

# Worldwide Adoption of Regulatory Sandboxes: Drivers, Constraints and Policies

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# Worldwide Adoption of Regulatory Sandboxes: Drivers, Constraints and Policies\*

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**Abstract.** Regulatory sandboxes are becoming a valuable tool for promoting innovation in sectors such as finance, energy, telecommunications, and health. We analyse 199 cases across 92 countries to understand the dynamics of worldwide adoption. Results show significant geographical concentration, with three countries (USA, Singapore, UK) accounting for a quarter of all sandboxes. We find that economic development and legal traditions are both strongly associated with sandbox adoption. Although regulated industries and innovation are critical for poverty reduction and growth, regulatory sandboxes are unfortunately exceedingly rare in developing countries. We use Laffont's theory of regulation to draw recommendations on how developing countries could be supported in order to bridge this innovation gap.

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## 1. Introduction

Regulatory sandboxes are a new mechanism that promotes innovation in regulated industries. They provide carefully controlled business ecosystems, in which a select number of participating firms are supported to trial innovative products and services, without some of the typical constraints, complications, and risks. The term ‘regulatory sandbox’ appears to have originated with the launch of the UK Financial Conduct Authority (FCA) sandbox in 2015. Although sandboxes have proliferated since then across many sectors and countries, academic literature remains scant. Broader research on innovation is relevant and can provide some insights on why and how sandboxes develop. However, it is important to appreciate the limitations of drawing direct comparisons, as regulatory sandboxes are fundamentally different than standard innovation tools. In the traditional sense, innovation is driven by individual firms striving to improve their outcomes and differentiate against competitors. Although these efforts are regulated (see Blind, 2012), they are the result of independent activities by competing firms. Regulatory sandboxes try to promote innovation in oligopolies or monopolies where regulatory constraints and uncertainty limit the drive to innovate. In regulatory sandboxes the key objectives are to inform regulators and benefit consumers overall, rather than improve the competitive advantage of a specific firm.

We compile a new dataset consisting of information about all the 199 regulatory sandboxes that we could identify worldwide.<sup>1</sup> Our analysis reveals three main empirical findings. First, regulatory sandboxes are highly concentrated, with three countries accounting for a quarter of all sandboxes worldwide. The literature on the geography of innovation reaches similar conclusions (e.g. Feldman, 1994; WIPO, 2019; Andrews and Whalley, 2022; Chien, 2022; Straccamore *et al.*, 2023). For example, Chien (2022) notes that in 2020, over half of new patents in the US are awarded to the top 1% of patentees, while the same proportion of patents is generated by just five coastal states. The narrow international spread we find is well approximated by a Pareto distribution with power law behaviour in the number of sandboxes per country. Patents are also known to follow power law distributions (O’Neale and Hendy, 2012). We explain the concentration of sandboxes borrowing arguments from the literature on the benefits of agglomeration for innovators and regulators. These benefits arise from factors such as common infrastructures, thick labour markets, and proximity to research institutions.

Our second empirical result links economic development to sandbox adoption. We find that variables such as income, OECD membership, economic freedom, number of patents, spend on research and development, and government spending, are positively associated with the adoption of a sandbox by a country. For example, 72% of countries that are characterised as high income by the World Bank have

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<sup>1</sup> The database is updated regularly and is available to researchers through the Centre for Competition Policy (CCP) Regulatory Sandbox Portal <https://competitionpolicy.ac.uk/research-projects/portal-on-regulatory-sandboxes>

a sandbox, whilst this is only 16% for lower income countries. OECD countries are 4.5 times more likely to have a sandbox compared to non-OECD countries. Higher levels of unemployment, inflation, and growth, typically markers of developing countries, are associated with a lower likelihood of sandbox adoption. In a regression framework, we find that the World Bank Competitiveness Index score of a country is a proxy that best captures the overall effect of economic development on sandbox adoption. Our results, concur with the extensive literature on the concentration of innovation in wealthier countries. This phenomenon arises because innovation requires a favourable context in terms of financial resources, infrastructure, skills, institutions, policy, incentives, and broader economic, social, cultural, and environmental conditions. Regulatory sandboxes have similar requirements, so our results do not come as a surprise. Several studies focus on the innovation creation, adoption, and diffusion in developing countries (see the literature reviews by Crane, 1977; Lorentzen, 2010; Lema et al 2021, Fu and Shi, 2022). Our second finding is partially related to the agglomeration of sandboxes noted previously, although the former has more to do with the nonlinear relationship between certain aspects of economic development, geography, and innovation. As noted by Chien (2022), “*The economic, geographic, and demographic concentration of innovation highlight how the intersections between two traditionally discrete topics – innovation and inequality – have become increasingly relevant*”.

Our final finding identifies the legal system of a country as another key driver of sandbox adoption. Our results demonstrate that countries practicing civil law have a lower chance of developing sandboxes. Wen et al. (2022) find that common law countries perform better than civil law countries in terms of innovation inputs and outputs (see also Brown et al, 2013, Caprio et al. 2020, Neves and Branco 2020). They measure innovation using R&D spend, number of researchers and number of patents/trademarks. Several studies argue that the flexibility of common law can better adapt to changes in the environment and promotes innovation (e.g. Posner 1973, Rubin 1977) and offer stronger protection to investors (La Porta et al, 1998). The association between institutions, such as legal traditions, institutions and economic development are well known (see the literature review by Fernández and Tamayo, 2017; He and Tian, 2020).

The remainder of this paper proceeds as follows. Section 2 reviews the literature around regulatory sandboxes. We discuss relevant theories, empirical evidence, and criticisms. Section 3 discusses our data and presents the empirical analysis. Section 4 draws recommendations on how to best support the development of regulatory sandboxes in developing countries. The final section concludes.

## **2. Literature Review**

This section reviews the literature on regulatory sandboxes by discussing relevant theories and empirical evidence. We also discuss the criticisms that they have received. To the best of our

knowledge, this is the first attempt. There are two relevant studies that also review the literature, but from the perspective of a specific sector. First, Martin and Balestra (2019) review the literature and discuss the benefits, risks, and challenges of regulatory sandboxes. Their focus is on the potential role in promoting responsible humanitarian innovation. Second, Leckenby *et al.* (2021) undertake a systematic literature review of regulatory sandboxes in the healthcare sector. They use a sample of over 46 relevant papers and reports, many of which are from the ‘grey’ literature (e.g., reports, working papers, newsletters, white papers, policy documents). They conclude that regulatory sandboxes in healthcare are a relatively new development that is used mainly by wealthy countries.

