Volkswirtschaftliches Institut für Mittelstand und Handwerk an der Universität Göttingen

ifh Working Paper No. 28/2021

Institutional conditions for the up-take of governance experiments – A comparative case study

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Abstract:

Experiments are an important governance instrument to support niche development, promote niche-regime interaction, challenge existing regimes and manage transition pathways for sustainable development. However, policy and regulatory learning of experiments are under-explored in the transition experimentation literature. Thus, this paper examines the following research question: How is the up-take of regulatory experiments for sustainability transitions influenced by their design elements and what role do institutional dynamics play in their up-take? The paper uses comparative qualitative content analysis to examine 27 international cases of regulatory experiments. We analyze the up-take of experiment results towards the three dimensions of scalability, transferability and unintended consequences. The analysis demonstrates that the timeframe, timing, political support, regulatory context, geographical particularities, selection processes, evaluation procedures, test of different design options, heterogeneity of participants and communication processes are important influencing factors for the up-take of experiment results.

JEL: L51, O31, Q56, Q58

Keywords: Governance Experiments, Up-take, Scalability, Transferability, Unintended Consequences, Institutional Conditions

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1. Introduction

Innovation plays a major role for sustainability transitions of socio-technical systems. Numerous studies have analyzed radical innovations in socio-technical systems and how they develop in protected areas or "niches", including tailor-made experiments (e.g. Geels and Raven 2006; Sengers et al. 2019; Geels 2004). As the acceleration of sustainability transitions is a necessity to overcome "wicked" problems (Köhler et al. 2019; Markard et al. 2020), the question of how niche innovations can be more broadly applied and upscaled to a system level has become more relevant. The notion that "time is running out" (Levin et al. 2012) reformulates the relevance of developing instruments supporting niche developments and their system-wide application. Consequently, the search for governance instruments that can complement existing policy mixes (Kern et al. 2019; Kivimaa and Kern 2016) holds particular concern to foster systemic approaches and accelerate transformative processes.

Sustainability transition scholars and policy-makers have broadly discussed a variety of experiments to support niche development, promote niche-regime interaction, challenge existing regimes and manage transition pathways (Hildén et al. 2017; Jolly et al. 2012; Matschoss and Heiskanen 2017; Köhler et al. 2019; Loorbach 2010). Since the 1990s, e.g. in the context of strategic niche management, experimenting has become a guiding principle as a governance instrument (Verheul and Vergragt 1995), with the expectation that experiments will play a role as agents of change (Brown and Vergragt 2008). A large strand of literature has been published on experiments in sustainability transitions targeting socio-technical systems (Bernstein and Hoffmann 2018; Bos and Brown 2012; Kivimaa et al. 2017; Luederitz et al. 2017; Manders et al. 2018; Raven et al. 2019).

Governance experiments play an extraordinary role in niche initiation and regime-niche interaction, focusing on the coordination by different actors (Bos and Brown 2012). The literature on governance experiments[1] has emphasized the positive role during sustainability transition, through e.g. addressing multiple goals and societal participation and the interaction of different actors. Case studies particularly dominate the discussion on how experiments can be helpful for the policy mix (Kanger et al. 2020). Surprisingly, policy and regulatory learning as a key to understanding and shaping transitions has been under-explored in the transition experimentation literature (Boon and Bakker 2016). Learning as an integrated part of experimentation is particularly challenging, since experiments only exist for a limited time and they are often substantially influenced by real-world events, e.g. policy reversals leading to the abolishment of experiments (Pregernig et al. 2018; van der Grijp et al. 2019). Multiple challenges influence the outcome of experiments and make it difficult to learn since often various actors influence experiments, project-based experiments are often isolated events and systematic learning after the implementation of experiments is often not established. The relevance of policy learning during experiments has also been stated for topics like climate adaption strategies (McFadgen and Huitema 2017).

The recently-expressed need to focus on the acceleration of sustainability transitions changes the perspective on policy instruments. Markard et al. (2020) specifically address challenges of embedding innovations in broader socio-technical systems, interaction effects between different systems, the risk of actor groups that oppose transitions, changing behavior of consumers and coordinating processes in the policy sphere. This shift of perspective from the emergence of innovations in niches to more systemic changes also has consequences for experimentation, and a revision of the existing experimental approaches is necessary. In particular, the up-take of experimental results needs to be explored in further detail. The term 'up-take' as defined by Luederitz et al. (2017) includes the transferability, scalability and unintended consequences of experiments to support the generalization of experimental design and results.

Furthermore, the emphasis on accelerating sustainability transitions creates a need for knowledge on "how to govern later phases of transition" (Köhler et al. 2019, p. 9), and requires an understanding of the learning conditions that are prerequisites for experiments to contribute to transformative processes. To date, little is known about the successful learning in experiments for developing effective governance mechanisms and consequences for the experimental design to create adequate learning conditions, since only few studies exists (Ryghaug et al. 2019; Bossink 2020). We address this research gap, thereby following the demand of Sengers et al. (2019) "to get under the skin of experimental projects in more detail and spell out the actual practices in experimentation". Specifically, we focus on regulatory experiments as a sub-group of governance experiments that involves the participation of governmental actors (Bauknecht et al. 2020), thus picking up on a fragmented literature strand focused dominantly on small sets of experiments on immediate outputs of policy measures. By contrast, our paper focuses on learning in regulatory experiments regarding the implementation of effective regulatory frameworks as an instrument for the governance of innovation, and regarding support for the emergence of radical innovation in socio-technical systems. Taking this into account, we focus on the design of regulatory experiments regarding the up-take of experimental results and address the research question: How is the up-take of regulatory experiments for sustainability transitions influenced by their design elements and what role do institutional dynamics play in their

[1] In political science, the role of experiments has also been extensively discussed without an explicit focus on sustainability transitions (e.g. Bauknecht et al. 2020; Huitema et al. 2018; Ludwig et al. 2011; Morton and Williams 2009).

up-take? By answering this question, we aim to add to the conceptualization of experimentation in sustainability transitions.

