards. Vigilance against regulatory capture should not only be a priority but also a guiding principle for these spaces. Understanding and addressing these challenges is crucial to ensure that innovation does not sacrifice regulatory integrity or societal interests.

Cost reduction of new technologies

Moreover, beyond the possibility of creating a test environment for new products, *regulatory sandboxes reduce the costs and maturation time required to develop innovative products, services, and business models*.[91] The adoption of regulatory sandboxes has been demonstrated to directly influence cost control, mainly because of their potential to reduce cost asymmetry arising from managerial opportunism and economic uncertainties, whether in small or large companies. The implementation of this regulatory tool reduces entry barriers for smaller companies to operate in a regulated environment by reducing their compliance costs, as the burden of current regulations is reduced. The impact of regulatory sandboxes is not limited to small companies; it extends to larger companies.

With the increasing number of companies operating in regulated markets, there is a growing incentive for larger companies to improve their operational efficiency and use resources rationally.[92] This phenomenon can be attributed to several factors, the

[90] ibid, pp. 365-396.

[91] Phuc Nguyen and Vu M Ngo, "The Sandbox Effect on Cost Stickiness" (2025) <https://ssrn.com/abstract=5089045>.

[92] Prasanna Karhade and John Qi Dong, "Information Technology Investment and Commercialized Innovation Performance: Dynamic Adjustment Costs and Curvilinear Impacts" (2021) 45 MIS Quarterly 1007.

most significant of which are the rise in customer expectations and the need to sustain profitability in an increasingly competitive market environment. Consequently, larger corporations are forced to adapt and innovate to maintain their market position and relevance in the industry. This competitive pressure drives innovation across industries, encouraging larger firms to adopt more flexible approaches, invest in emerging technologies and improve their processes. Additionally, the collaborative nature of many sandbox initiatives promotes knowledge sharing and partnerships between established players and newcomers, potentially leading to industry-wide advancements and more effective regulatory frameworks that balance innovation and consumer protection.

Regulatory sandboxes are linked to cost reduction and have a positive impact on capital raising, where venture capital plays a crucial role. Venture capital serves as a fundamental funding source for firms with innovative ideas, not only by injecting capital into disruptive business models but also by providing strategic guidance and a valuable network that can help newer companies operate in the market.[93] Thus, it is worth mentioning that venture capital plays a key role in driving economic growth, especially in modern economies based on innovation and entrepreneurship.

This type of financing provides capital to startups and emerging companies with high growth potential but often find it difficult to obtain funding in traditional financial markets due to the high risk associated with their operations. Ultimately, venture capital can transform visionary ideas into concrete realities, playing a crucial role in strengthening both local and global economies. Therefore, it is possible to conclude that any initiative that promotes the growth of this specific type of investment will be beneficial for the entire market.

Several studies have identified a positive correlation between the implementation of sandboxes and an increase in venture capital investment. As reported, firms

[93] Sabrina T Howell, "Reducing Information Frictions in Venture Capital: The Role of New Venture Competitions" (2020) 136 Journal of Financial Economics 676.

participating in a sandbox experiment had an increase of approximately 15% in the total amount raised through venture capital financing.[94] Sandbox environments provide a valuable and safe environment for firms to develop and demonstrate their potential with reduced risk, which may explain this funding upturn. Nonetheless, it is also true that persuading investors to finance innovative products or services may present significant challenges.

First, convincing customers of the quality of a new product or service can be challenging, particularly in industries with established norms and expectations.[95] Consumers often turn to familiar brands or traditional methods, making it difficult for innovative services to be recognized. Additionally, the volume of options available in the mass market can lead to choice overload, causing potential customers to choose familiar brands over exploring new offerings. Hence, the large-scale implementation of innovations further compounds these challenges.

Second, scaling up operations while maintaining quality and consistency across a broad customer base requires substantial financial and operational resources, which can be difficult for early-stage firms. This often necessitates significant investments in infrastructure, technology, and personnel training. Moreover, adapting to diverse customer needs and preferences across different market segments can be complex, requiring flexibility and customization that may be difficult to achieve on a large scale.

Thus, the implementation of regulatory sandboxes has shown promising results in attracting venture capital investment, with the participating firms experiencing a notable increase in funding. However, the path to successful innovation and market penetration remains challenging for them. Despite these obstacles, the positive impact of sandboxes on venture capital funding suggests that creating supportive environments for innovation can help mitigate some risks and foster growth in the FinTech sector.

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[94] *Giulio Cornelli and others*, n. 39.

[95] *Christian Haddad and Lars Hornuf*, n. 73.

An additional limitation associated with sandbox environments is the cost-effectiveness of the experiments conducted in them. Sandboxes can be expensive because of their resource requirements.[96] These environments often necessitate dedicated hardware, software licenses, and specialized infrastructure to accurately replicate the real-world conditions. The expenses associated with setting up and maintaining sandbox environments can be substantial, particularly for organizations that deal with complex systems or large-scale applications.