## 2.1 Theoretical Foundations

Allen (2019) characterises regulatory sandboxes as being a form of principle-based regulation that fit within the ‘new governance’ theory of regulation. In this context, top-down command-and-control is replaced with a partnership between the regulator and regulated firm, which functions as an iterative learning process. Zetzsche *et al.* (2017) place regulatory sandboxes within a broader framework of how regulators may approach new financial innovations. They characterise such approaches under five categories: (i) do nothing, (ii) cautious permissiveness, i.e., proceed on a case-by-case basis, (iii) structured experimentalism, which includes regulatory sandboxes, and (iv) developing new regulatory frameworks. Ahern (2020) views regulatory sandboxes as being a form of agile ‘opportunity-based regulation’ that helps to reduce regulatory lags. Ahern suggests that opportunity-based regulation is a third way which moves away from Baldwin and Black’s (2016) dialectic between risk-based regulation and problem-based regulation.

Alaassar *et al.* (2020) use a case study approach to perform a detailed study of regulator-regulatee interactions within sandboxes based around social capital theory. This perspective views the relationships that a network actor has as being critical to the transfer and exchange of knowledge across different analytical levels (individual, organisation, and society). The connections of a network are then classified into three main dimensions: structural (subdivided into ties, connectivity, density, frequency of contact and hierarchy), relational (subdivided into trust, norms, obligations, and expectations) and cognitive (subdivided into shared goals, culture, language and codes). Van der Waal *et al.* (2020) also use case studies to map relationships between actors in sandboxes, and employ a mapping based around the schemes being multi-actor, polycentric decision-making systems. Armstrong and Rae (2017) argue that regulation can either be advisory, adaptive, or anticipatory depending on its goals, desired outcome and the participants involved. Ideally, they fit into ‘anticipatory’ regulation where regulation is seen as an iterative process with a strong input from innovators and other key stakeholders.

Fahy (2022) also adopt a similar case study approach but with a focus on responsive regulation theory. The first main finding is that firms experiencing frontline ‘cooperative or collaborative’ interactions

with a regulator are more likely to cooperate with that regulator in the future and that these interactions cause innovators to normalise regulatory cooperation and perceive it as a moral good. This is in line with responsive regulation theory, new governance theory and the partnership characterisation proposed by Allen (2019). The second finding is that less established firms may be more likely enter a sandbox for reasons other than those posited by responsive regulation theory. Specifically, they may want to overcome limited resources, inexperience, uncertainty, and lack of partnerships. This is also in line with new governance theory and Allen (2019) but goes beyond responsive regulation theory as it suggests that newer firms may be more incentivised to interact with regulators than established ones.

Crampes and Estache (2023) urge that greater efforts be devoted to considering the distributional tradeoffs involved with sandboxes, not solely efficiency effects. They introduce a model that demonstrates that there may be tradeoffs between efficiency and distribution, particularly with respect to regulatory sandbox design parameters. They observe that monopolists will tend to undersupply goods, and that this bias should be taken into account in the design of sandboxes to focus more on consumer effects and, in particular, the production of goods that would be preferred by the poorest segment of the population.

## 2.2 Empirical Evidence

The existing empirical literature in this area focuses mostly on examining single regulatory sandboxes, rather than a wider sample. Cornelli *et al.* (2023) analyse the effects of participating in a regulatory sandbox. They assess whether participation in the FCA sandbox increases the amount of capital a firm can raise. They find that the quantity of capital raised in the two years following sandbox entry increased by around 15%, while the probability of receiving capital investment in each quarter rose by roughly 50%. These findings are obtained following two alternative diff-in-diff approaches. The first approach exploits the fact that distinct cohorts of firms entered the FCA sandbox. It performs a comparison of firms that entered the sandbox in each period, with firms that only entered the sandbox in later period. The second approach constructs a control group of firms that never entered the sandbox using a coarsened exact matching approach with a limited number of variables.

While Cornelli *et al.* (2023) are cautious to note that their results do not necessarily indicate that regulatory sandboxes are welfare enhancing, their evidence suggests that regulatory sandbox entry has two results: it signals that an accepted firm is of higher quality and reduces regulatory uncertainty facing the firm. The authors argue for the quality signal story on the grounds that the investment increases following sandbox entry are from first-time investors and investors outside the UK who are likely to face greater information asymmetries. Furthermore, the increase in funding is largely confined to the first two quarters following sandbox entry. Regarding the influence of reduced regulatory uncertainty, they note that sandbox participants who had a CEO with a background in financial law, i.e., individuals

likely to have a good understanding of regulation, saw less benefit from sandbox entry. Cornelli *et al.* (2023) also argue that if the beneficial impact of a sandbox to participating firms was that it simply raised their profile, you would not have expected to find these systematic variations in funding across firms.

Choi and Lee (2020) use semantic analysis (namely keyword and group network analysis) to determine why firms use the South Korean fintech regulatory sandbox. They find that regulatory sandboxes are used by firms of differing sizes for different reasons. Large enterprises are focused on developing overall security-related technologies. Middle-standing enterprises are striving to develop infrastructure-related technologies, with particular emphasis on elementary technologies. Small and medium-sized enterprises are also making efforts to develop user-centred technologies that can directly be used in fintech.

Although most papers offer some insight into regulatory sandboxes in the fintech sector, there are a number of papers which focus on other sectors. Van der Waal *et al.* (2020) assesses through four case studies the effectiveness of a Dutch sandbox focussed on decentralised sustainable electricity. They explained the limited success by highlighting factors that the regulatory sandbox cannot address directly: access to finance, double taxation of energy storage, distribution system operators unwilling to engage with small entities, EU rules requiring third party access to networks, and ability of consumers to switch supplier. Schittekatte *et al.* (2021) provide a case study review of three regulatory experimentation schemes in the energy sector two of which are regulatory sandboxes. The schemes are assessed by 6 criteria: eligible project participants, type of derogations, length of derogations, administration, if the scheme receives funding and level of transparency. Their key findings are that the schemes differ significantly but are converging through time.