Based on an extensive comparative case study using qualitative content analysis with 27 international cases of regulatory experiments, we aim to contribute to existing literature in two ways. First, the role of institutional conditions in the up-take of governance experiments has not yet been explicitly discussed. Furthermore, the interaction of actors when mainstreaming experiments and fostering regime changes requires can benefit from new insights. This explorative study helps to comprehensively understand the underlying conditions in the experiment design and the context of the experiment, which are prerequisites for the up-take of experiments. Second, concepts will be needed for evaluative schemes that produce robust insights about the role of experiments. Numerous experiments in the context of sustainability transition have contributed to the sustainability transition literature. As a main component of innovation policy mixes that complement traditional policy approaches, comprehensive insights into the up-take are missing. Our paper contributes to this need in combining the up-take part of the scheme by Luederitz et al. (2019) with a qualitative method for institutional analysis and provides insights from the practical implementation of governance experiments.

The remainder of this paper is structured as follows. In the second section, we review literature with a focus on experiments in sustainability transitions, especially governance experiments, and their up-take. In the third section, we describe our method and elaborate on our sample of cases. In the fourth section, insights from the comparative analysis with a focus on upscaling, transfer of results and unintended consequences are presented. Section five discusses the results reflecting upon our contribution to the existing literature and concludes with policy and practical recommendations.

2. Literature background

Experiments have been a popular means for sustainability transition scholars. In the context of sustainability transitions, the notion of experimentation has been widely used to characterize frameworks for innovative practices and developing solutions concerning wicked problems (Evans and Karvonen 2011). The fundamental and comprehensive synthesis by Sengers et al. (2019) defined an experiment in the context of sustainability transition as “an inclusive, practice-based and challenge-led initiative designed to promote system innovation through social learning under conditions of uncertainty and ambiguity”. The implementation of experiments has brought about a broad range of different settings, multiple aims and outcomes that are difficult to measure. A fundamental argument supporting experimentation integrates the perspective that adaptive and reflexive experiments help to integrate niche knowledge in informed decision-making (Geels and Schot 2007).

2.1. Governance experiments in sustainability transitions

Although the term ‘governance experiments’ has been used less in comparison with other terms by sustainability transitions scholars (Sengers et al. 2020), they play an important supporting role as they can help – particularly in persistent regimes – to foster innovation processes and stimulate social learning (Bos et al. 2013).

Governance experimentation is broadly defined as a practice with the goal of changing the configural setting of decision-making with collaborative, participative planning leading to social learning (Bos and Brown 2012; Hoffmann 2011). Governance experimentation is in use to contest traditional administrative procedures. It deviates from regular governance frameworks due to the explicit uncertainty of the outcomes. Multiple roles of political actors in experiments complicate learning processes (Schreuer et al. 2010). The context in which governance experimentation emerge is central for understanding mechanisms that influence outcome and impact (Schreuer et al. 2010; Bos and Brown 2012). Particularly the interplay between actors in innovation systems creates the contextual conditions accounting for the success of experimentation (Bos and Brown 2012).

Various studies have explored success factors for governance experimentation. It has been established that the contextual conditions in which experiments take place are crucial for the initiation and implementation of successful experiments. These studies suggest that socio-demographic factors (Forrest and Wiek 2015a), cooperation in local communities (van den Heiligenberg et al. 2017; Hoogma et al. 2005; Kemp et al. 1998; Forrest and Wiek 2015b) and the interaction with local niche and regime actors (van den Heiligenberg et al. 2017; Forrest and Wiek 2015b) are closely linked to successful experimentation. Furthermore, the role of the embeddedness of experiments in socio-technical systems, their different manifestation depending on the context (Sengers et al. 2019) and the collaboration with administrative and governmental actors (van den Heiligenberg et al. 2017) can be beneficial for the implementation of experiments.

Broadening the scope to experiments that promote sustainability transitions in general with relevance for governance experiments, scholars have identified additional decisive factors. Specifically the formulation of an desired change process in socio-technical systems (van den Heiligenberg et al. 2017; Kemp et al. 1998; Hoogma et al. 2005; Hansen and Coenen 2015; Ornetzeder and Rohracher 2013), mobilizing and involving users in

experimental practices (van den Heiligenberg et al. 2017; Forrest and Wiek 2015b) and the initiation and dissemination of collaborative learning processes (van den Heiligenberg et al. 2017; Kemp et al. 1998; Ornetzeder and Rohracher 2013) as well as the availability of resources and the quality of project management (Forrest and Wiek 2015a) have been discussed in the literature.

A large share of the studies on governance experimentation emphasize the importance of bringing experimentation into mainstream governance. However, a clear path to generating knowledge on governance experiments and systematically using insights to refine and up-take governance experimentation is still missing.