Moreover, the cost-effectiveness of sandbox experiments is further affected by the need for skilled personnel to manage and operate these environments. Specialized expertise is often required to configure, monitor, and analyze the results of sandbox tests, which adds to the overall expense. Additionally, the time invested in conducting experiments within sandbox environments can be significant, potentially leading to delays in project timelines and increased labor costs. Organizations must carefully weigh the benefits of sandbox testing against these financial considerations to determine the most efficient resource allocation for their specific needs and objectives.

[96] *Parma Bains and Caroline Wu*, n. 4.

Mitigation of agency problem

A positive correlation has been demonstrated between the use of technological tools in a regulatory sandbox environment and the *reduction of agency conflict*. Companies are increasingly directing resources towards technological innovation, and this managerial behavior can lead to overinvestment in technology to satisfy shareholders to the detriment of the company's best interests.[97] In this sense, the regulatory sandbox, by creating a controlled environment through continuous disclosure of results to regulatory bodies, promotes greater alignment between managerial behavior and operational efficiency, thereby mitigating potential agency conflicts and promoting sustainable business practices.[98]

Because transparency and accountability improve in the context of close relationships between regulators and regulated parties, managerial discretion in the decision-making process tends to decrease. Furthermore, the reduction in managerial discretion is accompanied by standardized procedures, clear guidelines, and documented decisions, which leads to greater adherence to established regulatory frameworks. In addition, a controlled testing environment allows companies with new technologies to experiment with limited risk, which encourages better alignment between managerial behavior and shareholder interests. However, it is unclear how effective sandboxes are in diminishing managerial discretion.

As previously stated, the structured environment and increased regulatory oversight inherent in sandbox initiatives can impose constraints on managerial freedom in specific areas. Regulators typically establish specific parameters, reporting requirements, and operational boundaries that participating firms must adhere to, potentially limiting managers' decision-making scope. Nonetheless, this regulatory framework may simultaneously create opportunities for innovation and strategic maneuvering within defined sandbox parameters. The nature of sandbox initiatives

[97] Nilakshi Borah and others, "Does Corporate Diversification Reduce Value in High Technology Firms?" (2017) 51 Review of Quantitative Finance and Accounting 683.

[98] *Phuc Nguyen and Vu M Ngo*, n. 91.

often means that they operate in regulatory gray areas or address emerging technologies and business models that are not fully covered by existing regulations. This ambiguity can provide managers with increased discretion in interpreting and implementing regulatory guidelines, allowing them to explore innovative approaches and push the boundaries of traditional practice.

In this regard, it is important to highlight the concept of *forum shopping*, usually described in legal literature as "a colloquial term for the practice of litigants having their legal case heard in the court thought most likely to provide a favorable judgment."[99] The concept of forum shopping in regulatory sandboxes extends beyond its traditional legal context and presents unique challenges in the financial industry. As regulators compete to attract innovative firms by offering more lenient regulatory environments, there is a risk of creating a "race to the bottom" in terms of consumer protection and financial stability safeguards.

Moreover, the practice of forum shopping in regulatory sandboxes can have far-reaching consequences for cross-border financial activities and international regulatory cooperation in the future. As companies exploit regulatory disparities between jurisdictions, it becomes increasingly difficult for regulators to maintain consistent standards and oversee global financial operations effectively. This fragmentation of regulatory approaches may ultimately undermine the original purpose of sandboxes: to foster innovation while maintaining adequate consumer protection and financial stability measures.[100]

[99] Jakub Handrlica, Vladimír Sharp and Jan Nešpor, "Forum Shopping in Regulatory sandboxes and the Perils of Experimental Law-Making" (2023) 13 Juridical Tribune.

[100] Friedrich K Juenger, "Forum Shopping, Domestic and International," *Selected Essays on the Conflict of Laws* (Brill | Nijhoff 2000) <https://doi.org/10.1163/9789004480438_007> accessed June 27, 2025.

Sinergy between regulators and regulated entities

Another reported benefit associated with regulatory sandboxes is the *exchange of experience between regulators and regulated entities*, thereby improving the regulatory framework applicable to the regulated activities.[101] On the one hand, regulatory sandbox participants can acquire expertise on what it is like to work in a regulated environment while being constantly monitored by the regulatory entity, thus providing a unique platform for mutual learning and collaboration between regulators and regulated entities. This hands-on exposure to regulatory processes and requirements can be invaluable, especially for startups and companies entering new markets.

Moreover, participants can develop a deeper understanding of compliance requirements, risk management practices, and regulatory expectations, which are crucial for their long-term success in regulated industries. As mentioned, constant monitoring by regulatory entities during the sandbox period provides participants with real-time feedback and opportunities for improvement, potentially accelerating their learning curves and enhancing their ability to operate within regulatory boundaries.[102]

Additionally, the close collaboration between firms and regulators in sandbox environments may afford managers unique insights into regulatory thinking and the ability to influence future policy development, potentially expanding their sphere of influence beyond the traditional corporate boundaries. Regulated entities benefit from direct feedback and guidance from regulators, which helps them navigate complex regulatory environments more effectively. This iterative knowledge-sharing process can lead to more adaptive and responsive regulations that better address the needs of both innovators and consumers.