Beckstedde *et al.* (2023) examine 72 projects approved by energy regulatory sandboxes across 5 European countries (Belgium, France, Great Britain, the Netherlands, Norway). They find that regulatory sandboxes promote innovation in a variety of areas such as diversification of the gas sector and the rollout of renewables. They conduct a best practice analysis which recommends regulators are open to providing both derogations and advice, consider involving other regulators and treat sandboxes as an iterative process with scope to continual evaluation/evolution.

Correa *et al.* (2021) recommend that regulatory sandboxes are used for local flexibility mechanisms for electricity distribution as flexibility mechanisms still have barriers in national regulation, and regulatory sandboxes could be used to overcome this gap. They also make a proposal for such a scheme in Spain. Veseli *et al.* (2021) discuss the necessary legal framework to introduce an energy regulatory sandbox in Austria and conduct cluster analysis into the needs of its potential users. Besides from the academic literature, the grey literature locates and advocates regulatory sandboxes across a number of sectors. The OLA Mobility Institute (2021) finds 4 regulatory sandboxes in the transport sector and advocates

regulatory sandboxes as a tool to increase accessibility, diversity, inclusion and mobility. Higgins and Male of the Environmental Policy Innovation Centre (2019) recommend regulatory sandboxes as a means for testing conservation schemes. Reports by the OECD (2020a, 2020b) and CIPL (2019) recommend regulatory sandboxes in the privacy and data protection sectors.

### 2.3 Criticisms

The development of regulatory sandboxes does not enjoy universal support and has also attracted criticism from researchers and practitioners. Former DFS Superintendent Maria Vullo famously calls the concept '*preposterous*', claiming that '*toddlers play in sandboxes, adults play by the rules*'.<sup>2</sup> Malladi (2020) uses economic modelling to show that regulatory sandboxes may be preferred to full approval of innovations. Even when firms can guarantee that the innovation will improve the status quo, committing to a limited level of approval always reduces a regulators worst-case regret. This suggests that regulatory sandboxes may actually limit or slow down innovation in some markets, particularly when it is easy to show the benefits of new innovations. Brown and Piroška (2022) accuse regulatory sandboxes of 'risk washing'. They argue that regulatory sandboxes can be socially disruptive and may lead to a distorted, redistribution of wealth, privacy violations, selection bias, and can undermine social trust in institutions due to arbitrariness of digital valuation.

Zetzsche *et al.* (2017) take a somewhat sceptical stance towards sandboxes as they merely allow a constrained testing environment rather than a full scaling up of Fintech businesses. They argue that rather than just using a sandbox to promote innovation, regulators need to establish 'Smart Regulation' which involves four tiers of support. In this framework, from initial idea to final licensing of a full-scale product, regulatory sandboxes are only one tier. This is also discussed by Ringe and Ruof (2020) who advocate the need for a 'regulatory trajectory'. The authors also raise concerns about whether regulators have the necessary skills to accurately assess the innovativeness of applications. Zetzsche *et al.* (2017) note that competition between financial centres could lead to a race to the bottom via sandboxes. They also emphasise that some regulators copying the sandbox idea may not have the experience or resources to implement it well. Finally, they discuss how the advantages of sandboxes to firms means that the regulator is making the playing field less level. Also, that the success of sandboxes depends on there being a pool of firms able to utilise the regulatory sandbox. Finally, they identify that although transparency as of vital importance, this is something that many existing sandboxes do not do very well.

Buckley *et al.* (2020) argue that most of the benefits of regulatory sandboxes can instead be provided by innovation hubs, which avoid most of the downsides. The authors argue that many of the benefits attributed to sandboxes are the result of poor use of terminology. Also, that regulatory sandboxes should

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<sup>2</sup> See *New York Offers Post-Covid Fintech Regulatory Guidance*, Bloomberg Law, 2020.



be viewed as a specialised element within innovation hubs. In this sense, innovation hubs are viewed as portals through which industry can access regulators to discuss fintech innovations, gain some guidance on regulatory requirements, and potentially argue for regulatory adjustments. While innovation hubs still require significant resources, their greater openness means they pose fewer risks regarding the removal of a level playing field. To support this, Buckley *et al.* (2020) cite the case of the Australian ASIC regulator. On the one hand, the ASIC innovation hub provided informal assistance to 347 firms and granted 69 new credit licenses between March 2015 and December 2018. On the other hand, the regulatory sandbox only admitted 6 firms over the same time period.

Allen (2019) expresses the concern that regulatory sandboxes can be used by the financial sector to achieve deregulation by the back door. This reflects a more general scepticism about whether financial innovation should be an objective for regulators. If regulatory sandboxes are to be beneficial, Allen argues that a focus needs to be on learning by regulators themselves around new innovations. He also notes that the selection criteria used to admit firms into a sandbox and the advantages a sandbox confers on participants could distort the learnings that a regulator could take away from running a sandbox. Allen raises the concern that close co-operation between regulated firms and the regulator in a sandbox could lead to ‘cognitive capture’ where a regulator becomes too sympathetic. He suggests that to limit potential downsides, any legislation to implement sandboxes in the US should be subject to a sunset clause.

Zetzsche *et al.* (2017) argue that both unregulated and existing regulated firms should have access to the sandbox. Allen (2019) argues against admitting important financial institutions or ‘Big Tech’ firms as it could help entrench their already strong positions. He further develops ideas around the importance of learning and information sharing from regulatory sandboxes. Ideally regulators should share detailed learnings from their individual sandboxes since many financial products are similar at a global level. However, financial regulators may not have the incentives to undertake this information sharing. This view is informed by Allen framing regulatory sandboxes within the context of competition between financial jurisdictions and that firms are aiming to pursue regulatory arbitrage in terms of their location decisions. The Global Financial Innovation Network (GFIN) initiated by the FCA could be a coordination device to limit regulatory arbitrage by establishing minimum standards. However, the ambition of GFIN has been scaled back from a global regulatory sandbox involving multi-lateral trials to a body that helps regulators co-ordinate when separate but simultaneous trials are being performed in different jurisdictions.

