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The soft channels of policy diffusion: Insights from local climate change adaptation policy

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Abstract

Diffusion has become both an important concept for studying policy spread and a popular governance approach, particularly where direct coercion is unavailable or undesirable. However, the prevailing mechanism-centered concept is difficult to measure and poorly captures the governance potential of policy diffusion. To address these issues, this article presents a new channel-centered framework that distinguishes between six soft policy diffusion channels: autonomous, collaborative, exemplary, persuasive, organized, and funded diffusion. The framework is probed by studying local climate change adaptation policy using original survey data collected from the administrations of 190 municipalities located in the central German state of Hessen. The regression results indicate that the local institutionalization of adaptation in Hessen is associated with several interventions by higher levels of government, including the provision of a policy model, a municipal climate network, and grant programs. However, the density of concrete adaptation measures is associated with noninstitutionalized exchanges between municipalities. External grants are also found to be more effective in institutionalizing adaptation in larger municipalities. These results demonstrate the usefulness of the framework for distinguishing and comparing different diffusion channels and suggest that different types of interventions may be required to effectively support adaptation policy development at the local level.

KEYWORDS
climate change adaptation, governance, local level, policy diffusion channels, scaling

INTRODUCTION

Many scholars and policymakers have argued that policy innovations are needed to address some of society's most pressing problems, including climate change (Hughes et al., 2020; UNRISD, 2017). Subnational units such as states and municipalities are seen as places where policy innovations driven by local problem-solving and experimentation are particularly likely to emerge (Bernstein & Hoffmann, 2018; Castán Broto & Bulkeley, 2013; Hildén et al., 2017). However, there is also a growing understanding that individual policy innovations will not be sufficient to address global climate change and its impacts. Rather, scholars have argued that climate policies need to be more widespread across multiple levels and places to achieve cumulative effects and systemic change (Andonova et al., 2009; Ostrom, 2010; Tosun, 2018). This situation highlights the need to better understand how climate policies spread across jurisdictions and what kinds of interventions may be needed to support such processes.

Policy diffusion, which can be broadly defined as a process of interdependent policymaking with an analytical focus on external determinants (Berry & Berry, 2018; Walker, 1969), has emerged as an important concept for studying policy spread across jurisdictions. Scholars have identified various mechanisms that can drive policy diffusion, most notably, learning, competition, emulation, and coercion. In brief, learning refers to changing beliefs in response to new information and policymaking elsewhere, while emulation occurs when jurisdictions strive to conform to widely accepted solutions and socially constructed norms. Competitive diffusion occurs when jurisdictions respond to each other's policy activities to attract or retain resources, while coercion is observed when powerful actors attempt to impose specific policies and ideas on others (Graham et al., 2013; Simmons et al., 2006).

Studying these mechanisms is essential but inherently difficult—because they are not easily conceptualized and measured (Blatter et al., 2021; Maggetti & Gilardi, 2016; Starke, 2013). For example, learning can have very different rationalist and constructivist notions, which can be difficult to distinguish from emulation (Dunlop & Radaelli, 2018; Simmons et al., 2006). Furthermore, mechanism-centered diffusion research has diverted attention from other issues in the conceptualization and measurement of policy diffusion. In particular, the concept of diffusion does not systematically address how policy diffusion can be actively governed, that is, how higher levels of government can promote the spread of public policies at lower levels.

Diffusion studies tend to focus either on *horizontal* diffusion, that is, the spread of policies across units at the same level of government (Gilardi, 2016; Karch, 2007), or on *bottom-up vertical* diffusion from lower to higher levels, such as when states adopt policies that originate at the local level (Gamkhar & Pickerill, 2012; Shipan & Volden, 2006) or when national governments are influenced by state policy experiments (Béland et al., 2018; Boeckelman, 1992). In contrast, *top-down vertical* dynamics, in which higher levels of government influence lower levels, are either excluded from the policy diffusion concept (Busch & Jörgens, 2005; Elkins & Simmons, 2005; Maggetti & Gilardi, 2016) or predominantly understood in terms of direct coercion or "hard" interventions by higher-level governments or powerful organizations, typically in the form of preemptive legislation or conditional funding (Graham et al., 2013; Kim et al., 2018; Shipan & Volden, 2008). However, by focusing on direct coercion, the diffusion perspective risks overlooking important less coercive or "soft" interventions that higher levels of government can use to promote policy development at lower levels (but see, e.g., Karch, 2012; Welch & Thompson, 1980).

This neglect of soft interventions limits the analytical value of the diffusion concept, especially in multilevel environments with varying levels of authority and in policy areas where direct coercion is unavailable or undesirable, including in climate policy. For example, in many countries, higher levels of government lack the constitutional authority to mandate local climate action, or local authorities lack the capacity to comply with such mandates (Kern, 2019, p. 135). Therefore, national, regional, and international levels regularly turn to alternative approaches to facilitate local climate policy development. Existing studies highlight approaches such as increasing funding for local climate action (Kern et al., 2023; Persson & Remling, 2014) or establishing climate networks (Betsill & Bulkeley, 2004; Karhinen et al., 2021; Lee & Koski, 2015; Rabe, 2011). These studies provide important insights.

However, there is a systematic conceptual and empirical exploration of such options. Existing studies tend to focus on only one or a few of these interventions, leaving little knowledge about their relative and combined effects.

This paper addresses these gaps. First, to circumvent the difficulties in conceptualizing and measuring diffusion mechanisms, I propose an alternative that focuses on policy diffusion *channels*, understood as the observable ties between jurisdictions or organizations at the same or different levels of government, in which single or multiple mechanisms can operate to drive the spread of policies. Second, I systematically identify potential interventions that are relevant to understanding policy diffusion as a governance approach (Busch & Jörgens, 2012; Hakelberg, 2014; Steinbacher & Pahle, 2016).

To this end, I developed a framework of six different types of what I call *soft policy diffusion channels* through which new policies can spread across jurisdictions at the same level of government. These channels involve both horizontal and vertical dynamics and rely on information, reputation, positive financial incentives, and capacity building (i.e., pull mechanisms) as their primary governance resources without the sanctions and negative financial incentives (i.e., push mechanisms) that are typical of direct coercion and competition. Nevertheless, soft diffusion channels still entail varying degrees of coercive powers and transaction costs (Dolowitz & Marsh, 2000; Kim et al., 2022; Vedung, 1998), which the framework recognizes by broadly placing them on the following continuum ranging from less to more coerciveness or government intervention: *autonomous*, *collaborative*, *exemplary*, *persuasive*, *organized*, and *funded diffusion.*

I empirically illustrate the framework by examining local adaptation to climate change. I use original survey data collected in 2020/2021 from the administrations of 190 municipalities located in the state of Hessen in central Germany (Schulze & Schoenefeld, 2023), combined with additional data from climate networks and public records. The regression results suggest that the institutionalization of adaptation in Hessian municipalities, such as the creation of plans and new staff positions, can be linked to various interventions from higher levels of government, including the provision of a policy model, a formal climate network, and project grants. The latter were also found to be more effective in larger municipalities. In contrast, the development of concrete adaptation measures, such as the creation of open-air corridors, education programs, drainage and retention areas, and surface unsealing, is more associated with autonomous diffusion, that is, noninstitutionalized exchanges between municipalities. These results demonstrate that policy diffusion is a multi-channel and multi-mechanism process that can be steered toward beneficial outcomes. Moreover, they suggest that the effects of different diffusion channels may vary depending on the characteristics of the spreading policies (Makse & Volden, 2011; Zhou et al., 2019).

The channel-centered framework proposed in this study offers a valuable alternative to the mechanism-centered diffusion perspective. It contributes to a better understanding of how diffusion processes can be actively governed and of the relationship between horizontal and vertical diffusion, which is essential for advancing the diffusion concept (Levi-Faur, 2005, p. 27). In doing so, it generalizes our understanding of diffusion as a governance approach, which previous studies have mainly explored at the international and European Union (EU) levels (Busch & Jörgens, 2012; Hakelberg, 2014; Jaenicke, 2015). Beyond its conceptual contribution, the study specifically contributes to recent efforts to better understand patterns of climate policy adoption at the local level and how such processes can be supported (Kern et al., 2023). In particular, the results suggest that different types of interventions may be needed to support the diffusion of different types of adaptation policies. This is important information for the efficient allocation of scarce (local) resources and for policymakers seeking to capitalize on policy diffusion.