2.2. Up-take of experiments

To date, a small but growing strand of literature on experiments has analyzed the role of up-take for experiments. The relevance of strategies to employ upscaling and apply knowledge to broader scopes and transfer have been emphasized (Evans and Karvonen 2011). Our framework will be based upon the evaluative scheme of Luederitz et al. (2017). It analyzes the up-take of experimental results towards three different dimensions, namely 'transferability', 'scalability' and 'accounting for unintended consequences associated with the up-take'.

First, 'transferability' refers to the replication of experiments and the implementation of experimental settings in other policy objects, regions and innovation systems (Grin et al. 2010; Luederitz et al. 2017; Turnheim et al. 2018). In particular, the fact that governance experiments are often placed in real-world settings with a strong contextual influence complicates the attribution of success factors for transferring experimental results for researchers (Bos and Brown 2012). When experiments strongly rely on informal norms, rules and practices transferability becomes even more difficult (Smith 2007).

Second, 'scalability' refers to the discussion in the literature on strategic niche management and transition management regarding the upscaling of radical innovation (Luederitz et al. 2017; Grin et al. 2010; Naber et al. 2017; Jolly et al. 2012; Westley et al. 2014; Johansen and van den Bosch 2017). The process of scaling up and establishing innovation in the regime is still not fully understood and described as fuzzy (Augenstein et al. 2020). Jolly et al. (2012) derived from the observation of five Indian photovoltaic initiatives that institutional conditions play a major role and need to be taken into account when scaling up projects. Furthermore, Ryghaug et al. (2019) discuss the boundaries and impediments caused by traditional networks and industrial structures that prevent an effective upscaling of results from niche experiments. The interaction with regime actors is key for scaling up innovation in socio-technical systems, which requires the institutional conditions with formal and informal rules to be completely captured (Johansen and van den Bosch 2017). The process to grow out of niches can be supported by replicating successful experiments (Naber et al. 2017). This potentially results in the accumulation and transformation of relevant knowledge about scalability.Additionally, proximity can have ambivalent influences on the upscaling (Coenen et al. 2010). While proximity supports trust building and the formulation of common expectations, scarce resources in regions might impede the upscaling of experiments.

Third, unintended consequences caused by experiments may positively or negatively influence the results of experimentation and consequently increase the uncertainty (Luederitz et al. 2017). Unintended consequences can be explained by differences between the planning and implementation of experimental practices (Musch and Streit 2020). Knowledge production plays a major role. It is necessary to understand how unintended outputs and outcomes can be avoided and managed regarding risks of larger negative effects that emerge during the up-take (Evans and Karvonen 2011).

In comparison with other experimental fields like in laboratory experiments – as can be found in psychology or economics – governance experiments have to deal with conditions that are more difficult to control. Transition experiments have dealt with problems concerning influences and uncertainties due to multiple actor involvement and other real-world influences. Successful implementation often involves scientific and non-scientific actors (Wiek et al. 2014). Moreover, disparities between ex-ante planning and output ex-post have appeared due to pressure to effectively produce desired outputs and influence the impact of experiments (Musch and Streit 2020). When it comes to the up-take of experiments, the complexity caused by multidimensional experimental designs and the involvement of multiple actors has been acknowledged but remains under-explored. In order to understand the role of experiments as change agents (Brown and Vergragt 2008), more insights are needed to understand the influence of institutional conditions that foster regulatory learning for the acceleration of sustainability transitions.

2.3. The role of institutions during up-take

Thus far, several studies have integrated institutional theory in research on (the transition of) socio-technical systems (e.g. Fuenfschilling and Truffer 2014, 2016; Geels 2004). Geels (2004) demonstrated the role of informal and formal social rules that are negotiated between different groups of actors. Taking into consideration the dynamics and evolution of knowledge, processes for systemic learning might play a substantial role. Contrary to the idea of homogenous regimes in socio-technical systems, tensions and structural differences between groups of

actors can be key to understanding the behavior of actors and their perception of change processes (Fuenfschilling and Truffer 2014). Institutions require a particular research focus since institutional conditions evolve in co-creation and largely depend on the actors in socio-technical systems. The non-linearity of relations and interactions justifies the specific focus on actors and changing processes.

Studies on collective institutional entrepreneurship use the change of institutional settings for explaining growth and change processes in sustainability transitions (Jolly and Raven 2015; Battilana et al. 2009). Furthermore, concepts have been developed on how to implement institutional change processes in practice, focusing on participatory processes and supporting interaction in experimental settings (Weisenfeld and Hauerwaas 2018). However, as highlighted by Musch and Streit (2020), the implementation of such processes in experiments often differs from previous planning and interactive and participatory elements often are neglected due to the limitations of experimental designs.

We employ an actor- and institution-centric perspective to explore influencing factors for the up-take of regulatory experiments. Inspired by Geels (2004), we focus on the role of actors' interactions, not only inside niches but also between niche and regime actors, namely businesses, policy actors, administrators, users and other involved actors (Geels 2019). The set of formal and informal rules are decisive for the up-take since boundaries exist for our analysis, like the multiplicity of scope of experiments, actors' embeddedness in socio-technical systems and the perceived messiness of overlapping policy instruments. The central focus for governance experimentation is the coordination and interaction of actors. We therefore focus on the regulatory learning and the setup concerning how experiments support learning conditions The initial existing approaches with small-scale comparative studies highlight the role of different institutional dynamics influencing the success of experimentation (Raven et al. 2019; van den Heiligenberg et al. 2018). Nevertheless, comparative empirical evidence focusing on the up-take is still missing in the literature on experiments in sustainability transitions, specifically in regulatory experiments as a sub-group of governance experiments.