Ahern (2020) also raises concern about how competition between regulatory sandboxes for success may influence how regulatory discretion may be used and distort the evolution of Fintech markets. Illustrating this point Ahern points to jurisdictions guaranteeing decisions on sandbox admission within certain time frames and whether some of these time frames are so short that one might question whether thorough reviews are being performed. For example, the Central Bank of Malaysia is cited as providing

a full decision within 15 days. Ahern argues that this competitive pressure on the design features of sandboxes occurs because as more jurisdictions have sandboxes, the weaker the signal that copy-cat sandboxes provide in terms of identifying a particular regulator as being pro-innovation.

Furthermore, Ahern worries about regulatory capture within regulatory sandboxes as while regulatory sandboxes can facilitate regulator learning, there is still likely to be an asymmetry of information between the regulator and regulatee. Also, if success is defined by the number of trialled services entering the market, it could create an incentive for regulators to be excessively supportive of allowing sandbox firms to enter the market. Ahern argues that some countries such as France, Germany and the Republic of Ireland have made a conscious choice not to pursue sandboxes and that rather than this implying they are regulatory laggards it is because they have fundamental concerns about sandboxes. Alaassar *et al.* (2020) provide further detail on the relationships between regulator and regulatee based on interviews with 6 regulators in 5 jurisdictions and 9 regulatees. They make several observations including that, unsurprisingly, that tensions can arise with regulators and regulatees potentially approaching sandboxes from different directions. For example, they observe that regulators can be very process and time orientated, while regulatees focus on financial outcomes and suspect regulators have limited technical knowledge. However, common ground could be found around particular objectives such as disrupting traditional financial service providers. Other interesting observations from Alaassar *et al.*'s interviews were that: (i) the frequency of interaction between regulator and regulatee could vary between weekly and quarterly, (ii) generally rather than regulators revising their rules, sandbox participants were generally encouraged to adapt their products to existing regulations, and (iii) regulators could boost their ties to regulatees by, for example, introducing them to other regulators and using them as case studies in presentations.

Knight and Mitchell (2020) reflect on the support provided to firms in regulatory sandboxes and focus on how this can distort competition by giving an advantage to sandbox firms over non-sandbox firms. Given that regulatory sandboxes focus on innovations, this is likely to take the form of a first mover advantage. While, Knight and Mitchell mostly just discuss this issue in general terms, they do suggest that firms not allowed into regulatory sandboxes should be able to appeal decisions and time limits on a firm's participation in a sandbox is beneficial. They also note that the structure of sandboxes in Utah and the US Consumer Financial Protection Bureau potentially lower competition concerns by specifically helping firms gain access to their regulatory sandboxes if their competitors have used the regulatory sandbox previously. However, they are unimpressed by the fact that few sandboxes report to external parties the clarifications of laws and regulations that are communicated to sandbox participants.

Johnson (2023) acknowledges that whilst regulatory sandboxes offer benefits to innovation and emerging technologies, they can also be problematic, both from a technical and political perspective and that more particularly, they can suffer from issues surrounding tension between compliance and

legitimacy. These issues can be particularly problematic for low-income jurisdictions as regulatory sandboxes can require the allocation of significant resources, particularly as they are fine tuned.

Despite some outright critics, most critics of regulatory sandboxes adopt more intermediate positions, critiquing some facet of regulatory sandboxes and generally acknowledging that regulatory sandboxes are, or least could be, a useful policy tool for facilitating innovation, and deserve someplace within the regulatory landscape. Calls for greater scrutiny and additional empirical work are common and indeed best practice analyses have begun to emerge both from policy makers and academics. For example, the 2019 ESMA, EBA and EIOPA joint study on regulatory sandboxes, the 2023 European Commission study on regulatory sandboxes and Flavia *et al.* (2023) study on the role of regulatory experimentation in the energy transition.

**Table 1.** Regulatory Sandboxes by Sector

Sector	Number	%
Communications	5	2.51%
Energy	17	8.54%
Financial Services and Insurance	132	66.33%
Multisector	19	9.55%
Public Health	7	3.52%
Transport	8	4.02%
Other	11	5.53%
<b>Total</b>	<b>199</b>	<b>100.00%</b>

### 3. Empirical Analysis

The dataset on regulated sandboxes used in this paper was compiled by the research team up through 2024 through an online search using relevant keywords for each country worldwide. Identifying regulatory sandboxes is in itself a challenging task and our dataset is a function of the keywords and search methodology we adopted. We included cases that were labelled as a regulatory sandbox, without investigating in depth if the definition was correct. Information was also drawn from websites of regulators, relevant reports, and reviews. It is possible that we missed some of the regulatory sandboxes that exist. For example, Sherkow (2022) argues that the USA’s emergency use authorisation (EUA) program is a form of regulatory sandbox as it has similar characteristics to a fintech regulatory sandbox.

The EUA program also focuses on real world deployment as a means of information gathering, whilst also being technologically flexible and a two-way irritative communitive process between regulator and participant. Sherkow suggests that regulatory sandboxes in other industries may be ‘waiting to be discovered’. It is difficult to quantify the number of schemes which exhibit ‘sandbox-like’ features, as it would be impossible to identify all these schemes without checking practically every innovation support scheme ever introduced.

For each sandbox identified we collected the years of creation and operation (or of planned creation), the sector affected, the geographic area covered by the sandbox (whether national or sub-national), the objectives, the benefits offered to participants, and the governance of the sandbox itself (e.g., the sandbox operator, the process for entering the sandbox). Regulatory sandboxes are a relatively recent development, with only 5 created in our sample prior to 2015. Sandboxes are being formed far more frequently than they are being closed. Our database also includes a number of sandboxes which have been announced or considered but have not yet begun accepting applicants, suggesting that the growth of regulatory sandboxes may continue.

As shown in Table 1, the majority of sandboxes are in the sector of Financial Services and Insurance (66.3%), with Energy and multisector being the next most popular. Communication, Public Health and Transport are the sectors with the fewest sandboxes. Over 74% of sandboxes (149) have a national scope, while only one has a global perspective. A large proportion is regional (19.6%), with only a handful being municipal (2.51%).