FROM DIFFUSION MECHANISMS TO DIFFUSION CHANNELS

In an increasingly interconnected world, scholars have long observed patterns of policy diffusion, including in climate policy (Castán Broto & Bulkeley, 2013; Jordan & Huitema, 2014). Four mechanisms

underlying policy diffusion have become prominent, namely, emulation, learning, competition, and (more controversially) coercion (Graham et al., 2013; Shipan & Volden, 2008). However, scholars regularly stress the difficulties in conceptualizing and measuring these mechanisms, despite their theoretical appeal (Blatter et al., 2021; Kuhlmann, 2021; Maggetti & Gilardi, 2016; Starke, 2013). For instance, depending on the level of uncertainty of a problem and the authority of the actors involved, learning can refer to very different processes and overlap with the other diffusion mechanisms (Dunlop & Radaelli, 2018; Gerlak et al., 2018). Similarly, emulation can have very different meanings, such as the development of shared norms through communicative procedures or symbolic imitation based on a desire for social conformity (Blatter et al., 2021; Braun & Gilardi, 2006). Moreover, distinguishing between learning and emulation is complicated by the need to demonstrate whether a change in beliefs has occurred (Simmons et al., 2006, p. 795). A widely cited meta-analysis by Maggetti and Gilardi (2016) of more than two decades of policy diffusion research highlights the many ways in which the same diffusion mechanisms have been operationalized by either different or catch-all indicators such as geographic proximity, making it difficult to compare results and distinguish between mechanisms.

Given the difficulties in conceptualizing and measuring diffusion mechanisms, this study takes an alternative approach. Instead of mechanisms, it focuses on diffusion channels, understood as the observable ties between units in which single or multiple mechanisms can drive the spread of policies. This change in perspective has several advantages. First, channels are easier to identify than mechanisms. Second, it eases the analytical burden of mechanism-based explanations, which require specifying all the entities, properties, activities, and relations of a causal process that produce a given outcome (Hedström & Ylikoski, 2010). Finally, when multiple mechanisms can be plausibly linked to a particular channel, it is not necessary to distinguish between them.

The point is not that mechanism-centered approaches to policy diffusion are unnecessary or ineffective but rather that a channel-centered perspective can often be more appropriate, especially, but not exclusively, in the context of quantitative designs. Indeed, most quantitative diffusion studies identify channels rather than mechanisms and assume that a particular mechanism operates through that channel to produce the outcome of interest (see, e.g., Cao, 2010; Zhou et al., 2019). However, as Starke (2013, p. 566) argues, the inference that a particular mechanism drives diffusion depends on whether the identified channel can be plausibly associated with a particular mechanism (and *no other* mechanism, I would argue). Adding to this debate, I argue that where the mechanisms cannot be convincingly identified and distinguished, progress can also be made by instead focusing on the channels. Moreover, policymakers seeking to capitalize on policy diffusion will often be as interested or even more interested in the effects of channels than in the underlying mechanisms.

GOVERNING POLICY DIFFUSION

In addition to shifting the focus from diffusion mechanisms to channels, this article contributes to the literature by generalizing and comparing the different options available for actively governing diffusion processes. These options are scattered across the literature, in which only a few studies explore several different options at the same time, mainly at the international and EU levels (Busch & Jörgens, 2012; Hakelberg, 2014; Jaenicke, 2015; Steinbacher & Pahle, 2016). By doing so, this study contributes to a more nuanced understanding of the relationship between horizontal and vertical diffusion dynamics from a governance perspective (see also, e.g., Benz et al., 2015; Schulze et al., 2024).

Diffusion studies typically adhere to a governance model of coordinated direct coercion, which is mainly reflected in compliance with legal obligations set by higher levels of government (e.g., EU member states implementing EU directives) and conditionality, that is, policy adjustments required by higher levels of government or powerful organizations in exchange for organizational membership or funding (e.g., IMF lending practices) (Blatter et al., 2021; Graham et al., 2013). However, some scholars have seriously challenged this understanding, arguing that coercion should not be considered a diffusion mechanism because, unlike other mechanisms, it involves at least one jurisdiction or organization exerting

pressure on another. According to this perspective, the diffusion concept should be reserved for policy spread that is uncoordinated (or unintended) and inherently voluntary (Elkins & Simmons, 2005; Kern, 2019; Maggetti & Gilardi, 2016).

Other scholars do not exclude coercion from the set of diffusion mechanisms, but they highlight higher-level interventions that go well beyond the dominant notion of direct coercion. For example, in a seminal review of policy diffusion research, Graham et al. (2013, p. 693) view national governments and intergovernmental organizations as "go-between actors" that can promote diffusion not only through coercion but also by facilitating learning, socialization, and competition. Moreover, federalism scholars routinely highlight less coercive vertical interventions to promote policy diffusion. Summarizing the wealth of this research, Karch (2007, pp. 67–68) lists a variety of tools that national governments can use to influence state policymaking and promote policy diffusion, ranging from financial incentives to signaling and disseminating policy-relevant information. Individual top-down interventions aimed at influencing policymaking at lower levels that have been studied include providing financial incentives and institutional support (Karch, 2006; Ostrom, 2010; Welch & Thompson, 1980) and signaling policy preferences by making policy commitments, setting goals, issuing public statements, holding hearings, or launching legislative initiatives (Allen et al., 2004; Karch, 2012; Lee & Koski, 2015; McCann et al., 2015). However, a systematic examination and comparison of these different options is lacking, and this study seeks to address this gap.

Another strand of the literature on vertical top-down policy dynamics that has yet to find greater resonance among policy diffusion scholars is the scaling literature (Schipper et al., 2014; van der Heijden, 2022; Van Doren et al., 2018). This literature recognizes classic horizontal patterns of policy spread, referred to as "horizontal scaling" but also emphasizes transfer through administrative and organizational levels that are not the origin of the policy, typically referred to as "vertical scaling" or "upscaling" (Van der Heijden, 2022, p. 8). The scaling perspective has been used, for example, to describe patterns of "multilevel reinforcement" of climate policy in the EU, referring to both top-down and bottom-up dynamics (Fuhr et al., 2018; Jaenicke, 2015; Kern, 2019). More recently, Kern et al. (2023) suggested combining diffusion and upscaling approaches to better understand the top-down and bottom-up patterns of local climate policy spread. However, there do not appear to be any similar attempts to conceptualize horizontal and vertical dynamics from a diffusion perspective, especially in a more generalized way that is applicable to different multilevel settings. The next section presents such an attempt. Examples are mainly drawn from local climate policy, while the framework is generic and applicable to different policy areas and multilevel settings.

CONCEPTUALIZING SOFT DIFFUSION CHANNELS

The proposed framework is based on the idea of policy diffusion channels, which are observable ties between jurisdictions or organizations at the same or different levels of government in which single or multiple mechanisms can operate to drive the spread of policies. This includes uncoordinated as well as coordinated interactions. Diffusion mechanisms are thus the critical causal links between diffusion channels and their effects. However, diffusion channels are not merely subtypes of mechanisms, as it is possible for multiple mechanisms to operate within a single channel, both horizontally and vertically. In addition, the framework recognizes that different diffusion channels can exist in parallel and sometimes overlap intentionally, so multiple channels can drive diffusion processes simultaneously. Different diffusion channels thus represent complementary governance options, while policy diffusion is a multilayered process that can involve many different mechanisms and channels.

The framework focuses on, and is limited to, what I call *soft policy diffusion channels*. Rather than rejecting the notion of coercion as a diffusion mechanism, this approach acknowledges that all diffusion channels and mechanisms contain varying degrees of coercive powers, including in nonmaterial forms (Dolowitz & Marsh, 2000), as well as varying degrees of transaction or mechanism costs (Kim et al., 2022). For example, learning is frequently not a purely reflexive exercise among peers

but can occur in more or less hierarchical settings and involve unequal distributions of knowledge and expertise (Dunlop & Radaelli, 2018). Emulation may be motivated not only by the desire to reduce uncertainty and gain public praise but also by the fear of losing social acceptance if a dominant policy model is not adopted (Sharman, 2008, p. 647). Based on this understanding, I argue that soft diffusion channels can be better understood by situating them on a continuum ranging from less to more coerciveness, which I primarily observe through the degree of intervention by higher levels of government in a given channel.