3. Method and data

We conducted a qualitative multiple-case study to develop theoretical understandings (Eisenhardt 1989; Eisenhardt and Graebner 2007; Starr 2014) about the institutional conditions of regulatory experiments in sustainability transitions. Our analysis focuses on the transferability, scalability and unintended consequences of experiments in sustainability transitions. We examine international cases of governance experiments that are related to the UN SDGs.

3.1. Case selection and description

The SDGs emphasize many areas of sustainable development, including not only global warming and environmental protection but also areas such as poverty, health, education, decent work and inequalities. They are applicable to many different contexts and are not limited to specific regions. As a result, experiments in sustainability transitions have been used in diverse contexts and regions, which is also reflected by the diverse concepts of experimentation in the literature on sustainability transitions (Sengers et al. 2019; Hildén et al. 2017; Jolly et al. 2012; Matschoss and Heiskanen 2017; Köhler et al. 2019; Loorbach 2010). Starting from this rather broad view on experimentation, we applied a theoretical sampling approach (Glaser and Strauss 1967) based on desktop research to build our sample. In line with the variety of experiments in sustainability transitions, we included experiments from many different countries, which can be related to different SDGs. Table 1 lists all cases in our sample. Our cases can be related to the goals of SDG 1 – No poverty, SDG 3: Good health and well-being, SDG 4 – Quality education, SDG 7 – Affordable and clean energy, SDG 8 – Decent work and economic growth, SDG 9 – Industry, innovation and infrastructure, SDG 10 – Reduced inequalities, SDG 11 – Sustainable cities and communities, SDG 12 – Responsible consumption and production and SDG 13 – Climate action. The sample includes cases from different countries in Europe, North America and Asia. Examining varying cases from different fields and countries promotes the robustness of theoretical insights (Yin 2009). The cases can be broadly divided into experiments that provide exceptions from the existing regulatory framework (IDs 1-12) and those testing new regulatory options (IDs 13-27).

Table 1. Overview of selected cases

ID	Experiment	SDGs
1	Austria: Regulatory sandbox in the electricity sector (Energy.Free.Room)	7
2	Australia: Regulatory sandbox in the electricity sector	7
3	Singapore: Regulatory sandbox in the electricity & gas sector	7
4	Germany: Smart meter standardization	7, 9
5	Netherlands: Regulatory sandbox in the electricity sector	7
6	United Kingdom: Regulatory sandbox in the electricity & gas sector UK	7
7	Norway: Exemption clauses in the energy regulation	7, 8
8	Germany: Retroactive reimbursement in the electricity sector (SINTEG Ordinance)	7
9	Denmark: Regulatory sandbox in the financial sector	8, 9
10	United Kingdom: Regulatory sandbox in the financial sector	8, 9
11	European Union: Authorization scheme for the use of chemicals	12
12	Italy: Derogations and pilot projects in the electricity sector	7
13	China: Trading scheme for CO_2 emissions	7, 13
14	Germany: Tender procedure for promoting renewable energy systems	7, 8
15	Pennsylvania, United States: Promoting grocery stores in under-served neighborhoods (Fresh Food Financing Initiative)	3
16	India: Immunization access and incentives	3
17	Norway: Promoting electro-mobility	13
18	Berlin, Germany: Shared space pilot projects	3, 11, 13
19	Copenhagen, Denmark: Promoting biking	3, 13
20	Germany: Occupational licensing in the crafts sector	8
21	Indonesia: Labor market consequences of school construction	1, 3, 4, 8
22	Finland: Basic income experiment	1, 3, 8, 10
23	Ontario, Canada: Basic income experiment	1, 3, 8, 10
24	Seattle, United States: Minimum wage policy	1, 8
25	Ontario, Canada: Minimum wage policy	1, 8
26	Berlin, Germany: Solidary basic income experiment	1, 3, 8, 10
27	Barcelona, Spain: Decentralized citizen-owned data ecosystem (DECODE)	7, 8, 9, 10, 11, 12

3.2. Data collection and analysis

We first collected publicly-available documents (scientific publications, internet sources, newspaper articles, etc.) on all cases. The research team analyzed the text material using qualitative content analysis (Mayring 2010). We used both the interdisciplinary institutional analysis of Bizer and Führ (2015) and a comprehensive framework for analyzing regulatory experiments developed by Bauknecht et al. (2020) as our category system to structure the content.[2] The interdisciplinary institutional analysis focuses on the institutional conditions of the experiments, including the goal of the experiment, relevant actors, actor behavior, institutional factors influencing actor behavior and possible design options for the experiment. The framework of Bauknecht et al. (2020) supplements this analysis by examining experiments along the topics of (1) testing explicit hypotheses, (2) interaction between actors, (3) causality and (4) monitoring and learning processes.[3]

After this first analysis, we collected additional data on ten of the cases (IDs: 5, 6, 11, 12, 13, 14, 18, 20, 22, 23), where we gathered additional information on learning conditions in experiments using a guideline-based interview approach (Gläser and Laudel 2010). Based on the results of the qualitative content analysis of the text documents, we developed a semi-structured questionnaire covering the topics of experimental design, participating actors, learning processes and case-specific questions for the interviews.[4] Overall, we conducted 24 expert interviews lasting 45-90 minutes from April 2020 to September 2020. Since interviewees reported based on their personal experience, we conducted 2-3 interviews per case with different actors to ensure the inclusion of different perspectives (experimenters, participants, scientific experts, stakeholder representatives) and cross-check the collected data. The interviews were recorded and transcribed. The research team used the results of the first analysis of the text documents to refine the category system (Bischoff et al. 2020), which was then applied to the interview transcripts using the MAXQDA software. The authors discussed and adapted the coding of the interviews to ensure

[2] See Appendix.