**Table 2.** Regulatory Sandboxes by Continent

Continent	Number	%
Africa	17	8.63%
Asia	58	29.44%
Australia and Oceania	6	3.05%
Europe	64	32.49%
North America	44	22.34%
South America	8	4.06%
<b>Total</b>	<b>197</b>	<b>100.00%</b>

In Table 2 we can see that there is a geographical concentration of sandboxes in Europe (32.5%), Asia (29.4%) and North America (22.3%). Africa and South America has much fewer sandboxes. Table 3 illustrates the country champions of sandboxes are the USA (31 sandboxes), Singapore (10), UK (9), Canada (6), Thailand (6) and Germany (5). Although the high number of regulatory sandboxes in the US is due to 26 state or district level sandboxes, and in practice regulatory sandboxes appear to have spread across a similar number of sectors in the US, Singapore and the United Kingdom.

The distribution of sandboxes worldwide appears to follow the Pareto principle, according to which 80% of outcomes are due to 20% of causes. Specifically, 37 countries in our sample have 71.8% of the total sandboxes worldwide. The Pareto distribution also offers the best fit to the sandbox data with the highest value of the log-likelihood function (LL=-33.54) with a parameter  $a$  estimated at 2.72 (s.e. 0.29). Alternative distribution specifications did not offer such a good fit in terms of LL (Exponential -99.67, Chi-square -157.87, Logistic -193.44, Weibull -159.54, Gamma -155.58).

**Table 3.** Countries with 5 or more regulatory sandboxes, arranged by sector

Country	Number	Sectors
United States	31	7
Singapore	10	8
United Kingdom	9	7
Canada	6	5
Thailand	6	4
Germany	5	4

Further analysis of sandboxes indicated that there are three main groups of design choices: objectives, participant benefits, governance, and administration. Innovation was by far the most common objective for regulatory sandboxes. Other common objectives included sustainability, improving costs/services for consumers and influencing future regulation and policy. Analysis of objectives was based on publicly available mission statements and sandbox provider descriptions. Evaluation of meeting objectives and key performance indicators (KPIs) or not always clear as regulatory sandboxes operate against less prescribed frameworks (OFGEM, 2020). Whilst best practice recommends the introduction of KPIs, there are no clear examples or general guidelines of what these should be. For example, OFGEM stated in 2020 it was thinking about introducing KPIs by which to judge its performance, but still did not have enough experience to offer relevant ones (this regulatory sandbox has been running since 2017). In practice, relevant KPIs are tailored each individual scheme. Most common indicative

KPIs relate to timescales, mostly for decisions on applications. Most regulatory sandboxes are quite new, which makes ex-post assessment difficult. Only a limited number of quantitative studies have assessed impact of regulatory sandboxes on innovation.

In terms of benefits to participants, some schemes offer explicit exemptions from regulations or allow applicants to request exemption from a particular regulation (although when offering such a feature, sandboxes limit the breadth of regulatory exemptions). One scheme grants automatic exemption from some regulations for a firm located in a certain area (as occurred, for example, with the Thor Park Regulatory Sandbox). Exemptions are not a necessary feature of sandboxes however, as some instead offer regulatory oversight (and comfort letters during a time in the sandbox) which is another way to increase regulatory certainty. The offering of exemptions is particularly critiqued, due to the possibility of conferring a competitive advantage to one company over another by having a preferential regulatory treatment for an individual company, as mentioned in Allen (2019) and Ahern (2020). Other benefits for participants include: access to data, guidance and mentoring, networking benefits, flexibility, quality signalling and increased visibility. The participant benefits generally did not focus on consumer benefits, supporting the point of Crampes and Estache (2023) that more significant focus is needed on less well-off customers. We would argue that an extension to focus on consumer effects may be particularly valuable in developing countries.

Finally, in terms of governance most sandboxes are administered by a regulator. We have many fewer cases (four) that are led by private entities, code operators and enterprise agencies. The application process is either rolling-based (sandbox opened indefinitely) or cohort-based (sandbox is split into application windows, where it is open for a certain amount of time, then shuts and then another window is opened at a later date). The first offers greater freedom of choice for applicants on when to apply and administration burden is more even. However, it might be more difficult to make adjustments as there is no automatic period in which to analyse data, and there is no time to adjust between cohorts. The second makes it easier to adjust between cohorts and offers greater control on number of applicants. It also gives the sandbox operator opportunity to target different sub-sectors with each cohort and limit the number of participants per cohort. However, some innovators may have to wait to join while an unproportionable number of applications at the end of an application window, can create an uneven administrative burden.

Eligibility for sandboxes was based mostly on the degree of innovation that the project needs to demonstrate. Other common criteria included readiness to implementation (technologically, financially and organisationally) and existence of an identifiable regulatory barrier for the project proposed. Other criteria included: geographical location, scalability, monitoring and evaluation procedures, exit strategy, defined boundary conditions, risk mitigation strategies, supportability, support from an external party, transparency and geographical location. A few sandboxes offered unclear criteria for selection beyond the general objectives.

**Table 4.** Codification of variables

<b>Acronym</b>	<b>Description</b>	<b>Source (Year used)</b>
SBX, SBXN	Existence of sandbox in country, number of sandboxes	Author estimates
OECD, EU	Membership of OECD and EU	
NAM, EURO, NOEURONAM	North America (NAM), Europe (EURO) or other (NOEURONAM)	
INC_HIGH, INC_MID, INC_LOW	Income classification: High (HIGH), Lower middle or upper middle (MID), Low (LOW)	World Bank (2021)
LEG_CIV, LEG_COM, LEG_MLT	Law System: Civil (CIV), Common (COM), Multiple (MLT)	JuriGlobe, Uni. Of Ottawa (2021)
CMP	Global Competitiveness Index (2017–2018) measures national competitiveness—defined as the set of institutions, policies and factors that determine the level of productivity.	World Bank (2017)
IDF	Index of Economic Freedom (0 - 100)	Heritage Foundation (2021)
GDPPC	GDP per capita	Heritage Foundation (2021)
TARIFF	Tariff rate	
TAXGDP	Tax Burden as % of GDP	Heritage Foundation (2021)
SPENDGDP	Government spending as % of GDP	Heritage Foundation (2021)
GROWTH5Y	GDP Growth over one year and 5 years	Heritage Foundation (2021)
UENPL	Unemployment rate	Heritage Foundation (2021)
INFL	Inflation	Heritage Foundation (2021)
DEBTGDP	Public debt as % of GDP	Heritage Foundation (2021)
PATENT	Number of patent grants to residents	WIPO (2021)
RNDGDP	Research and Development expenditure expressed as a percentage of GDP.	Worldbank (2021)
PDI, IDV, MAS, UAI, LTOWVS, IVR	Dimensions of national character for Power, Uncertainty Avoidance, Individualism, Indulgence, Masculinity and Long-term orientation	Hofstede (2015)

### 3.1 Drivers of Regulatory Sandbox Adoption

We now turn to investigating the factors that drive the adoption of sandboxes at a national level. To this end we collected a number of variables at country level, irrespective of if they have adopted a sandbox or not. Table 4 presents an overview of the variables used in our empirical analysis that cover geographical, economic, institutional, social and cultural characteristics. These were selected based on the academic literature that has investigated the determinants of innovation at a country level. Table 5 and 6 gives descriptive statistics the variables in our sample. There is a variation in terms of the characteristics of the countries analysed that suggests a good coverage of the population.