On the other hand, this exchange of experience allows regulators to gain valuable insights into emerging technologies, business models, and market dynamics, which can inform and refine the regulatory framework. Engaging with innovators and

[101] *Hilary J Allen*, n. 13.

[102] *Ross P Buckley, Douglas W Arner and Dirk A Zetzsche*, n. 3.

entrepreneurs provides regulators with more knowledge of cutting-edge developments, potential risks, and opportunities within various sectors.[103] This deeper insight enables them to craft nuanced and effective regulations that balance innovation, consumer protection, and market stability.

Moreover, this collaborative approach can lead to the development of adaptive regulatory frameworks that are better equipped to address the challenges posed by disruptive technology.[104] As regulators become more familiar with emerging business models and market trends, they can proactively identify potential regulatory gaps and adjust their strategies. The process of learning and adaptation inherent to sandbox experimentalism helps ensure that regulatory measures remain relevant and effective in an increasingly complex and interconnected global economy. Nevertheless, there is a potential risk of regulatory capture and forum shopping, as previously mentioned.

Despite the benefits of sandboxes, the close relationship between regulatory agencies and regulated entities poses significant challenges to governance and policy implementation. The risk appears when regulatory agencies, originally established to act in public interest, advance the commercial or political interests of specific groups they are charged with regulating.[105] This can lead to distortion of the regulatory process, potentially undermining public trust and the effectiveness of oversight mechanisms. In the context of forum shopping, entities may seek jurisdictions with more lenient regulations or enforcement practices, further exacerbating the risk of regulatory capture.

The interplay between regulatory capture and forum shopping creates a complex landscape for policymakers and stakeholders. This dynamic can potentially compromise the integrity of regulatory systems on a broader scale, leading to inadequate protection of public interests and potential erosion of standards across multiple sectors or regions.

3. IMPLEMENTATION STRATEGIES

[103] *Hilary J Allen*, n. 13.

[104] ibid, p. 636.

[105] *Jakub Handrlica, Vladimír Sharp and Jan Nešpor*, n. 99.

3.1. Optimal Implementation Strategies

To date, the primary characteristics and objectives of regulatory sandboxes have been examined. The historical development of this significant innovation tool was reviewed, and its principal advantages and disadvantages were analyzed from the perspective of regulatory agents. In this context, it is essential to examine the beneficial factors and best practices associated with the development and implementation of regulatory sandboxes while ensuring consumer protection and financial stability.

In 2020, the Consultative Group to Assist the Poor (CGAP)[106], a coalition of over 40 prominent development organizations that collaborates to improve financial inclusion, published a technical guide drawing upon the accumulated experiences of utilizing regulatory sandboxes globally up to that point.[107] To conduct the study, more than 30 regulatory sandbox structures were analyzed by interviewing financial sector regulators and stakeholders in different countries.[108]

One research question focused on determining the optimal strategy for efficiently implementing a regulatory sandbox. Despite the numerous advantages of this innovative approach, it is important to acknowledge that emerging technologies also present risks that are challenging to evaluate beforehand. This difficulty arises from the lack of established scientific evidence to support their efficacy. Consequently, it is imperative for regulators to possess a comprehensive understanding of the conditions under which a new regulatory tool is developed, particularly given that its initial application will be costly and limited to a select group of participants. According to the CGAP´s conclusions, there are three primary guidelines for establishing a decision-making process that ensures the effective implementation of a new regulatory tool. The decision-making process illustrated in Figure 2 facilitates this analysis. The subsequent sections