Recognizing that coercion is better understood as a continuum, I draw the boundaries of the framework based on the policy instrument literature by focusing on channels that operate through pull (i.e., reward) and informational mechanisms, as opposed to push (i.e., punishment) mechanisms (Ejelöv et al., 2022; Wicki et al., 2019). Thus, soft diffusion channels typically lack sanctions and negative financial incentives (disincentives) and instead rely on information, reputation, positive financial incentives, and capacity building as their primary governance resources. Therefore, the framework excludes direct coercion (mandates and conditionality) as the most obvious push mechanism. Moreover, following the above distinction, competition cannot be considered a soft channel either. This is because competition is usually associated with involuntary policy adjustments in response to externalities caused by the policy decisions of others and is thus a push rather than a pull mechanism. Indeed, competitive diffusion is typically not conceptualized as taking place among equals but rather as involving differences in economic power and market size, which can lead to either race to the bottom or race to the top in terms of policies and standards (Damro, 2012; Shipan & Volden, 2008). Sharman (2008) makes a similar point by associating coercion and competition with instrumental compliance, as opposed to emulation which triggers noninstrumental compliance.

To conceptualize soft diffusion channels, I mainly draw on concepts that highlight the various governance resources and degrees of coerciveness that characterize different policy instruments (Hood & Margetts, 2007; Steurer, 2011; Vedung, 1998). This approach expands upon the idea of "governance by diffusion," which is the deliberate use of diffusion as a mode of governance, beyond the purely decentralized and uncoordinated form of policy spread described by Busch and Jörgens (2012). Specifically, I broaden this idea by explicitly incorporating more centralized interactions and incentives (see also Busch & Jörgens, 2012, pp. 238–242), which I contend can be differentiated more effectively in terms of governance resources and principles. Based on this approach, I distinguish between six soft diffusion channels through which policies may spread across jurisdictions at the same level of government. The next sections describe each channel in turn, while Table 1 presents a summary.

Autonomous diffusion

The first channel, autonomous diffusion, exemplifies horizontal policy spread through voluntary and noninstitutionalized (uncoordinated) interactions between jurisdictions at the same level of government. This channel does not involve higher levels of government and thus represents the least coercive channel of the framework. Rather, jurisdictions interact directly and mainly bilaterally with each other to share experiences, knowledge, and best practices, for example, on climate impacts, adaptation problems, and potential solutions. Learning is thus an important diffusion mechanism in this channel. However, jurisdiction can also be socialized into the norms, rules, and policy models of others, especially when interactions become more frequent and there are popular leaders to follow, making emulation another potentially relevant mechanism in autonomous diffusion.[1]

Kern (2019) argues that this type of diffusion is particularly characteristic in the early stages of diffusion processes and among leading cities in a given policy area, while the institutionalization of communication channels in later stages of diffusion processes promotes wider policy spread, including to rural areas. I agree with this characterization but would stress that institutionalized channels (which are discussed next) complement rather than replace autonomous diffusion dynamics, even if the latter may become less relevant. In other words, autonomous diffusion does not necessarily end with the

TABLE 1 A typology of soft policy diffusion channels.

Channel	Description	Governance resource	Diffusion mechanism	Logic of policy change	Example
Autonomous diffusion	Noninstitutionalized (bilateral) exchanges between jurisdictions at the same level of government	Information	Learning, emulation	Jurisdictions learn from each other and/or gain reputation and legitimacy	Self-organized exchanges on climate action between (neighboring) municipalities, use of personal contacts
Collaborative diffusion	Self-governing networks between jurisdictions at the same level of government	Information, structures, capacity, reputation, and *money*	Learning, emulation, *soft coercion*	Jurisdictions learn from each other, receive network support and services, gain reputation and legitimacy, and/or *gain better access to funding opportunities*	Membership-based municipal climate networks
Exemplary diffusion	Policy activity by higher levels of government	Information, reputation	Learning, emulation	Jurisdictions respond to policy signals and examples from higher levels of government	State climate plans and strategies
Persuasive diffusion	Guidelines and support tools provided by higher levels of government	Information, capacity	Learning	Jurisdictions learn from information and/or use support tools	Federal information platforms for municipal climate action
Organized diffusion	Networks initiated by higher levels of government that connect jurisdictions at lower levels of government	Information, structures, capacity, reputation, *money*	Learning, emulation, *soft coercion*	Jurisdictions learn from each other, receive network support and services, gain reputation and legitimacy, and/or *gain better access to funding opportunities*	State-run municipal climate networks
Funded diffusion	Funding provided by higher levels of government	Money, capacity	Soft coercion	Jurisdictions apply for and use funds	State grants for municipal climate projects

Note: Own elaboration. Indirect governance resources, diffusion mechanisms, and logics of policy change in italics.

emergence of climate networks and other institutionalized channels but may continue to contribute to policy diffusion alongside these other channels.

Collaborative diffusion

The second channel, collaborative diffusion, materializes in the creation of formal multilateral networks among jurisdictions at the same level of government. These networks are typically created by pioneers in a given policy area, such as cities, with the aim of promoting the exchange of experiences and knowledge among members, enhancing their capacities to address societal problems, representing their interests at higher levels of government, and attracting new followers (Andonova et al., 2009; Busch et al., 2018; Heikkinen et al., 2020). I argue that collaborative diffusion reflects bottom-up networks that are initiated and self-governed by their members, with higher levels of government playing a minor role at best. Higher levels of government engage with such networks only to a limited extent, for example,

by initiating joint projects and using their expertise and knowledge. In contrast to government-led initiatives (see organized diffusion), collaborative networks typically charge membership fees. Examples include transnational city networks such as Local Governments for Sustainability (ICLEI) and the Climate Alliance, both of which were created in 1990 by groups of committed cities and communities when climate change became an international issue (Kern & Bulkeley, 2009).

Formal networks rely on multiple governance resources and diffusion mechanisms to spread public policies that are difficult to disentangle (Hakelberg, 2014; Krause, 2012). First, they establish multilateral relationships connecting multiple jurisdictions simultaneously and integrate members into various types of institutionalized interactions, such as regular meetings, conferences, and campaigns. This expansion of nodes and ties promises to accelerate diffusion processes. Second, formal networks typically provide support and consulting services based on their expertise to their members (and sometimes beyond), which can enhance their specific capacities to address problems (Busch, 2015). For example, the Climate Alliance offers planning tools for developing and implementing local climate measures such as emissions inventories.[2] Third, network members gain the external reputation and legitimacy that they can use to advance their domestic policy agendas. Finally, members may gain increased access to financial resources and participate in joint projects involving the network and higher levels of government (Busch et al., 2018).[3]

Learning is thus an important diffusion mechanism at work in collaborative channels. Emulation also plays a role, as members become familiar with the norms and rules of networks and pursue policies recognized as appropriate and effective (Betsill & Bulkeley, 2004; Blatter et al., 2021). In addition, positive financial incentives in the form of increased access to funds (soft coercion) can blend with these mechanisms. The latter may be considered an indirect mechanism, as funds are typically not provided by the networks themselves.

Exemplary diffusion

Instead of, or in addition to, mandating policy action at lower levels, higher levels of government can try to create a model for policy diffusion by engaging in policy activity themselves. Such activity can send a signal to lower levels about their policy preferences and about the salience and popularity of an issue. It can also provide the lower levels with information about policy problems and potential solutions (Allen et al., 2004; Karch, 2006, 2012; McCann et al., 2015). In turn, lower-level governments may not only benefit from the information transferred by higher-level policies but also reference higher-level policies to mobilize support for their own actions. Similarly, higher-level policies may mobilize interest groups to push for similar policies at lower levels (Allen et al., 2004, p. 321). Finally, lower-level governments may also want to demonstrate conformity with higher-level policies to enhance their own reputation.

Thus, policy learning and emulation are relevant diffusion mechanisms in the exemplary diffusion channel. There is empirical evidence that the climate policy activities at higher levels of government influence local climate policymaking. For example, Lee and Koski (2015) and Homsy (2018) find that US cities in states with climate action plans are also more likely to act themselves. It should be noted, however, that policy initiatives by higher levels of government can in principle have both contagious and deterrent effects at lower levels, i.e. they can either increase the likelihood of similar actions at lower levels or decrease this likelihood if lower-level units perceive that sufficient action is already being taken at the higher level (Krause, 2011; Shipan & Volden, 2006). In addition, in principle, the induction of policy action at lower levels may or may not be a motivation (among others) for higher-level governments to take their own policy action, which complicates an exact assessment of coercive power exercised through this channel.