**Table 5.** Country characteristics

Variables	N	%
INC_HIGH	61	33.52%
INC_MID	96	52.75%
INC_LOW	25	13.74%
OECD	40	21.86%
EU	27	14.75%
NAM	3	1.64%
EURO	54	29.51%
LEG_CIV	78	42.62%
LEG_COM	20	10.93%
LEG_MLT	82	44.81%

Table 7, gives the profile of the countries in terms of the variables analysed and sandbox adoption. Overall, this suggests that economic development plays an important role. For example, while 72% of high-income countries have at least one sandbox, this percentage is only 16% for low-income countries. This is a difference by a factor of 4.5 times. Economic variables paint a similar picture. Countries that have adopted regulated sandboxes (vs. those that have not) have a higher GDP per capita (\$23,177 vs. \$16,596), lower unemployment (6.37% vs. 8.26%), higher government spending (32.64 vs. 29.89), and higher scores in competitiveness (65.48 vs. 54.38) and economic freedom (66.03 vs. 57.91). Also, there seems to be a link to legal traditions with common (civil) law systems being more



common in countries that adopt sandboxes. Finally, we find that regulatory sandboxes are more common in countries that are more individualistic and long-term oriented. These results are in line with previous results in the literature related to innovation and national culture (eg. see Boubakri *et al.*, 2021).

**Table 6.** Descriptive Statistics

<b>Variable</b>	<b>N</b>	<b>Min</b>	<b>Max</b>	<b>Mean</b>	<b>Std. Dev.</b>
<b>GDPPC</b>	173	221.16	235,132.78	19,906.09	32,557.51
<b>GROWTH5Y</b>	167	-18.70	14.30	2.94	3.11
<b>UENPL</b>	165	0.10	43.50	7.31	6.25
<b>INFL</b>	165	-16.40	255.30	5.32	20.86
<b>DEBTGDP</b>	165	2.50	265.80	59.16	40.58
<b>TARIFF</b>	163	0.00	22.10	7.41	4.62
<b>TAXGDP</b>	163	0.10	46.10	21.25	10.36
<b>SPENDGDP</b>	164	11.50	94.50	31.28	12.59
<b>CMP</b>	140	35.10	84.80	60.65	12.47
<b>IDF</b>	162	5.20	89.70	62.07	11.35
<b>PATENTS</b>	83	1.00	58,4891	11,363	67,564
<b>RNDGDP</b>	67	0.00	0.06	0.01	0.01
<b>PDI</b>	69	11.00	104.00	59.13	21.86
<b>IDV</b>	69	6.00	91.00	43.72	24.01
<b>MAS</b>	69	5.00	110.00	48.72	19.83
<b>UAI</b>	69	8.00	112.00	67.78	23.71
<b>LTOWVS</b>	90	3.50	100.00	45.62	23.91
<b>IVR</b>	90	0.00	100.00	45.22	22.45

**Table 7.** Profile of Countries with respect to sandbox adoption

SBX			SBX			SBX		
Variable	0	1	Variable	0	1	Variable	0	1
<b>INC_HIGH</b>	27.87%	72.13%	<b>GDPPC</b>	16,596	23,177	<b>PATENTS</b>	104.77	16,499
<b>INC_MID</b>	54.17%	45.83%	<b>GROWTH5Y</b>	2.97	2.92	<b>RNDGDP</b>	0.95%	1.60%
<b>INC_LOW</b>	84.00%	16.00%	<b>UENPL</b>	8.26	6.37	<b>PDI</b>	59.35	59.04
<b>OECD</b>	27.50%	72.50%	<b>INFL</b>	4.11	6.51	<b>IDV</b>	36.90	46.51
<b>EU</b>	29.63%	70.37%	<b>DEBTGDP</b>	56.25	62.04	<b>MAS</b>	43.55	50.84
<b>NAM</b>	0.00%	100.00%	<b>TARIFF</b>	8.63	6.23	<b>UAI</b>	74.25	65.14
<b>EURO</b>	40.74%	59.26%	<b>TAXGDP</b>	20.17	22.28	<b>LTOWVS</b>	39.59	48.63
<b>LEG_CIV</b>	53.85%	46.15%	<b>SPENDGDP</b>	29.89	32.64	<b>IVR</b>	46.20	44.73
<b>LEG_COM</b>	35.00%	65.00%	<b>CMP</b>	54.38	65.48			
<b>LEG_MLT</b>	48.78%	51.22%	<b>IDF</b>	57.91	66.03			

*For binary variables in the left part of the table, numbers denote proportion out of the total. For example, 72.13% of countries with high income (INC\_HIGH) have a sandbox, while the remaining (27.87%) do not. For the remaining variables in the middle and right part of the table, the numbers represent average values.*

In Table 8 we summarise the results of correlation analysis between the variables underhand and the binary variable indicating if a country has a regulatory sandbox. Results are in line with what was observed previously, with economic development having a significant association. In the case of legal traditions, signs are in line with what we expect but the relationship is not statistically significant. Most dimensions of cultural dimensions, except for long term orientation, appear insignificant. However, we need to observe these results with caution as the correct specification is likely to be multivariate, so the relationship between the variables needs to be examined in a regression framework.