[3] The results of this first analysis step are summarized in Bischoff et al. (2020).

[4] See Appendix.

a high level of validity and reliability of the results. We summarize and discuss the results of both the analysis of text documents and interview transcripts in the following chapter.[5]

4. Results

Building on the literature review, the structure of this chapter follows the analytical framework developed by Luederitz et al. (2017) to evaluate the up-take of sustainability transition experiments. It therefore evaluates the (1) transferability, (2) scalability as well as (3) accounting for unintended consequences associated with the up-take. The first two features describe the possibility for the up-take of experiments. Transferability refers to the potential for the experimental results to be replicated and applied to different contexts, while scalability refers to whether the experiment can be upscaled to a higher system level, e.g. for a broader regulatory scope of application. The third feature – accounting for unintended consequences – points to the notion that the up-take may have (positive and negative) side effects that were not expected (Luederitz et al. 2017).[6]

4.1. Scalability

Upscaling the experimental results to a larger system level can be a key goal of regulatory experiments. Taking scalability into account is important when designing regulatory experiments. Scalability "refers to generalizable knowledge that facilitates up-take" (Luederitz et al. 2017) and can be divided into scaling out experimental results in the initial system or scaling them up to a larger system level (Luederitz et al. 2017; Bos and Brown 2012; Westley et al. 2014; Smith et al. 2014). Learning processes are a key requirement for scalability. However, they are often experienced as quite difficult by the actors involved and in some cases they are not recognizable, which indicates that the scalability of regulatory experiments is generally limited. Learning processes depend on the knowledge of the participants and the implementers of an experiment. Due to their sequential character, learning processes take time and can extend the timeframes of regulatory experiments, especially when feedback towards different actors occurs. Feedback in the form of communication between the regulator, other political actors and participants facilitates learning processes and enlarges their knowledge. Involving all relevant actors – for example, in a stakeholder committee – can enhance learning and knowledge transfer processes, as happened in the shared space pilot projects in Berlin [18]. These forms of communication can increase the scalability of experimental results as they entail collaboration with more actors (Luederitz et al. 2017; Laakso and Lettenmeier 2016).

There are several factors in regulatory experiments that affect the learning process and the scalability of experimental results. Our analysis suggests that the timeframe, timing and political environment of an experiment influence the scalability and potential upscaling of its results.

Timeframe and timing

The timeframe of an experiment can influence learning processes and the generalizable knowledge from experimental results that facilitate up-take. Participants take into account the timeframe of an experiment and might adapt their behavior accordingly. Consequently, experimental results could be biased, which makes the development of generalizable knowledge more difficult. Interviewees suggest that the behavior in experiments indeed differs compared with behavior under reforms that are not limited in time. Moreover, generalizable knowledge about the long-term outcomes of an experiment are difficult to obtain as timeframes are rather short. As a result, insufficient timeframes can reduce scalability.

However, excessive timeframes can also hamper the scalability of results, as experiments are not isolated events and they can be influenced by broader societal changes. Limiting experiments in time can minimize the influence of these factors and facilitate causal interpretation. The timing of political events can also be an important influencing factor for policy learning. These events can occur either before the start of an experiment or while an experiment is running. In the former case, political events like elections can induce time pressure, which leads to mistakes in the planning of the experiment and adaptions in the timeframe. Similar events can occur when an experiment is already running and can even cause the cancelation of an experiment. For example, the basic income experiment in Ontario [23] was canceled after a change in government. One reason was cost considerations of the new government. In such cases, it is difficult to obtain generalizable knowledge that facilitates the up-take of results.

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[5] In the following part, we do not evaluate single cases but rather formulate findings on a more general basis. We use illustrative examples where appropriate and where findings rely on individual cases. Sometimes, results differ or are more important depending on the experiment type (exceptions from the existing regulatory framework and experiments testing new regulatory options). If this is the case, we mention it in the text.

[6] In the following chapters, we analyze the influencing factors of the three features. Some of the influencing factors have an impact on more than one feature. To avoid repetitions, we describe most influencing factors only for the feature where they seem to be most important for up-take. However, we are aware that some factors can also be important for the other features.

Political support

As policy-makers often play an important role in governance experiments, their support influences successful learning processes. Especially policy-makers' willingness to learn might have a positive influence on the up-take of experimental results. However, up-take can be limited because legislators tend to view new forms of regulation such as experimentation more critically than traditional legislation and the over-emphasis of uncertainty and risks in experiments can reduce their political support. By contrast, the political priority of the experiment's topics supports policy learning for transformative processes.

Other influencing factors

Our analysis shows that further factors exist that influence the scalability and actual upscaling of experimental results. First, knowledge strategies and management are important for the integration of experimental results in the existing regulatory framework and for upscaling governance experiments to permanent regulations. Second, experiences from previous international experiments can be used to adapt the design of new experiments to increase the up-take of results. Third, dialogue events with stakeholders to actively promote experimental results increases scalability through collaborations with different actors [13].