Persuasive diffusion

The fourth diffusion channel, persuasive diffusion, refers to the provision of information and knowledge resources by higher levels of government. This includes guidelines, information clearinghouses,

and platforms designed to persuade and support jurisdictions at lower levels to take necessary policy actions. For example, to promote climate adaptation at the local level, national and state governments have developed databases of adaptation policy measures and best practices, as well as more comprehensive adaptation support tools (Clar et al., 2013; Van de Ven et al., 2016). Such initiatives not only provide information but also aim to strengthen specific capacities. For instance, they guide local actors through adaptation processes and assist them in developing adaptation plans (Clar & Steurer, 2018).

Learning is thus the primary diffusion mechanism associated with persuasive diffusion. Unlike exemplary diffusion, the reputational incentives associated with emulation mechanisms are mostly absent in this channel. However, the persuasive channel can still be considered more coercive than the exemplary diffusion channel, mainly because information provision in the persuasive channel is always a deliberate effort by higher-level actors to induce policy action at lower levels, whereas exemplary diffusion may be more or less intentional. However, although higher levels of government typically produce and disseminate information and support tools, their application (e.g., by local governments) is still voluntary and usually not directly incentivized. Therefore, the persuasive channel ranks below organized and funded diffusion in terms of coerciveness, which is discussed next.

Organized diffusion

The fifth channel, organized diffusion, is similar to collaborative diffusion but differs in the sense that networks are created by higher-level governments or organizations to connect jurisdictions at lower levels, thus combining horizontal and vertical dynamics and departing from the bottom-up nature of collaborative diffusion. Consequently, jurisdictions are usually not required to pay membership fees to join these networks. Scholars have also referred to such government-run networks as "intermediaries" suggesting that they can play an important role in climate action and sustainability transitions (Karhinen et al., 2021; Kivimaa, 2014). A case in point is the Covenant of Mayors for Climate & Energy (CoM), which originated from initiatives by the EU Commission's Energy (2008) and Climate (2014) Directorates-General. Local authorities that join the CoM commit to reduce greenhouse gas emissions by 55% by 2030, strengthen resilience, and alleviate energy poverty. To this end, they submit action plans and report on their progress. The plans and reports are evaluated by the Commission's Joint Research Centre, which also manages the CoM together with a consortium of other city networks. Financial support is provided by the Commission (Kona et al., 2019).

Organized diffusion builds on more governance resources and diffusion mechanisms than persuasive diffusion and thus is a further increase in coerciveness. In particular, in addition to information provision and capacity building, the creation of organized diffusion channels opens up additional learning and emulation mechanisms (reputational incentives) by facilitating peer-to-peer interactions, locking in commitments and legitimizing local climate action. In addition, financial incentives come into play when these networks facilitate access to additional funding.

Funded diffusion

The final and most coercive channel of the framework is funded diffusion. This reflects positive financial incentives and the provision of additional resources, such as climate project grants, by higher levels of government to encourage and support policy actions at lower levels. Although still a soft channel, funded diffusion involves somewhat more coercive elements than the other channels, as applying for grants may require considerable knowledge and resources on the part of lower-level units. If accepted, grants usually come with monitoring and reporting requirements that must be met. A lack of capacity may therefore discourage jurisdictions from applying.

Where direct coercion is not possible, financial incentives are arguably one of the easiest and most direct ways for higher levels of government to influence policymaking at lower levels (Allen

et al., 2004, p. 326). In funded diffusion, higher levels of government essentially subsidize the costs of policy innovations, helping to overcome a major barrier to innovation (Karch, 2006, p. 406). Overall, there is ample evidence that financial support from higher levels of government can help to spread and implement policies at lower levels (Börzel & Risse, 2012; Honadle, 2001; Koontz & Newig, 2014), including in local climate mitigation and adaptation (Keskitalo et al., 2013; Persson & Remling, 2014).

With respect to the conceptual boundaries of soft diffusion channels, the focus is on positive financial incentives (i.e., pull or reward mechanisms) as opposed to negative ones (i.e., push or punishment mechanisms). Thus, in the funded diffusion channel, jurisdictions may forgo additional funding by not applying, but they are not at risk of losing previously or regularly allocated funds by remaining inactive.[4] Welch and Thompson (1980) show that policies based on such positive incentives diffuse more rapidly among US states than those with negative incentives. The main governance resources of funded diffusion are thus money and capacity building, while the primary diffusion mechanism can be classified as "soft coercion," although with a focus on positive incentives, deviating from its original meaning (Simmons et al., 2006).[5]

EMPIRICAL ANALYSIS

Case selection

Empirical analysis studies local climate change adaptation policy, which is an excellent case for conceptualizing and measuring different diffusion channels for several reasons. First, adaptation is a relatively new climate policy area with a high density of recent policy activities given the urgent need to adapt to increasingly frequent and severe climate impacts such as droughts, heatwaves, storms, and heavy precipitation (IPCC, 2022; Smith & Lenhart, 1996). Second, while adaptation policies are typically developed at the local level (Dolšak & Prakash, 2018; Javeline, 2014; Vogel & Henstra, 2015), many municipalities lack the capacity and/or willingness to experiment with and invent new solutions. These municipalities may therefore look elsewhere for solutions and/or require additional support and/or incentives to develop climate policies, which drives patterns of policy diffusion. Especially where direct coercion is not possible, higher levels of government are turning to different types of interventions to encourage the voluntary development of adaptation policies at the local level (Hauge et al., 2019; Lesnikowski et al., 2017; Schoenefeld et al., 2023). These developments have triggered a growing body of literature that tracks the diffusion of adaptation policies, for example, as a function of municipal networks (Hauge et al., 2019; Papin, 2019) or with respect to specific mechanisms such as learning and emulation (Feinberg, 2021).[6] However, studies comparing the effects of multiple channels and mechanisms are still lacking (Schoenefeld et al., 2022).

To investigate the role of soft policy diffusion channels in local climate adaptation policy, I focus on Germany, a country with a rich multilevel governance structure where adaptation is still a voluntary task for municipalities. Germany is a federal country consisting of 13 area states and three city-states (Berlin, Hamburg, and Bremen), called *Länder*, with a pronounced vertical distribution of powers between the central federal government and the regional Länder governments. Local governments are at the lowest administrative level and are part of and subject to their respective *Länder*. The local level is composed of two tiers: counties and independent (county-free) cities at the upper level and municipalities at the lower level. Within this governance framework, the subsidiarity principle enshrined in the German constitution grants considerable executive and legislative authority to the *Länder*, particularly in areas such as education, regional development, culture, and notably, local government affairs. Under this principle, municipalities and counties are afforded the right to self-government within the limits set by the law. Consequently, regulatory authority over local government affairs rests primarily with the *Länder*, with limited intervention from the federal level (Climate Chance & Adelphi, 2021; Kuhlmann & Wollmann, 2019).

As part of their self-government, German local governments perform two types of tasks: mandatory tasks delegated by the state and voluntary tasks. Climate policy, including adaptation, falls under the latter category (Heidrich et al., 2016; Otto et al., 2021). Thus, German municipalities are free to take climate actions, such as drafting climate mitigation and adaptation plans, hiring climate managers, creating retention areas, and buying electric vehicles. However, there are no state or nationwide guidelines or requirements in place.[7] German municipalities thus face the challenge of balancing and integrating climate mitigation and adaptation with both their mandatory tasks, such as land-use planning, fire protection, schools and preschools, water and waste management, and other voluntary tasks, such as public transport, cultural activities, sports facilities, and elderly care.