Finally, we estimate regression models in order to test in a multivariate framework the effect of the variables underhand. Table 9 presents the estimation results for several logit regression models where the binary variable of sandbox adoption is the dependent variable. The first 5 models focus on different groups of variables, whilst Model 6 is the “best” model that includes the significant variables across all groups. Results concur with those from the correlation analysis. The best model suggests that country competitiveness has a positive impact on the likelihood of sandbox adoption, whilst the effect of a civil law system has a negative impact. Specifically, for a one unit increase in the country competitiveness score, we can expect an 11.4% ( $e^{0.1083}$ ) increase in the odds of the country having a regulatory sandbox.

Countries with a civil law tradition have a 26% ( $e^{-1.3284}$ ) smaller chance of having a regulatory sandbox. Other variables do not enter with a significant sign in the regression. Given its nature, we can infer that competitiveness is a proxy that captures the effect of variables related to economic development with respect of regulatory sandbox adoption.

**Table 8.** Correlation analysis with SBX

<b>Variable</b>	<b>Phi</b>	<b>Variable</b>	<b>Point-biserial</b>	<b>Variable</b>	<b>Point-biserial</b>
<b>INC_HIGH</b>	0.309**	<b>GDPPC</b>	0.101**	<b>PATENTS</b>	0.311*
<b>INC_MID</b>	-0.093	<b>GROWTH5Y</b>	-0.140**	<b>RNDGDP</b>	0.214**
<b>INC_LOW</b>	-0.273**	<b>UENPL</b>	-0.132**	<b>PDI</b>	0.175
<b>OECD</b>	0.235**	<b>INFL</b>	-0.198**	<b>IDV</b>	-0.002
<b>EU</b>	0.167*	<b>DEBTGDP</b>	0.1759**	<b>MAS</b>	0.143
<b>NAM</b>	0.128	<b>TARIFF</b>	-0.231**	<b>UAI</b>	-0.033
<b>EURO</b>	0.116	<b>TAXGDP</b>	0.083**	<b>LTOWVS</b>	0.290*
<b>LEG_CIV</b>	-0.071	<b>SPENDGDP</b>	0.220**	<b>IVR</b>	-0.146
<b>LEG_COM</b>	0.103	<b>CMP</b>	0.369**		
<b>LEG_MLT</b>	0.017	<b>IDF</b>	0.198**		

*Correlation with dichotomous (continuous) variables is the phi (point-biserial) coefficient. One star (two stars) denotes two-tailed significance at the 5% (1%) level. Confidence intervals are estimated using bootstrap with 1,000 samples.*

**Table 9.** Logit Regression of Country Sandbox Adoption (SBX)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
INC_HIGH	0.7578*					
INC_MID	-0.1853					
INC_LOW	-1.6582**					
OECD	0.3479					
CMP		0.1184**				0.1083**
IDF		-0.0397				
LEG_CIV			-0.1541			-1.3284**
LEG_COM			0.6190			
PATENTS				0.2019*		
RNDGDP				4.6579		
PDI					0.0041	
IDV					0.0033	
MAS					0.0225	
UAI					-0.0200	
LTOWVS					0.0310*	
IVR					-0.0101	
Constant		-4.3383				-5.5119

*Coefficient covariance computed using the Huber-White method.*

**Table 10.** Poisson Count Regression of number of Country Sandboxes (SBXN)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
INC_HIGH	0.1774					
INC_MID	-0.4341**					
INC_LOW	-1.8325**					
OECD	0.7775*					
CMP		0.1095**				0.0500**
IDF		-0.0330				
LEG_CIV			-0.1372			-0.4774**
LEG_COM			1.0473			
PATENTS				0.2315**		0.1614**
RNDGDP				25.001*		
PDI					0.0084	
IDV					0.0206	
MAS					0.0063	
UAI					-0.0207**	
LTOWVS					0.0007	
IVR					0.0039	
Constant		-4.8488		-1.3016**		-3.5761**

*Coefficient covariance computed using the Huber-White method.*

Table 10 summarises the results from a Poisson count regression where the number of regulatory sandboxes is the dependent variables. Results are broadly in line with what we found previously, in terms of signs and significance. In terms of the best model, patents (this variable has been logarithmically transformed) also appear as a significant predictor along with the competitiveness score and civil law dummy variable. Exponents of coefficients can be used as before to estimate odds ratios and the effect of variables on the number of regulatory sandboxes developed by a country.

#### **4. How can we Support Regulatory Sandboxes in Developing Countries?**

At first glance, regulatory sandboxes appear to be thriving worldwide with an exponential increase in their adoption since they were first introduced just a few years ago. Our analysis shows that this increase is unbalanced as regulatory sandboxes are very rare in developing countries. This is worrying for at least two reasons. First, we know that innovation has a significant impact on reducing both inequality and poverty (Acemoglu 2002; Bhatti and Ventresca, 2012; Chataway et al., 2013; Pansera and Martinez, 2017; Fragkandreas 2022; Kaplinsky and Kraemer-Mbula, 2022). In the absence of regulatory sandboxes, innovation may suffer in developing countries. Second, the regulated sector is a substantial part of developing economies so the scope for impact of sandboxes is substantial. In developed countries it is estimated that the regulated sector represents a quarter of the GDP.<sup>3</sup> As the state sector is typically larger in developing countries, the regulated sector is likely to be smaller. Rapid privatisation in developing countries over recent decades means that the regulated sector is growing, so the role of regulated sandboxes is increasingly important. Especially, since it is known that the success of privatisation depends on effective regulation (see Parker and Kirkpatrick, 2005).

But how can we address the problem of regulatory sandboxes becoming a luxury for developing countries? Our empirical analysis shows that the drivers of national adoption are linked to national competitiveness and legal traditions. Both of these factors are notoriously difficult to affect in the short term. This means that “organic” international convergence in regulated sandboxes is likely to be very slow at best. Estache and Wren-Lewis (2009) highlight the limited success of regulatory reforms in developing countries. In line with Laffont (2005), they explain this on the basis that policymakers relied on traditional regulatory theory, which is unsuitable given the institutional limitations in developing countries. We argue that the unpopularity of regulatory sandboxes in developing countries may be rooted in the same problems. Grounded on Laffont’s theory, Estache and Wren-Lewis (2009) identify the key aspects of institutional failure that affect developing countries: limited regulatory capacity, limited commitment, limited accountability, and limited fiscal efficiency. In the remainder of this

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<sup>3</sup> Estimate for the UK provided by CMA Chairman, David Currie at the SCDI conference 'Agile Regulation: Shaping Economic Growth' in Edinburgh, September 2015.

section we adapt the discussion by Estache and Wren-Lewis (2009) about the problems caused by institutional failure along with possible solutions for regulatory sandboxes.