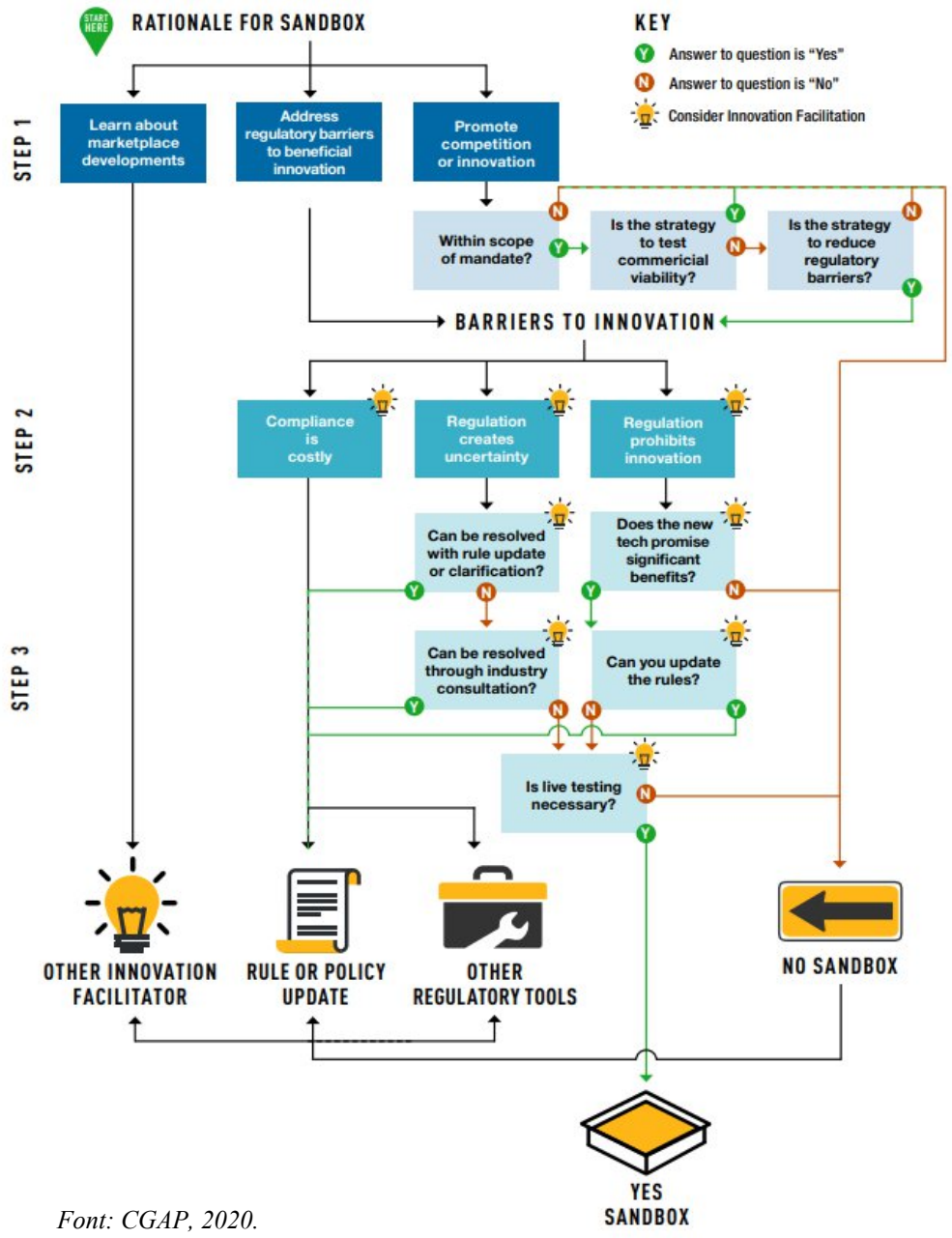
[106] https://www.cgap.org/

[107] Consultative Group to Assist the Poor, Ivo Jenik and Schan Duff, "How to Bulid a Regulatory Sandbox - A Practical Guide for Policy Makers" (2020).

[108] "Interactive Map of Regulatory Sandboxes" (*CGAP*) <https://www.cgap.org/regulatory-sandbox/interactive-map> accessed July 14, 2025.

critically evaluate the foundational hypotheses in the context of adopting a sandbox approach.

Figure 9 Decision making process



Font: CGAP, 2020.

3.1.1. Rationale Behind Sandbox Adoption

The survey conducted by CGAP demonstrated that the main reason for promoting a regulatory sandbox is to *learn about market developments*.[109] In response to the ongoing advancements in the FinTech sector, regulatory bodies frequently employ innovation facilitators, such as sandboxes, to gain a comprehensive understanding of the potential risks and advantages of emerging technologies. This approach enables regulatory bodies to make informed decisions regarding potential policy adjustments and regulatory frameworks. As FinTech continues to disrupt traditional financial services, sandboxes provide regulators with a unique opportunity to assess the impact of new technologies on financial stability, consumer protection, and market integrity. Nevertheless, as previously indicated, the learning process can be intricate and expensive for both regulators and the entities they regulate.

In this context, it is discussed whether regulators should adopt alternative pathways to acquire knowledge about new technologies, including their advantages and disadvantages. One alternative could be the deployment of innovation hubs, described as a "point of contact for firms to raise inquiries about FinTech-related issues and seek non-binding guidance on regulatory and supervisory expectations."[110] Innovation hubs are considered easier to deploy and integrate into existing regulatory frameworks than sandboxes.

Furthermore, innovation hubs are more stable as it is possible for market entrants to receive continuous advice and support, helping them to navigate into regulatory landscape. In the EU, for instance, market participants are more engaged with authorities through innovation hubs.[111] However, certain challenges are associated with the operation of innovation hubs. Primarily, authorities have noted that a substantial

[109] Ivo Jenik and Sharmista Appaya, "CGAP-World Bank: Regulatory Sandbox Global Survey" (CGAP Background Documents 2019).