However, it should be noted that German federal and state laws have integrated climate mitigation and adaptation to a certain extent, even though climate action at the local level remains generally voluntary. This integration affects the remaining room within which local governments can maneuver and may be considered an indirect climate obligation (Verheyen & Hölzen, 2022). For instance, municipalities are required to comply with federal energy efficiency standards in urban land-use planning. Some states have also started mandating action in specific climate policy areas, such as the preparation of heating plans, which is now required in all states under a federal law passed in November 2023. However, there are no similar requirements for climate adaptation. Most states have adopted some form of adaptation plan, but none of them mandate municipal adaptation actions (King, 2022).[8]

This study specifically focuses on municipalities[9] in the state of Hessen, a land-locked area state in central Germany (see Appendix Figure A1). Hessen is a good choice among Germany's 16 *Länder* because it is representative of Germany's decentralized administrative and settlement structure. Hessen has a total population of approximately 6.3 million people living in only 12 relatively larger cities (of more than 50,000 residents) and 409 small- to medium-sized cities, towns, and rural communities that are organized into 21 counties (and five independent cities) and three governing districts.[10] Approximately two-thirds of Hessen's population lives in municipalities with fewer than 50,000 inhabitants, compared to approximately 60% for Germany as a whole.[11]

Hessen has repeatedly experienced a range of climate impacts in recent decades, including heatwaves and heavy rainfall, which have caused severe damage to communities, infrastructure, and the environment. In response to these challenges, the German federal and the Hessian state governments have established a number of programs to incentivize and support local climate action, including funding for climate mitigation and adaptation projects, guidelines, and a climate network for its municipalities, the so-called *Klima-Kommunen* (Schulze & Schoenefeld, 2022). This diverse range of activities makes Hessen a suitable (multilevel) environment for studying soft policy diffusion channels and their effects.

Data collection

To examine the various soft policy diffusion channels and their potential effects, three things are needed: a measure of municipal adaptation policy, measures of diffusion channels, and additional relevant variables to isolate the distinct effects of various diffusion channels on adaptation policy. The primary data source is an original survey conducted in collaboration with the Institute for Housing and Environment (IWU)[12] among the administrations of Hessian municipalities between November 2020 and January 2021. The questionnaires (online and pencil-paper options) were sent to the mayors of all Hessian municipalities with instructions to forward them to the relevant administrative units and staff. Some responses, particularly regarding the existence of adaptation plans, were subsequently verified using administrative sources and additional inquiries (for more details, see Schulze & Schoenefeld, 2023). Data on adaptation policy and soft diffusion channels are available for 190 municipalities (approximately 45% of all Hessian municipalities). I combine the survey data with additional data collected from the websites of municipalities and climate networks as well as various public records, including those from the statistical offices of the Hessian state government.

Measuring local adaptation policy

Local adaptation policy is measured through a recently developed Climate Adaptation Policy Index (CAPI) (Schulze & Schoenefeld, 2023). The index measures public adaptation policy output in terms of institutionalization and measures, which are equally weighted dimensions. Details on all index variables and aggregation rules can be found in Appendix Table A1 and in the original publication.

The institutionalization dimension includes three equally weighted indicators that capture the degree of strategic activity and administrative capacity for adaptation that exists in a municipality. The first indicator captures the existence and quality of adaptation plans (1). It ranks adaptation plans, if they exist, from more advanced to less advanced based on their type (ranging from full-fledged adaptation strategies to urban development plans, including adaptation to administrative stock-takes of adaptation needs) and how many sectors and typical adaptation process steps they cover. The second institutionalization indicator captures administrative resources for adaptation measured by the creation of new staff positions to address increasing adaptation needs across sectors (2). Finally, the third indicator focuses on specific collaboration efforts by indicating whether an interagency working group exists in a municipality's administration and, if so, the extent to which it integrates different administrative departments (3).

The measures dimension assesses the density of concrete adaptation measures in seven typical areas of municipal adaptation action, such as in green and open spaces, transport infrastructure, buildings, disaster management, information, and education. In total, it includes the adoption of up to 39 different adaptation measures, such as the creation of open-air corridors, education programs, drainage and retention areas, green roofs and facades, and surface unsealing. Data were aggregated by calculating the share of measures adopted in each action area and then adding up the scores for each area with equal weight.

The CAPI offers a comprehensive measure for analyzing the impact of different diffusion channels on adaptation policies rather than solely focusing on effects related to specific policies (Dolowitz & Marsh, 2000). While it provides a comprehensive measurement approach, the index still distinguishes between adaptation institutionalization and measures, allowing for testing whether policymaking along these two policy dimensions can be associated with different diffusion channels. Schulze and Schoenefeld (2023) argued that both institutionalization and measures are important and interdependent dimensions of adaptation policy and showed that they do not necessarily advance in tandem. Excluding one dimension could therefore lead to biased conclusions. For instance, studying only adaptation plans would overlook policies that are not included in such documents.

Measuring soft policy diffusion channels

To simplify the analysis of the six soft policy diffusion channels, they were measured using binary variables. The measures are designed to isolate key characteristics of each diffusion channel, but there may still be overlaps. For example, contacts made through network activities may also be used in noninstitutionalized exchanges and vice versa. The operationalizations attempt to disentangle such effects, as does the applied analytical strategy of including all channels in one model (see also Shipan & Volden, 2008).

The first channel, autonomous diffusion, is measured by a simple survey question that asks municipalities if they have exchanged information with other municipalities on adaptation issues *beyond* any network activities.[13] This measure aims to differentiate the horizontal, noninstitutionalized, and often bilateral interactions of this channel from more coordinated and multilateral forms, particularly formal networks.

The second channel, collaborative diffusion, reflects membership in the Climate Alliance, which is the largest European municipal network focused on climate change.[14] The Climate Alliance was founded in 1990 by a coalition of dedicated municipalities and representatives of indigenous peoples and is headquartered in Frankfurt am Main, the largest city in Hessen. It remains a horizontally organized,

membership-based network, primarily funded by membership fees. However, even with this channel, there is a certain blending of horizontal and vertical dynamics, for example, when the Climate Alliance participates in government-funded projects. In 2020, the Climate Alliance had more than 1800 members, including 50 municipalities from Hessen.[15] Importantly, the Climate Alliance, like many other climate networks, was initially focused on mitigation but has since broadened its scope to include adaptation, for example, by establishing a Working Group on Adaptation in 2015.

The third channel is exemplary diffusion, which emphasizes the role of policy activity by higher levels of government. Since the sample consists of municipalities from the state of Hessen, the only exploitable variation is at the county level, where two out of 21 counties had adopted a climate adaptation strategy at the time of the survey. Accordingly, the 18 municipalities belonging to these two counties are coded as one, and all others as zero.

The fourth channel, persuasive diffusion, highlights the use of information and knowledge resources offered by higher levels of government. A dedicated survey question operationalizes this channel by asking whether municipalities used information and knowledge sources from the EU, the German federal government, the state of Hessen, or the county during the development of their adaptation activities. Municipalities that affirmed the use of information sources from any of these four levels are coded as one, while those indicating no use of such sources are coded as zero.

The fifth channel, organized diffusion, measures membership in the already mentioned state-run climate network *Klima-Kommunen*.[16] This network was established in 2009 by the former state government of Hessen as part of its sustainability strategy and continues to be fully funded and run by the state government. As of the end of 2020, 252 (60%) of all 422 Hessian municipalities were members.[17] Although the *Klima-Kommunen* were initially established with a focus on climate mitigation, adaptation was officially added to its portfolio in 2015.

Finally, the sixth channel, funded diffusion, reflects financial incentives and support offered by higher levels of government to lower-level units. This channel is operationalized by a survey question that asks municipalities whether they have received funding for adaptation from the EU, the German federal government, or the state of Hessen. Municipalities that responded affirmatively to any of the three possibilities were coded as one (approximately 60%), while those that denied receiving any funding from these sources were coded as zero.

Descriptive evidence

Table 2 presents initial evidence from descriptive statistics regarding the relationship between diffusion channels and adaptation policy development in Hessian municipalities. The results confirm that municipalities participating in the outlined diffusion channels have consistently higher average scores for adaptation policy, including both institutionalization and measures, compared to those who do not. The differences in institutionalization between members and nonmembers of the Climate Alliance and the *Klima-Kommunen* as well as between recipients and nonrecipients of funding are particularly pronounced. T-tests comparing group means were mostly significant at the 5% level.

Control variables

Of course, the observation that municipalities participating in a given diffusion channel have higher adaptation policy scores does not necessarily imply that this channel caused the adoption of adaptation policies. Most importantly, there may be other municipality characteristics that differentiate participants in a given channel from nonparticipants and that may account for the observed differences in adaptation policies (confounding variables). In the following paragraph, I consider several such control variables.