4.2. Transferability

The transferability of experiments' design and experimental results to other policy objects, regions and innovation systems allows conducting regulatory experiments for a broad scope of subjects, illustrated – inter alia – by the broad range of SDGs. The transfer allows learnings to be not only broadened but also deepened, e.g. through sequential learning processes in different experiments or by repetition with a larger sample size. In addition, the learning effects experienced in regulatory experiments – especially in the experimental and surrounding regulatory framework – can help to accelerate the set-up of future experiments.

There are several aspects of regulatory experiments that determine whether the results can be transferred to different contexts. One main baseline for regulatory experimentation is that institutional, economic and socio-cultural contexts influence individual behavior. Experiments can help to determine how a governance instrument in a specific context attains its behavioral targets. At the same time, it is difficult to transfer results to different contexts. In reference to chapter 2.2, transferability increases if the contextual influence – especially of informal norms, rules and practices – on the results is reduced. In other words, transferability is mostly limited by the aspects of experiments that determine a context that is specific to the experiment, namely the regulatory context, geographical particularities of the experiment location and the timeframe. In addition, the participants' selection influences transferability by determining the ability to establish causalities in the experimental context. Furthermore, an independent evaluation increases the robustness of results, which contributes to transferability.

Regulatory context

Regulation that is not included in the experimental framework can still set rules affecting the behavior of actors who are not formally recognized in the experimental context, which reduces the transferability of the results. For example, the tax regulation influenced regulatory experiments by setting economic incentives, e.g. basic income experiments [22, 23] and a regulatory sandbox in the electricity sector [5]. The influence of the regulatory context in the experimental environment differs depending on the experimental subject. Results from the experimentation of basic income schemes [22, 23, 26] are therefore likely to be more transferable to other settings than those from regulatory sandboxes in the highly-regulated energy sector [1-8].

Geographical particularities

Geographical particularities of the experiment location influence behavioral patterns, thereby creating informal practices, which in turn reduce the transferability of a regulatory experiment. For example, the high population density and flat geography of Copenhagen favor cycling, while the cold winters have the opposite effect [19]. These factors influence behavior and thus make it difficult to establish causality regarding the behavioral effects of governance instruments. At the same time, regulatory experimentation requires a delimited geographical framework to draw causal conclusions in comparison with external circumstances.

Timeframe

The time limitations of regulatory experiments also have an indirect impact on their transferability, as behavior differs in experimental settings during fixed time periods. In experiments that provide exemptions from the regulatory context, the limited timeframe can create informal rules; for example, if regulatory sandboxes cannot ensure continuation of their exemptions after the experiment and participants are therefore reluctant to make large investments in the tested technology, product or service. Moreover, very narrow time limits make experimental results preliminary if long-term results cannot be evaluated. However, if experimentation phases are very long,

broader changes of the institutional conditions become more likely, from which regulatory experiments – as real-world experiments – cannot completely isolate.

Selection processes for participants

Determining causal effects of the experimental framework on the behavior of actors facilitates the interpretation and transfer of results. When comparing similar regulatory experiments, those with control groups and randomization measures were more able to establish causalities [22, 23]. For example, participants in the basic income experiment in Finland were selected randomly, which allowed measuring causal effects. In the basic income experiment in Ontario, participants had to apply for the project, which could lead to biases due to self-selection into the treatment group. Thus, selection processes for participants can influence the transferability of the experiment.

Randomization measures can make the results more independent from the institutional conditions of specific participants by providing a broad cross-section of the target population. At the same time, experimenters have to take into account the fact that a randomization bias has been established for randomized control studies, e.g. by Levitt and List (2009), where the sample population differs from the true population, as persuading individuals to participate is difficult [23] and those who choose to take part possess specific characteristics. Mandatory participation of the randomly-identified target group members is one option to address the randomization bias [22].

Evaluation

An evaluation of regulatory experiments – especially if conducted by independent actors such as research facilities – supports the verification and validation of results and thus represents a key factor for transferability. Such strict organizational separation between evaluation and experimentation helps to avoid confirmation biases of experimenters, thereby increasing the robustness of results. In addition, the quality of the evaluation can be decisive if follow-up experiments seem feasible. This also includes the systematic and transparent reporting of results. While evaluation processes are very common in regulatory experimentation, the responsibility for evaluation is quite diverse. The government agency carrying out the experiment or the ministry initiating it often conduct the evaluation themselves, while independent evaluation by researchers or research facilities – either planned or at their own initiative – is seldom.

4.3. Accounting for unintended consequences associated with up-take

Unintended consequences reflect major challenges in the analyzed cases for the transferability and upscaling of experimentation. Anticipation, screening and monitoring of unintended consequences are particularly relevant to improve the conditions for learning and successfully establish regulatory experiments. In particular, interactions of researchers with administrative and political actors, participants and external stakeholders are central to screen effects and monitor their influence on the up-take after the experiment. Our analysis demonstrates that regulatory experiments include optimizing communication with stakeholders, involve heterogeneous participants and testing several design options to deal with unintended consequences. In cases like the abrupt stop of the Ontario basic income experiment, stakeholders indicate neglected impacts on experimentation beyond direct effects on participants. Outcomes and impacts of the experiment negatively affected political actors' perception of the role of experiments as policy tools and specifically the basic income as an instrument contributing to sustainable transitions.