[110] European Securities and Markets Authorities (ESMA), "FinTech: Regulatory Sandboxes and Innovation Hubs" (2018).

[111] -------, "Update on the Functioning of Innovation Facilitators – Innovation Hubs and Regulatory Sandboxes" (2023).

proportion of inquiries submitted by market entrants are either incomplete or unclear, with most of these inquiries pertaining to information that is already publicly accessible. Also, while regulatory sandboxes are often perceived as costly, innovation hubs also face resource constraints because of the necessity of maintaining permanent staff.[112]

Innovation hubs and regulatory sandboxes serve as platforms for exploring and evaluating emerging technologies. While both serve important roles in technological advancement, innovation hubs provide a more enduring and straightforward mechanism for engaging with technology than incubators. Conversely, regulatory sandboxes facilitate the expansion of regulatory frameworks by enabling experimentation within controlled settings. Despite their distinct approaches, the determination of the most suitable tool for this process remains ambiguous; the decision is contingent upon the regulator's specific objectives and the developmental stage of the technology in question.

Moreover, additional critical factors in determining the necessity of developing a regulatory sandbox are its capacity to *mitigate regulatory barriers and to foster innovation*.[113] It is important for regulatory authorities to identify the challenges and opportunities to consider the creation of a regulatory sandbox. First, regulators must define specific areas or topics in which a sandbox would be useful. To achieve this objective, it is essential to evaluate and establish priorities that will promote effective solutions for the identified challenges. Following the identification of these priorities, regulators should assess which barriers are most significant in obstructing innovation.

3.1.2. Identify Barriers to Innovation

Regulatory barriers that impede innovation can manifest in various forms, including compliance costs, limited understanding of existing regulations, and uncertainty arising from current legal frameworks.[114] *Compliance costs* often represent

[112] ibid.

[113] *Jayoung James Goo and Joo-Yeun Heo*, n.7.

[114] *CGAP*, n. 107.

a substantial hurdle, as companies must allocate resources to meet regulatory requirements, potentially diverting funds from research and development initiatives. These costs can be particularly burdensome for small businesses and startups with limited financial resources, potentially stifling their ability to bring innovative products and services to market. Regulators should evaluate whether the reduction in compliance costs associated with regulations, facilitated by innovation facilitators, justifies the implementation of sandbox testing.

A *limited understanding of existing regulations* can also hinder innovation, as businesses may struggle to navigate complex and legal landscapes.[115] This lack of clarity can lead to hesitation in pursuing new ideas or technologies for fear of unintentional, non-compliance. Furthermore, uncertainty arising from current legal frameworks, especially in rapidly evolving fields such as artificial intelligence and financial solutions, can create a risk-averse environment. Companies may be reluctant to invest in cutting-edge research or product development when the regulatory landscape is unclear or subject to frequent changes, potentially slowing the pace of innovation across industries.

In addition to the challenges posed by regulatory uncertainty, market participants often view *regulatory constraints as barriers to innovation* because of the additional costs, time, and resources required to comply with established rules and standards.[116] These constraints can limit the flexibility and agility of businesses in rapidly developing and implementing new ideas, products, or services. However, there has been a controversial debate on the impact of regulatory instruments on innovation. Empirical evidence suggests that this negative effect is contingent on two factors: the type of regulation and the degree of market uncertainty.[117]

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[115] European Commission, Jacques Pelkmans and Andrea Renda, "How Can EU Legislation Enable and/or Disable Innovation?" (2014).

[116] Karen Palmer, Wallace E Oates and Paul R Portney, "Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm?" (1995) 9 Journal of Economic Perspectives 119.

[117] Knut Blind, Sören S Petersen and Cesare AF Riillo, "The Impact of Standards and Regulation on Innovation in Uncertain Markets" (2017) 46 Research Policy 249.

First, it is important to outline the differences between these concepts. Regulations are divided into two main categories: formal standards and enacted regulations. Formal standards are a "result of a consensual negotiation process carried out by firms and other interested stakeholders in a voluntary process within standardization organizations."[118] Differently, enacted regulations are rules "developed and enacted by the government to shape the market environment and influence the behavior of the concerned actors."[119] Therefore, standards are considered a self-regulatory mechanism and a market-driven process, while enacted regulations respect a formal approach adopted by governments.

Second, an econometric analysis was employed to assess market uncertainty, where the degree of uncertainty was measured through self-reported perceptions related to the technological environment and the evaluation of product quality.[120] Regarding the technological environment, self-reported perceptions likely focus on factors such as the pace of technological change, complexity of new innovations, and predictability of technological advancements within the industry. In terms of product quality evaluation, uncertainty may arise from challenges in assessing the performance, reliability, or value of products, particularly in rapidly evolving markets.