First, I include municipal capacity and development indicators in terms of the logged number of inhabitants and the percentage population growth. Moreover, the fiscal capacity to pursue adaptation is

TABLE 2 Average adaptation policy scores for different diffusion channels.

Channel	N	CAPI Mean	CAPI SD	Institutionalization Mean	Institutionalization SD	Measures Mean	Measures SD
Autonomous diffusion							
Exchange with other municipalities	65	2.64*	1.87	1.78*	2.52	3.50*	1.88
No exchange with other municipalities	125	1.75	1.47	1.00	1.74	2.51	1.77
Collaborative diffusion							
Climate alliance member	34	3.48*	2.17	2.82*	3.15	4.14*	2.10
Not a climate alliance member	156	1.74	1.36	0.92	1.56	2.56	1.69
Exemplary diffusion							
Adaptation strategy at county level	18	2.74	2.05	2.30*	2.25	3.18	2.45
No adaptation strategy at county level	172	1.98	1.62	1.16	2.02	2.81	1.80
Persuasive diffusion							
Information resources offered by higher levels used	99	2.34*	1.72	1.48	2.14	3.21*	1.97
No information resources offered by higher levels used	91	1.74	1.56	1.03	1.97	2.46	1.67
Organized diffusion							
Klima-Kommunen member	132	2.32*	1.81	1.62*	2.27	3.02*	1.96
Not a *Klima-Kommunen* member	58	1.45	1.10	0.46	1.16	2.44	1.58
Funded diffusion							
Funding offered by higher levels received	116	2.52*	1.84	1.82*	2.37	3.22*	1.93
No funding offered by higher levels received	74	1.32	0.99	0.39	0.97	2.26	1.60

Note: Significantly different from channel nonparticipants at *$p < 0.05$.

approximated in terms of per capita municipal tax revenue and public debt. I expect that larger, growing, wealthier, and less indebted municipalities may be more active in adaptation. Next, I consider the role of different interests in adaptation by including the percentage of industrial employment and Green Party seats in municipal councils. More industrial municipalities may be hesitant to pursue adaptation policies, perceiving them as an additional burden on industrial production. Conversely, a stronger presence of the Green Party may indicate greater political pressure to pursue adaptation. Finally, I include two additional demand-side variables gathered from the survey. The first is reported extreme weather experience, which serves as a proxy for municipalities' vulnerability to climate change impacts. It is measured on an ordinal scale that identifies up to five types of extreme weather events (heavy rainfall, flooding, heatwaves, drought, and storms) that municipalities have reported experiencing in the past 10 years. On the one hand, this variable may be a rather crude proxy for vulnerability that I use in the absence of better data. On the other hand, the perceived experience with extreme weather events (or perceived vulnerability) may be more consequential for local adaptation policymaking than other, technically monitored extreme weather (or vulnerability) indicators (Braunschweiger & Ingold, 2023). The last variable reflects municipal climate change awareness in terms of the extent to which climate change is perceived as a problem by local administrations, measured on a 5-point Likert scale. Climate awareness in the municipal administration may be an important driver of adaptation actions (Lenzholzer et al., 2020). Table A4 in the Appendix summarizes all variables and data sources, whereas Table A5 provides pairwise correlations.

Regression analysis

Next, I use regression analysis to estimate the relative impact of each soft diffusion channel on local climate adaptation policy while controlling for the potential confounders described above. Because

the CAPI and its dimensions have nonnegative right-skewed distributions, I estimate Poisson regression models with robust standard errors clustered at the county level. This approach is appropriate for such distributions, and scholars have argued that it is preferable to transforming the dependent variable, which can lead to biased estimates in the presence of heteroskedasticity (Silva & Tenreyro, 2006; Wooldridge, 2010, pp. 723–767).

However, the analysis of the institutionalization dimension is further complicated by the large number of zero values due to the presence of municipalities with no measured institutionalization efforts (100 out of 190 observations). A two-part model such as the zero-inflated Poisson model could address this problem, but it would assume two separate data generating processes for zero and nonzero outcomes. Thus, one would have to assume that the reasons why municipalities become active in institutionalizing adaptation (at all) are different from those that determine the level of their institutionalization efforts, which would be difficult to defend. Therefore, I prefer to estimate Tobit models for the institutionalization dimension that assume a single data-generating process in which zero values arise due to censoring (Boulton & Williford, 2018). In doing so, I essentially assume that my measurement instrument, which primarily captures the creation of plans, new staff positions, and interagency working groups for adaptation, is in fact not sensitive enough to identify more limited and nuanced institutionalization efforts. These may include, for example, assigning new adaptation responsibilities to existing staff or increasing budgets for adaptation. Smaller municipalities in particular may rely on such more limited institutionalization steps.

Table 3 shows the results of the Poisson and Tobit models. The first models include only the diffusion channels, and the next models also include the control variables. As a robustness check, I also estimate Poisson models for the institutionalization dimension and run linear regressions after square root transformation of the dependent variables, which yields very similar results (see Appendix Tables A6 and A7).[18]

The first two models show that all soft policy diffusion channels yield positive coefficients, with those for autonomous, collaborative, exemplary, and funded diffusion reaching conventional levels of statistical significance. When the control variables are added, the coefficients for the autonomous, exemplary, and funded diffusion channels decrease in magnitude but remain statistically significant, while the coefficient for the collaborative diffusion channel becomes very small and insignificant. According to Model 2, all else being equal, the CAPI increases by 43% for municipalities that have received external funding, by 33% for municipalities located in counties with adaptation strategies, and by 22% for municipalities that autonomously exchange adaptation information with other municipalities. The latter result implies that local adaptation policy diffusion in Hessen can also be attributed to self-organized, horizontal exchanges, even when controlling for participation in more coordinated channels.

Regarding the institutionalization dimension, the full Tobit model yields significant and positive coefficients for exemplary, organized, and funded diffusion. The estimated effects are sizeable. According to Model 4, municipalities located in counties with adaptation strategies have a 1.3-point higher institutionalization score than those located in other counties, all else being equal. The score is 1.2 points higher for members of the *Klima-Kommunen* and nearly two points higher for municipalities that received external adaptation funding. These results are consistent with those of Kern et al. (2023), who found that the spread of adaptation strategies among Germany's 104 largest cities is strongly associated with the so-called Kommunalrichtlinie (KRL), a federal funding line established in 2008 to promote the development of municipal climate strategies.[19] Overall, these findings suggest that higher levels of government can play an important role in institutionalizing adaptation at the local level by setting an example, creating formal policy networks, and providing financial incentives.

Regarding the second dimension, that is, the density of adaptation measures, only the coefficient of the autonomous diffusion channel is consistently significant at conventional levels. According to Model 6, Hessian municipalities that report having interacted with other municipalities on adaptation issues have a more than 20% higher score in the measures dimension than those that do not report such interactions. Interestingly, none of the channels significantly associated with the institutionalization dimension are significant predictors of adaptation measures.

TABLE 3 The impact of soft diffusion channels on local climate adaptation policy output.

	CAPI		Institutionalization		Measures	
	(1)	(2)	(3)	(4)	(5)	(6)
Autonomous diffusion	0.305***	0.198**	1.043*	0.648	0.251***	0.182**
	(0.086)	(0.087)	(0.561)	(0.422)	(0.077)	(0.091)
Collaborative diffusion	0.635***	0.026	2.397***	−0.238	0.455***	0.043
	(0.126)	(0.143)	(0.809)	(0.722)	(0.108)	(0.132)
Exemplary diffusion	0.464***	0.291***	2.316***	1.316***	0.209***	0.099
	(0.078)	(0.084)	(0.328)	(0.347)	(0.067)	(0.071)
Persuasive diffusion	0.025	0.090	0.068	0.385	0.100	0.146*
	(0.100)	(0.084)	(0.517)	(0.477)	(0.090)	(0.087)
Organized diffusion	0.091	0.011	1.566**	1.146**	−0.035	−0.101
	(0.099)	(0.075)	(0.653)	(0.530)	(0.108)	(0.099)
Funded diffusion	0.524***	0.359***	2.555***	1.947***	0.270**	0.129
	(0.116)	(0.103)	(0.610)	(0.484)	(0.111)	(0.102)
Population size (log)		0.253***		1.067***		0.199***
		(0.075)		(0.376)		(0.060)
Population growth		0.007		0.092**		−0.005
		(0.009)		(0.046)		(0.008)
Tax revenue p.c. (log)		0.018		0.288		−0.030
		(0.089)		(0.535)		(0.060)
Public debt p.c.		−0.037		0.327		−0.092**
		(0.052)		(0.237)		(0.042)
Industrial employment		0.001		0.013		−0.000
		(0.004)		(0.016)		(0.004)
Green seats		0.006		0.031		0.005
		(0.008)		(0.052)		(0.005)
Extreme weather		0.061*		0.016		0.074**
		(0.036)		(0.164)		(0.031)
Climate awareness		0.155**		0.499		0.173***
		(0.073)		(0.318)		(0.066)
AIC	617.568	597.878	566.756	551.321	724.251	703.840

Note: $N = 190$. Robust standard errors (clustered at the county level) are in parentheses. (1), (2), (5), and (6) are Poisson models. (3) and (4) are Tobit models.