Design options

The introduction and review of various design options increases the knowledge basis and reduces the potentially undetected consequences of regulatory experiments. A variability of design options can serve as a means to adjust experimental settings and monitor a broad range of outcomes. Nevertheless, in the reported cases, the extensive analysis of design options remains an exception since most cases only test one design option. Efficiency-oriented goals and cost-cutting due to external demands explain the limitation of design options. Particularly for the production of scientific knowledge, missing design options undermine comprehensive comparison and affect the learning for changing regime regulations. The lack of various design options can hinder regulatory and policy learning, specifically when translating experimental settings in a long-lasting legal framework. In addition, in case of only one design option, this only allows a comparison with the status quo. The case of various regulatory options introducing a CO2 emission trading system in China is an experiment where different design options have been implemented [13]. This fostered learning and accelerated the integration into the regulatory framework for the whole economy and other regions. Furthermore, in the case of the Finnish basic income experiment [22], it was planned to account for different payment schemes, taxation structures and test it in various regions. Although diverse options were suggested by researchers involved, the governmental actors insisted on reducing the number of design option to receive results before the next election.

Heterogeneity of participants

During the interviews, the heterogeneity of participants was expressed as important to reduce unintended consequences and comprehensively understand the effects of experiments on different actors. This can lead to improved knowledge production during and after the experiments. The lack of heterogeneity among the participants can hinder covering obstacles caused by the experimental setting and unintentionally reduce positive impacts of experiments. In the analyzed cases, the diversity of actors has been emphasized according to conditions for participating, the duration of the regulatory experiments and location-specific characteristics. The formulated conditions for participants depend on the target groups. Narrowly-defined requirements for participation reduce the variance between the effects on the participants. Consequently, the outcome and its inference depends on a non-diverse sample. While participation was voluntary in most cases, selecting a heterogeneous sample is perceived as challenging in terms of acquiring a substantial number of participants. In cases like the Berlin shared space experiment [18] where participation was unavoidable for local residents and shopkeepers, a diversity of impacts concerning the experimental setting and unintended consequences during early experimentation phases has been reported [18]. Nonetheless, heterogeneity can also lead to conflicts due to diverse interests and capabilities.

The experiments with regulatory options can explicitly encourage heterogeneous samples, while experiments providing exceptions from the regulatory framework address small specific groups, resulting in less heterogeneous groups. For experiments with regulatory options, conclusive results concerning broader effects and indirectly affected stakeholder often could not be stated.

During the interviews, it was confirmed that active strategies to increase the diversity of participants have been implemented aiming for a sufficient degree of heterogeneity. The experimenters formulate broader participation criteria, offer additional incentives to improve participation, design well-defined timeframes and take location-specific factors into consideration. Additionally, in case of testing regulatory options, control groups are helpful to increase effects covered by the screening of the experiments. While they have also been widely discussed in the literature, small fixed budgets and time restrictions are difficult when setting up control groups.

Communication

Communication-related measures help to reduce the time span required for identifying unintended consequences during the experiments. The interviewees describe the need to improve internal and external communication. Internal communication often entails coordinative processes between interdisciplinary research teams and administrative organizations. Setting up long-lasting communication channels and procedures is central to gather and disseminate the relevant procedural knowledge. Transparency about decision-making, clarity of rules and formalized procedures support improving the trust level between the actors and systematizing knowledge production that influences subsequent learning effects.

Moreover, communication with external actors demonstrates a challenging activity. This communication is relevant to disseminate information about the experiment to participants as well as other stakeholders. Feedback mechanisms for the acceptance of experimental measures and efficient distribution of information were pressing topics during the interviews. In these communication channels, clarity of communication, explanation about the role of causality – if relevant – and a transparent dissemination of results are prerequisite to enable a large group of actors to benefit from the experiment. This requires targeted communication with political actors, administrative staff and other interest groups. Experience knowledge is key to support beneficial cooperation structures. Specifically the knowledge transfer to relevant political actors to enable learning conditions in the medium and long run requires resources during the implementation. Political actors have been responsive to demands and impulses from societal groups. Hence, in our sample suggestions and remarks by individuals as well as coordinated actor groups were often included in later stages of the experiments. It should be mentioned that an exact separation of top-down or bottom-up impulses was not possible or might be under-observed in our sample and requires further investigation since they might only be effective after the experiments have been finished.

Regulators use strategic approaches to enable reciprocal learning processes and overcome impediments regarding a lack of experience with experimental procedures. Participatory activities support the communication and interaction between involved actors. In particular, participatory elements in the experiments were designed to prevent a low level of commitment and formalize the involvement of a broad range of actors. The responsible regulators hoped to positively influence the outcome and support further governance experiments. In order to learn about the participants' needs, participation in planning and implementation discussion, the interviewees expected better-targeted communication with different stakeholders, like businesses, households, administrators and societal actors. A greater emphasis on participation resulted in the introduction of participatory activities during the implementation, like the selection of participants and discussions with stakeholder about consequences for participants and other actors.