Empirical findings demonstrate that formal standards act as barriers to innovation in low-uncertainty markets, whereas enacted regulations are obstacles in high-uncertainty markets.[121] These findings support the hypothesis that rules and laws (regulations) are more effective in mature and established markets. This is because advanced markets are less likely to be influenced or controlled by the industries they are meant to regulate. In simpler terms, when a market is well developed, it is harder for

[118] "Decisions and Recommendations Adopted by the TBT Committee since 1 January 1995," , *WTO Agreements Series* (WTO 2014) <https://doi.org/10.30875/61b896b0-en> accessed July 17, 2025.

[119] Knut Blind, "The Influence of Regulations on Innovation: A Quantitative Assessment for OECD Countries" (2012) 41 Research Policy 391.

[120] Liisa-Maija Sainio, Paavo Ritala and Pia Hurmelinna-Laukkanen, "Constituents of Radical Innovation—Exploring the Role of Strategic Orientations and Market Uncertainty" (2012) 32 Technovation 591.

[121] *Knut Blind, Sören S Petersen and Cesare AF Riillo*, n. 117.

powerful companies or interest groups to manipulate the rules in their favor, allowing regulations to function as intended for the benefit of all participants. In contrast, less developed markets are more adversely impacted by legislation, as they are more prone to evolution and may find it challenging to adapt to the rapid pace of change imposed by inflexible laws.

3.1.3. Addressing the Barriers

The final step in assessing the necessity of developing a sandbox is to confront the identified innovation barriers and the current regulatory frameworks. In this scenario, regulators should answer some questions to guide their decision on the adoption of this innovative tool.

In the first place, it is essential to evaluate the adequacy of existing legislation in overseeing proposed innovations, and a comprehensive analysis of the current regulatory landscape is crucial. This assessment should consider the scope, flexibility, and adaptability of existing laws to accommodate new technological advancements and business models. Regulatory bodies must determine whether the current framework can effectively address the potential risks, consumer protection concerns, and market dynamics associated with this innovation. In many instances, minor modifications or interpretations of existing regulations may suffice to create an environment that fosters innovation while maintaining the necessary safeguards.[122] However, if the existing legislation proves insufficient, more substantial regulatory reform may be necessary.

This process involves identifying gaps in the current framework, consulting stakeholders, and developing new regulations that strike a balance between promoting innovation and protecting public interests. Additionally, international cooperation and harmonization of regulations may be required to address the global nature of many innovations, particularly in sectors such as finance and technology. Nonetheless, if the

[122] ibid.

existing framework is unsuitable for transformation or if the process proves excessively costly, implementing a regulatory sandbox may be advantageous.

After addressing the issue of the feasibility of legislative reform, it is essential to assess whether innovation requires a controlled test environment and rules flexibility. This evaluation helps determine whether the proposed changes can be safely and effectively implemented within the existing regulatory frameworks or whether they require a more experimental approach.[123] A controlled test environment, such as a regulatory sandbox, allows for the temporary relaxation of certain rules to facilitate innovation within a limited scope before full-scale implementation. Furthermore, regulatory authorities must ensure that the relaxation of standards does not introduce legal, economic, or operational risks that could undermine market integrity.

In some cases, innovation does not require a testing environment. A new tool may be created by improving an existing product or by recombining several existing aspects of available solutions.[124] For instance, a software update that enhances the user interface design or streamlines existing processes can be considered an innovation that does not necessitate extensive testing in a separate environment. Similarly, combining features from multiple successful products to create a new, more comprehensive solution can result in an innovation that is ready for immediate application. This approach to innovation can lead to faster development cycles and quicker market entry as the focus shifts from testing entirely new concepts to refining and optimizing existing ones. Although these innovations may not require a separate test environment, they are still subjected to rigorous quality assurance processes to ensure effectiveness and reliability.