$*p < 0.10; **p < 0.05; ***p < 0.01$.

Overall, these results demonstrate that the proposed framework can aid in the analysis of multilayered diffusion processes by disentangling the effects of different channels. Identifying and comparing channel effects can not only advance policy diffusion research but also inform policymakers on how to govern diffusion processes and design potentially effective interventions. For example, the present results suggest that such interventions play a more important role in the local institutionalization of adaptation, while the diffusion of adaptation measures is driven more by noninstitutionalized exchanges among local peers without the involvement of higher levels of government.

The results for the control variables consistently show that larger municipalities have higher adaptation policy scores in both the institutionalization and measures dimensions. This result is consistent with many previous studies of local climate policy (e.g., Krause, 2011; Schoenefeld et al., 2022; Zeigermann et al., 2022). Another notable finding is that extreme weather experience and climate awareness among

local governments are seemingly unrelated to adaptation institutionalization but are significant and positive predictors of adaptation measures. This finding contradicts the notion that increasing climate impacts will eventually encourage the development of adaptation strategies (Aguiar et al., 2018). Rather, they suggest that vulnerability and awareness lead to functional, reactive responses in terms of concrete adaptation measures but do not seem to systematically translate into a broader strategic and more proactive response in terms of institutionalizing adaptation (see also Buschmann et al., 2022). These findings are broadly consistent with Patterson's (2021) research, which suggests that institutional adaptation cannot be viewed as a direct and rational response to increasing climate risks but rather depends on additional factors, including actor preferences and political pressures.

Selection issues

Before jumping to conclusions about the effects of diffusion channels, it is important to carefully consider potential selection bias. The first concern relates to nonresponse bias. Table 4 reveals that the sample reflects the population of all Hessian municipalities quite well with respect to the control variables. However, the sample has a significantly higher membership in both the Climate Alliance and the *Klima-Kommunen*. A probit model estimating inclusion in the sample shows that *Klima-Kommunen* membership is indeed a significant predictor, even when controlling for the other variables, while Climate Alliance membership is not (mainly due to its high correlation with population size).

Sample selection based on the values of the organized diffusion variable would make the estimates less certain, but it does not create an inference problem. However, it is also possible that municipalities that are more active in adaptation policy were also more likely to respond to the survey. This selection rule essentially censors less active municipalities that are not members of the *Klima-Kommunen*, which should attenuate the causal effect estimates of this channel. Thus, the analyses may underestimate the true effect of the organized diffusion channel.[20]

In addition to nonresponse and selection on observable variables, potential bias may also be related to selection on unobservable variables (i.e., omitted variable bias). In addition, simultaneity may exist if more active adaptation policymakers are also more likely to participate in diffusion channels, while at the same time, these channels promote adaptation policy development. For example, more active municipalities may be more likely to share their experiences with other municipalities in noninstitutionalized exchanges and/or to join networks driven by a desire to legitimize their past policy actions.

TABLE 4   Comparison of the study sample and the population of all Hessian municipalities.

	Sample (*n* = 190)		All municipalities (*n* = 422)		Probit (*n* = 422)	
	Mean	Count (%)	Mean	Count (%)	*b*	SE
Collaborative diff.	0.18	34 (18.9)	0.12	50 (11.9)	0.328	(0.272)
Exemplary diff.	0.09	18 (9.5)	0.10	41 (9.7)	−0.000	(0.112)
Organized diff.	0.70	132 (69.5)	0.52	252 (59.7)	0.354*	(0.173)
Pop. size (log)	9.22		9.04		0.161	(0.131)
Population growth	0.50		−0.01		0.000	(0.008)
Tax rev. p.c. (log)	6.33		6.29		0.014	(0.096)
Public debt p.c.	1.29		1.23		0.090	(0.082)
Industrial empl.	30.82		32.78		−0.005	(0.004)
Green seats	6.58		6.05		−0.006	(0.012)
Pseudo R^2					0.048	

Note: The sample mean is significantly different from the population mean at $p < 0.05$. The probit model is estimated with robust standard errors (clustered at the county level) in parentheses.

*$p < 0.05$.

Dealing with potential selection bias in a nonexperimental and cross-sectional setting is quite challenging. Here, I rely on three strategies used in previous studies estimating climate network effects (Krause, 2012; Lee & Koski, 2014), namely, propensity score matching (PSM), endogenous treatment effect (ETE) models, and instrumental variable (IV) regression, which together can increase the confidence in the regular regression results. Details of each strategy and the results are provided in the Appendix. They generally confirm the regular regression results, with organized and funded diffusion being the most robust predictors of adaptation institutionalization, while the measures dimension is most robustly associated with autonomous diffusion. However, it should also be noted that the model diagnostics generally suggest that the regular regression approach may be more appropriate.

Conditional effects

To date, the models assume that each diffusion channel is equally important for the development of adaptation policy in each municipality. However, the policy effects of diffusion channels may vary according to the characteristics of the municipalities, for example, because learning depends on institutional design or the predispositions of actors (Dunlop & Radaelli, 2018; Gerlak et al., 2018). Based on the initial regression results, I suspect that differences in the size of municipalities, their experience with extreme weather, and climate awareness may play a role. I investigate such conditional effects by estimating a series of interaction models in which each channel interacts with the three variables mentioned above. Appendix Table A9 presents the full regression results, while Figure 1 shows the (only) substantial interaction effect identified.

Figure 1 shows that external adaptation funding tends to have a stronger effect on the institutionalization of adaptation in larger municipalities. In contrast, such an effect does not seem to exist for the development of concrete adaptation measures. This suggests that larger municipalities, which typically have greater capacity to apply for external grants and implement funded projects, may also be able to use adaptation funding more effectively for institutional development. In contrast, smaller municipalities often lack the capacity to submit project proposals (see Appendix Table A10), but funding may also have less policy impact in these municipalities. In general, these results suggest that reducing application and implementation burdens could help smaller municipalities adapt to climate change such as by reducing co-financing requirements and providing more support for project implementation. However, these results must be taken with a grain of salt, as the analysis did not assess the amount of funding municipalities received or any other project characteristics.

In this context, it is important to note that most of the interaction terms between population size and diffusion channels yielded insignificant coefficients. Therefore, while this study confirms that municipal size generally plays a role in local adaptation policymaking, it also suggests that conditional diffusion effects associated with size may vary depending on the diffusion channel and mechanism in question (see also Kim et al., 2018; Taylor et al., 2023).
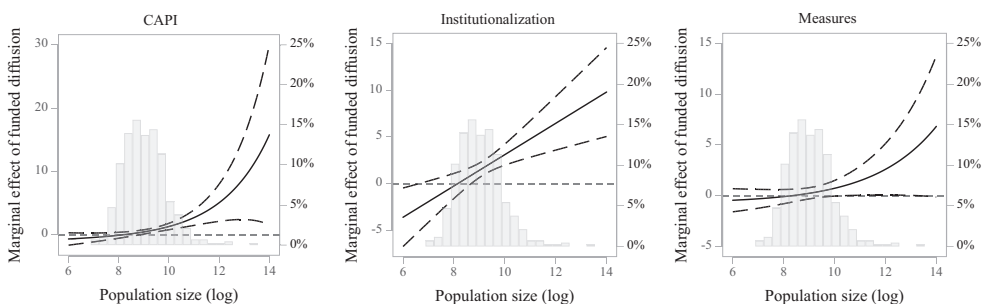
FIGURE 1 The effect of funded diffusion is conditional on population size.