4.4. Influencing factors for the up-take of regulatory experiments

The three previous chapters analyzed the main factors that influence the up-take of experiment results along the dimensions of scalability, transferability and accounting for unintended consequences. First, the timeframe, timing and political support affect scalability. Especially for the timeframe of experiments, it is important to weigh up the advantages and disadvantages of long and short durations of an experiment. Second, the dimension of transferability is mainly influenced by the context of the specific experiment. The main influencing factors are the regulatory context, geographical particularities, the timeframe, the selection processes for participants and evaluation procedures. Third, there are different strategies to deal with unintended consequences of experiments. Our analysis revealed that testing different design options, ensuring the heterogeneity of participants and enhancing communication are important aspects to avoid unintended consequences. It is important to mention that some factors not only influence the dimension to which we assigned it but can rather also have an effect on the other dimension.

5. Discussion and conclusion

This paper has focused on the role of the up-take of governance experiments in sustainability transitions in connection with institutional dynamics. We pursued a cross-case comparative analysis, conducting 27 international experiments. In our study, we explored three main elements, namely transferability, scalability and unintended consequences. Our main results emphasize the relevance of institutional dynamics and the need for methodological robustness and standards to enable experiments to be scaled-out, scaled-up or transferred, and finally to contribute to sustainable transitions.

This study extends the understanding of up-take in governance experimentation. To achieve this, we integrated the sub-group of regulatory experiments into governance experimentation (Bos and Brown 2012; Kivimaa et al. 2017) and explored the role of learning conditions for the up-take of experiments (Luederitz et al. 2017; Naber et al. 2017). Our results confirm and further elaborate on the heterogeneity of institutional conditions that influence the role of experiments in the innovation policy mix (Geels 2004; Fuenfschilling and Truffer 2014, 2016).

The transferability of regulatory experiments – i.e. the extent to which results can be applied to different contexts – is particularly important to deepen the learning around factors influencing stakeholders' behavior. Following Smith 2007), the transferability is mostly determined by the influence of informal norms, rules and practices from the specific institutional conditions on the experimental results (Geels 2004; Fuenfschilling and Truffer 2016). In this regard, our study adds to the transferability discourse regarding three parameters. Specifically, we demonstrate that the transferability of a regulatory experiment depends on a) the extent to which the experiment can identify and suppress its regulatory context, b) the effect of geographical particularities of the experiment location, and c) the impact of the experiment's time limitations on the behavior of the actors. Having extensively studied these three parameters, one way of reducing the influence of contextual conditions on transferability is the randomized selection of participants who are representative of the stakeholder population. However, randomization is not always practical in regulatory experiments, especially if the latter aim at creating leeway for innovators (Bischoff et al. 2020). Another approach comprises independent evaluations, which can reduce the confirmation bias of experimenters. Nonetheless, our analysis shows that it is difficult to evaluate results of single experiments without their specific context, indicating that results can be strengthened through parallel and sequential experimentation in different institutional contexts.

In regulatory experiments, scalability describes the production of generalizable knowledge that is applicable on a broader scale, pointing to a lively discussion in the literature (Jolly et al. 2012; Westley et al. 2014; Johansen and van den Bosch 2017). Our results show that especially the timeframe and timing as well as political support influence scalability. With respect to timeframes, duration holds paramount importance. On the one hand, insufficient timeframes may result in participants adapting their behavior to the experimental setting, whereby this adaption would render the analysis of long-term effects difficult. On the other hand, if timeframes are excessive, societal conditions during the experiment might change and impede the production of generalizable knowledge. Regarding the latter, the timing of political events such as elections can cause abrupt changes in an experiment, hindering the learning process. Finally, policy-makers' willingness to study attitudes towards experimentation in combination with the prioritization of specific experiment topics constitute two factors that further influence the upscaling. Therefore, considering the aforementioned factors when designing regulatory experiments can increase the scalability of experimental results. Moreover, knowledge strategies and management, lessons learned and best practices from previous international experiments as well as open dialogue workshops can function as catalysts for the production of generalizable knowledge that facilitates up-take.

Finally, our results add to the discussion on unintended consequences of societal and technological innovation (Tenner 1997; Musch and Streit 2020). Unintended consequences of experiments can increase the uncertainty of regulatory experiments. In this regard, the number of design options, the heterogeneity of participants and the

internal and external communication channels influence the capability to identify a broad range of impacts on participants and stakeholder groups. With experiments as our focal point, we demonstrate that experimenters are in need of methods and protocols as a prerequisite that reduce uncertainty to account for unexpected negative and positive outcomes. In particular, our results highlight the need to explore additional instruments to scrutinize the outcomes and the impact of experimentation.

To sum up, the findings of this study have three practical implications for conducting governance experiments. First, new practitioners and experimenters need support since institutional dynamics constitute a major challenge. While scholars perceive experiments as an established policy instrument, integration of experimentations in the regulatory practice is not yet mainstream. On this aspect, external support for experiments pursuing specific targets may accelerate experimentation up-take in transformative policies. Second, experiments as innovative practices have produced a significant number of methods to reduce the uncertainty during the experiment and support the consequent up-take of its outcomes. Transparency here is key, whereby experimenters must have access to all the relevant available information throughout the experiment life-cycle, i.e. during the design, implementation and evaluation. Experimenters can benefit from a robust experimental design, continuous monitoring and the inclusion of diverse stakeholders for a successful up-take. Third, the successful speed-up of sustainability transition via experimentation requires experimenters to build up knowledge. Capability building requires time. As demonstrated in the case studies, experimenting often only happens in small scale with a limited scope. In order to use governance experiments for the policy mixes, substantial up-take requires the capacity to develop institutional conditions that enable reflexive and recursive learning.

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