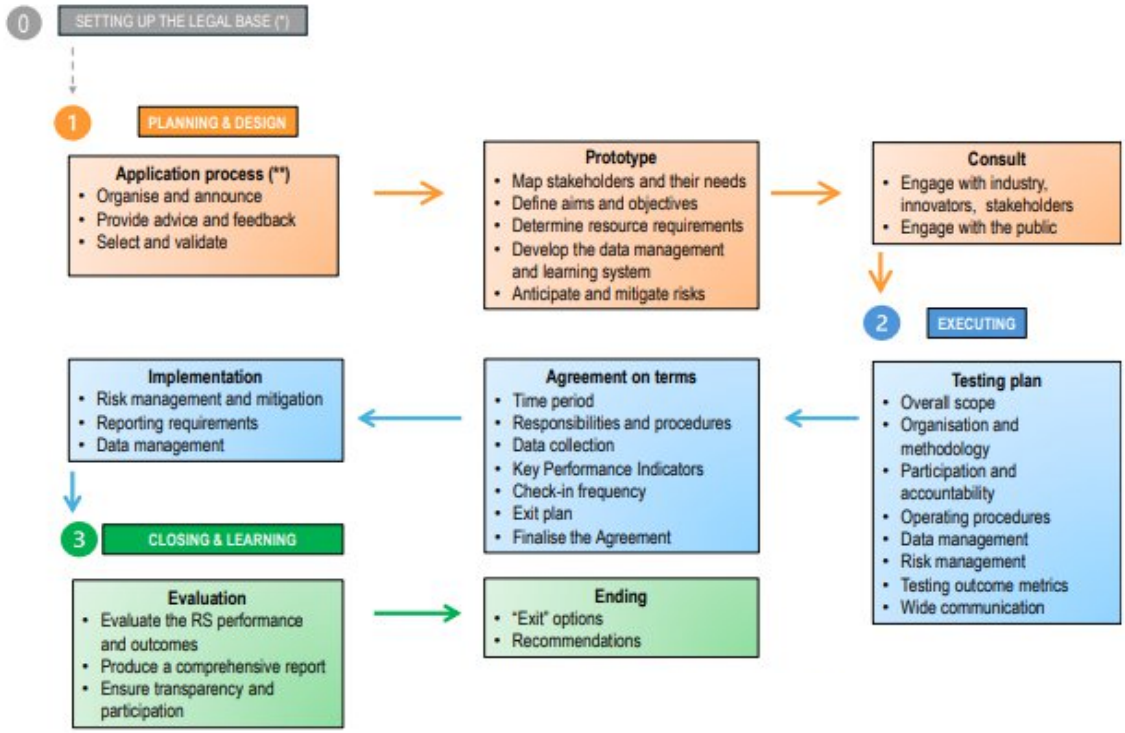
[123] Ministry of Development, Industry, Trade and Services of Brazil and Innovation Laboratory of the Attorney General´s Office of Brazil (AGU), "Regulatory Sandbox - Reference Guide" (2024).

[124] Gutemberg Ribeiro and Ana Paula Mussi Szabo Cherobim, "Environment and Innovation: Discrepancy between Theory and Research Practice" (2017) 14 RAI Revista de Administração e Inovação 30.

Finally, the assessment of regulatory sandboxes as a tool for fostering innovation requires careful evaluation of existing regulatory frameworks, potential risks, and the nature of proposed innovations. As some innovations may be accommodated through minor adjustments to current regulations, controlled testing environments may not be recommended. The decision to adopt a regulatory sandbox should be based on a thorough analysis of the adequacy of existing legislation, the need for rule flexibility, and the potential impact on market integrity.

3.2. Sandbox Design and Execution

Figure 16 Steps of a Sandbox



Font: OECD, 2025.

The initial step in the successful implementation of a sandbox environment is to establish the criteria for participant eligibility in the test. This process requires a thorough assessment of potential participants' qualifications, technical capabilities, and alignment with the sandbox's objectives. Factors such as industry experience, regulatory compliance history, and innovative potential may be considered when determining a

company's eligibility. Moreover, innovation should align with local market expectations, demonstrate genuine disruptiveness, and offer tangible benefits to consumers.[125]

Beyond participant selection, the success of a sandbox environment depends on effective stakeholder engagement. Involving stakeholders in the regulatory process can foster a sense of ownership and compliance, potentially reducing resistance to new regulations and facilitating smoother implementation. This collaborative approach can lead to more effective and tailored regulatory frameworks that address specific industry needs while maintaining market integrity and consumer protection. Furthermore, such consultations provide regulators with an opportunity to assess the potential impact of proposed regulations on different market segments and participants.

Once the eligibility criteria are established, a transparent application and selection process should be implemented. This may involve a detailed review of the applicants' proposals, business models, and potential impact on the industry. The selection process should also consider participant diversity to ensure a comprehensive testing environment that reflects various aspects of the sector. Clear communication of expectations, timelines, and responsibilities to selected participants is crucial for the smooth operation of the sandbox and the achievement of its intended results.

It is also necessary to delineate the parameters of the sandbox, which encompass the duration of the admission processes, length of the tests, and scope of the testing activities. The duration of the admission process is a key factor that determines how long applicants must submit their proposals and undergo initial evaluations. Similarly, the length of the tests within the sandbox must be carefully considered, as it directly impacts the depth and breadth of insights that can be gathered from the experiments.[126]

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[125] "Regulatory Sandbox Eligibility Criteria" (*FCA*, March 2, 2022) <https://www.fca.org.uk/firms/innovation/regulatory-sandbox/eligibility-criteria> accessed July 18, 2025.

[126] Organization for Economic Co-operation and Development (OECD), "Regulatory Sandbox Toolkit - A Comprehensive Guide for Regulators to Establish and Manage Regulatory Sandboxes Effectively"

The scope of testing activities is another vital aspect of the sandbox parameters. This encompasses the range of products, services, or technologies that can be tested and the specific aspects of these innovations that will be evaluated. It may also include limitations on the number of participants or customers involved in the testing phase and any restrictions on financial transactions or data usage. Clearly defining these parameters ensures that all stakeholders have a shared understanding of the sandbox's boundaries, facilitating more focused and productive testing and mitigating potential risks and regulatory concerns.