*Limited regulatory capacity* has to do with the shortages that regulators face in terms of financial resources and specialised staff. These limit the ability of regulators to effectively monitor firms. Monitoring costs are further stretched by the lack of adequate accounting and auditing systems in developing countries. Regulatory sandboxes require substantial resources, both financial and human. Recent survey evidence across 28 countries suggests that the creation of a sandbox may require funding in excess of \$1 million and up to 25 full time employees.<sup>4</sup> Evidence from an Insurtech Regulatory Sandbox in the US, indicates annual running costs in excess of \$200,000.<sup>5</sup> It is possible that innovation in developing countries is not regarded as such a high priority compared to, for example, reducing market power and setting access prices. This could mean that the significant resources required cannot be justified. The nature of sandboxes has to do with innovation, entrepreneurship, regulatory learning, all of which require staff that are unlikely to be employed by regulators. The selection, monitoring, and support of firms in the sandbox will be even more difficult given the limitations in accounting and auditing systems. Estache and Wren-Lewis (2009) propose pooling resources in multisector agencies as a way to overcome problems with staffing along with support from international bodies. Both these solutions are applicable to supporting regulatory sandboxes in developing countries. The sharing of resources across agencies and between countries could involve both financial and human resources. In order to overcome the barriers related to accounting and auditing, we propose that firms that are adopted in regulated firms could be asked to use international accounting standard and to be audited by international agencies.

*Limited accountability* refers to the fact that in developing countries institutions, such as regulators, are less accountable compared to those in developed countries. These problems mean that collusion and corruption are more likely to emerge. Sanctions may be less, or it may be easier to keep bribes hidden. In the context of regulatory sandboxes, regulators may extract private benefits from firms in order to allow them entry to the sandbox or to provide preferential treatment. They could also damage innovating firms in order to protect the monopolist or oligopolistic interests of dominant firms. One solution offered by Estache and Wren-Lewis (2009) is to have several regulators collecting similar information, which may limit opportunities for collusion and increase the revelation of information. In the case of regulated sandboxes, this could be possible in the case of multi-utility innovations, for example, but it is unlikely to be a practical solution. Another solution suggested to improve accountability is to increase consumer participation. This is likely to make sandbox decisions more pro-consumer, but it may be ineffective in preventing collusion. Another solution we propose is to employ corporate governance best practices in

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<sup>4</sup> CGAP-World Bank: Regulatory Sandbox Global Survey (2019).

<sup>5</sup> *An Act establishing the Fintech regulatory sandbox program and the Insurtech regulatory sandbox initiative*, sSB-482, Office of Fiscal Analysis, Hartford, CT.

overseeing the operations of regulatory sandboxes. For example, a board of directors with several independent external members could ensure that strategic objectives are met, while collusion is avoided.

*Limited commitment* means that in many developing countries it is not possible to rely with confidence on contracts. This problem is particularly important for the long-term contractual commitments involving regulators and utilities. In the case of regulated sandboxes, it has to do more with the rule of law and the trust by local and international investors. One way to overcome this problem would be to adopt within the regulatory sandbox a legal system in a trusted environment. For example, the Abu Dhabi Global Market (ADGM) is an international financial centre and free enterprise zone that is based on the on the Al Maryah Island in Abu Dhabi. Founded in 2013, it has three authorities: a financial services regulator, a registration bureau and the ADGM courts. The ADGM aspires to become an attractive jurisdiction of fintech and cryptocurrency firms. In order to overcome problems related to legal structure, ADGM has adopted English Law in 2015.<sup>6</sup> Specifically, ADGM's legal system is based on English common law, a number of English statutes and ADGM enactments which have been drafted from English statutory precedents and, partly, from those of other commercially respected common law jurisdictions. ADGM is not subject to the UAE federal civil and commercial laws, or any other laws of the Emirate of Abu Dhabi. ADGM justifies the decision to adopt English law on the basis of familiarity, certainty, alignment with ongoing common law developments, evolving case law volumes and automatic adaptation. We propose that regulatory sandboxes in developing countries consider adopting English law for similar reasons. The empirical results in our paper confirm that a civil law system is a limiting factor to the development of regulatory sandboxes. So adopting a common law system would overcome this barrier.

*Limited fiscal efficiency* relates to the fact that problematic collection of public revenue restricts the ability to subsidise consumers and the expansion of access to networks. This means that in developing countries governments subsidise firms less and taxes them more. This results in higher prices and smaller networks. In the case of regulated sandboxes, this could mean supporting firms that operate in or focus on only the wealthier urban centres rather than the poorer rural areas. Following Estache and Wren-Lewis (2009), a solution could be to use cross-subsidies from the rich to the poor region in terms of firm support. Also, network expansion could be set as an additional objective to firms applying to join the regulatory sandbox.

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<sup>6</sup> For a detailed description see *English Law in ADGM – Guidance Notes*, Abu Dhabi Global Market.



## 5. Conclusions

This paper compiles and analyses an international database of regulatory sandboxes. On the one hand, we find that regulatory sandboxes are far more likely to be created in countries that are economically developed. Out of the relevant variables that we examine, the World Bank Competitiveness score is the most significant predictor of regulatory sandbox adoption. On the other hand, we find that countries employing a civil law system are less likely to have a regulatory sandbox. We argue that these findings have worrying implications for the growth and poverty in developing countries. On the basis of Laffont's theory of regulation in developing countries, we propose solutions to overcome limitations in relation to developing countries' limited regulatory capacity, limited commitment, limited accountability, and limited fiscal efficiency.

Further work would be valuable in a number of respects. First of all, more evaluation of the costs and benefits of specific structures of sandbox would be valuable to determine what features of sandboxes add the most consumer, regulatee and regulator value. Second, more detailed analyses of the needs and benefits of sandboxes in developing country contexts would be valuable. Finally, a greater understanding of the benefits of sandboxes compared to other mechanisms for creating regulatory flexibility remains worthwhile. These topics remain beyond the scope of this paper.

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