Moreover, identifying potential risks in the experimental process is a critical step that can significantly impact the success and validity of research outcomes.[127] These risks encompass a wide range of factors, including but not limited to distorted competition, market integrity, and social inequality. Technological solutions must not introduce risks that exceed those inherent to the sector. Consequently, the sandbox design should incorporate safeguards to manage and mitigate potential risks that may arise during the experiment. Furthermore, continuous monitoring is essential for the success of the test, as it enhances the reliability of the findings, ensures the safety of all parties involved, and maintains the integrity of the research process.

Rigorous supervision is important to maintain proper oversight over the experiment to ensure transparency and efficiency. First, it ensures transparency throughout the research process, allowing for accurate documentation and verification of procedures, data collection, and analysis.[128] Periodic evaluations of regulatory sandbox operations require systematic and scheduled assessments of the tests, focusing on both adherence to the initially established conditions and performance in relation to the regulatory objectives. Moreover, periodic evaluations provide evidence regarding

(2025).

[127] Yuval Roitman, Yael Kariv-Teitelbaum and Romi Kaufman, “Legal Guide for Designing ‘Regulatory Sandboxes’” (2024).

[128] Innovation Laboratory of the Attorney General´s Office of Brazil (AGU), “Regulatory Sandbox Reference Guide” (2024).

whether to maintain or adjust sandbox parameters, thereby mitigating unnecessary risks or adverse effects on the market.

As the sandbox progresses through its operational phase, the subsequent stage of the experiment involves assessing the sandbox results. The assessment of sandbox results is a critical phase that follows the operational stage of the experiment and involves a comprehensive analysis of the data collected, outcomes observed, and insights gained during the active period of the sandbox. Researchers and stakeholders meticulously examine various metrics, performance indicators, and user feedback to determine the effectiveness of the sandbox environment in achieving its intended objectives.

The assessment stage typically encompasses multiple dimensions, including technical performance, user experience, regulatory compliance, and potential market impact of the technology.[129] Experts may employ both quantitative and qualitative methods to evaluate the sandbox's success, such as statistical analysis, user surveys, and in-depth interviews with participants. This thorough examination allows for the identification of strengths, weaknesses, and areas for improvement in the sandbox framework. The findings are relevant for informing future iterations of the sandbox, guiding policy decisions, and shaping the broader regulatory landscape for innovative technologies or business models.

[129] ibid.

4. CONCLUSION

This study explores the dual impact of regulatory sandboxes on FinTech innovation and regulatory practices. Regulatory sandboxes have become a crucial mechanism for fostering innovation in the rapidly evolving FinTech sector while ensuring appropriate regulatory oversight. This study examines how new technologies, such as AI and data analytics, have transformed financial services, creating new regulatory challenges. It underscores the need for regulators to adapt to these changes to ensure effective oversight while promoting innovation.

Moreover, several barriers to innovation exist, including compliance costs, limited understanding of regulations, and regulatory uncertainties. This text elucidates how regulatory sandboxes can mitigate these barriers by offering a more flexible regulatory environment. As described, the implementation of sandboxes offers several advantages, such as facilitating experimentation with novel technologies and business models, reducing costs and time-to-market for innovative products, and promoting knowledge exchange between regulators and innovators. Additionally, sandboxes are linked to attracting venture capital investment to the FinTech sector and mitigating agency problems by enhancing transparency. However, sandboxes also present challenges that require careful management, such as the risk of regulatory capture, potential market distortion, and the possibility of unfair advantages for sandbox participants.

Furthermore, it has been demonstrated that the efficacy of sandboxes depends on their design and implementation. Critical factors for success include clear eligibility criteria and transparent selection processes, well-defined testing parameters and timelines, robust risk management, continuous monitoring, and periodic evaluation.

Looking ahead, regulatory sandboxes are likely to continue evolving to address emerging technologies and market developments. Areas for future development may include the need for greater international coordination to facilitate cross-border sandbox initiatives and enhanced integration with other regulatory innovation tools such as

innovation hubs. In this context, it would be valuable to conduct a comprehensive investigation into the effectiveness of regulatory sandboxes in fostering financial innovation by analyzing both successes and failures across various jurisdictions. Such a study could examine the utilization of regulatory sandboxes to achieve a balance between the imperative for innovation and the requirements of consumer protection and financial market stability.

Future investigations could also focus on comparing the different regulatory sandbox models adopted globally. This study could examine variations in regulatory frameworks, eligibility criteria, supervisory processes, and the outcomes achieved. This study identifies best practices and proposes recommendations for implementing more effective regulatory sandboxes, considering the economic and cultural particularities of each region. As different economies have different nuances in their regulatory frameworks, it is relevant to examine how various countries structure their sandbox environments, including the scope of relaxed regulations, duration of testing periods, and level of regulatory oversight maintained. Furthermore, exploring the eligibility criteria across different models would reveal how jurisdictions balance innovation with risk management, potentially uncovering patterns in the types of firms and technologies prioritized for sandboxing.

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