CONCLUSION

Diffusion has not only become a crucial concept for studying policy spread but also provides higher levels of government with options beyond explicit mandates to promote their desired policies at lower levels of government. However, the prevailing mechanism-centered policy diffusion concept poorly captures these options, which remain scattered across the literature. To address this gap, this article proposed a new channel-centered framework that systematically incorporates these options, taking into account both horizontal and vertical dynamics. This study demonstrates that distinguishing between and comparing different channels can advance policy diffusion research and offer valuable perspectives for policymakers, even when the underlying mechanisms are indistinct.

Specifically, the empirical results indicate that the diffusion of adaptation policies among Hessian municipalities can be attributed to various "soft" interventions by higher levels of government and to noninstitutionalized exchanges between municipalities. The former is particularly associated with the institutionalization of adaptation, and the latter is associated with the density of concrete adaptation measures. These findings are broadly consistent with the growing body of (comparative) case study evidence highlighting the importance of the different diffusion channels for local adaptation policymaking and implementation (Vogel et al., 2020). For example, EU and national-level funding, as well as participation in nationally or regionally organized networks, have been identified as key drivers of adaptation policies, especially strategic adaptation planning, among very different local authorities in countries as diverse as Italy, Finland, Sweden, France, Germany, Norway, Canada, and the United Kingdom (Bauer & Steurer, 2014; Dannevig et al., 2012; Keskitalo et al., 2013; Simonet & Leseur, 2019). Recently, Buschmann et al. (2022), based on a qualitative analysis of 11 small municipalities in Bavaria, Germany, also recommended strengthening the two aforementioned channels to improve local adaptive capacities. Overall, these findings remind researchers that several different channels (and mechanisms) can drive policy diffusion and that diffusion effects may vary depending on the type of policy under study (Makse & Volden, 2011; Zhou et al., 2019). The proposed framework provides guidance for better distinguishing and comparing such effects, which in turn can inform the development of effective multilevel governance for policy diffusion.

Although the present study provides novel conceptual and empirical findings, it is important to note its limitations. First, although the response rate was higher than that in comparable studies, as discussed above, there may still be some nonresponse bias. Second, while the binary measures of the diffusion channels used in this study simplify the analysis, they do not capture the intensity of the interactions associated with each channel. To obtain more precise estimates of channel effects, future research could use more nuanced measures, such as exact funding amounts or more detailed assessments of the interactions between municipalities and networks. Third, the lack of longitudinal data is a major limitation. In fact, the present study did not directly model diffusion processes but inferred from observed outcomes the possible underlying diffusion processes. Future studies should use longitudinal data to track the operation of different diffusion channels over time. Such designs would also be much better equipped to address the simultaneity problem in identifying channel effects. In addition, they are able to examine which channels are more important at which stages of the diffusion life course (Mallinson, 2021a). Finally, it is important to acknowledge the limitations of the study's generalizability due to its focus on a specific policy area within the context of the rich multilevel governance structure of a Western European democracy. To assess the usefulness of the developed framework, it must be tested beyond the current case used for its development. Applying the framework to other policy areas and examining how multiple soft diffusion channels operate in different multilevel environments would allow for more generalizable conclusions. This could also uncover different contextual conditions that influence channel effects (Kern et al., 2023).

Going forward, the channel-centered framework can provide guidance for a number of future analyses. To this end, the approach is flexible enough to be adjusted to specific contexts and research needs. First, while the proposed framework provides a comprehensive overview of soft channels discussed in the literature, exactly how many and which channels to consider will ultimately depend on the research context

and interests. Second, the framework can be modified and extended to capture more specific interactions within each type of channel. For example, if partisan ideology is expected to influence policy diffusion (Gilardi & Wasserfallen, 2019; Mallinson, 2021b), observable channels beyond the shared partisanship of governments could be conceptualized as noninstitutionalized exchanges between actors of the same party or as more formalized interactions such as regional or national party conventions. Within the exemplary diffusion channel, various types of signals sent by higher levels of government may be distinguished, such as the initiation of national debates and legislation (Karch, 2012; McCann et al., 2015). Policy networks, whether membership-based or state-run, may be further distinguished depending on their functions and governance arrangements (de Francesco et al., 2020) or the spatial scales at which they operate (Hamilton & Lubell, 2018). Third, the framework could be extended beyond soft channels to achieve a more comprehensive concept, particularly for studying policy areas and contexts where more coercive mechanisms, including competition, can drive policy diffusion and present governance options (Benz, 2007).

Finally, researchers should explore the possibility that channel effects are interdependent (Gilardi & Wasserfallen, 2016). For example, municipalities may be able to use external funding more effectively in conjunction with expertise and support from relevant networks of which they are members. In contrast, some channels may be less effective in the presence of others. For instance, noninstitutionalized exchanges may become less important for members of formal networks (Kern, 2019). Answering such questions is vital not only for exploring the governance potential of policy diffusion but also for theorizing policy diffusion processes.

CONFLICT OF INTEREST STATEMENT

The author has no conflict of interest to declare.

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ENDNOTES

[1] Eventually, the extent to which different mechanisms (if applicable) influence policy diffusion in a given diffusion channel may vary depending on the characteristics of the channel, the linked jurisdictions, and the diffusing policies. However, distinguishing the relative importance of mechanisms is, as already stated, beyond the scope of this article.

[2] https://www.climatealliance.org/about-us/klima-buendnis-services.html.

[3] Higher levels of government sometimes deliberately mix these governance resources, for example, by conditioning their funding decisions on the participation of recipients in networks or on the participation of networks in project consortia.

[4] For example, conditional grants, which are regularly awarded to states in the US and account for a considerable portion of their revenue, would be excluded from the funded diffusion channel.

[5] While the resources and mechanisms associated with funded diffusion may seem straightforward, it is important to note that additional resources may come into play depending on the funding program in question. For instance, Kern (2019) emphasizes that the implementation of the German federal government's main program for funding local climate projects, the so-called Kommunalrichtlinie (KRL), involves close cooperation between municipalities, the federal environmental ministry, and additional service partners such as research institutes that can assist in project implementation. The empirical analysis of this study can be seen as an effort to disentangle such effects.

[6] The ways in which adaptation policies may give rise to and be influenced by competitive behavior remain largely unknown (Schoenefeld et al., 2022, p. 5). However, jurisdictions may increasingly view their adaptation capabilities as a competitive edge (Ko & Prakash, 2022), which could pave the way for more competitive adaptation policy diffusion and warrant further investigation.

[7] In November and December 2023, the German legislature passed a national climate adaptation law that requires all German jurisdictions, including the states and municipalities, to prepare adaptation plans and take necessary precautions to deal with climate impacts. However, the law does not include any funding provisions, so it is unclear at the time of writing how it will enter into force in 2024.

[8] Legally, German municipalities must consider the goals of climate mitigation and adaptation in the execution of their duties (*Berücksichtigungsgebot*). However, these goals *do not have unilateral priority* over other responsibilities. Therefore, German municipalities are free to prioritize other responsibilities over climate action, which may, for example, also justify additional emissions.

[9] To be precise, the analysis encompasses both independent cities and municipalities. For the sake of brevity, I refer to them collectively as "municipalities."

[10] At the time of data collection, Hessen had 422 municipalities. This number was reduced to 421 in 2023, as a result of a municipal merger.

[11] These figures underscore the importance of including smaller municipalities in adaptation policy research.

[12] www.iwu.de.

[13] The Appendix to this paper contains a list of the survey questions used to construct the independent variables.

[14] www.climatealliance.org.

[15] Other membership-based networks have little presence in Hessen. For example, Eurocities only has one member (Frankfurt am Main) and the ICLEI has no members at all.

[16] www.klima-kommunen-hessen.de.

[17] By 2023, membership had risen to 345 municipalities (82%). In contrast, the Covenant of Mayors has only gained membership from three large cities in Hessen.

[18] Policy diffusion research typically employs spatial lags of the dependent variable as predictors. However, this approach is not suitable for testing the soft channels framework for several reasons. First, only the two climate network variables (i.e., collaborative and organized diffusion), would enable the specification of a connectivity matrix. Second, even in the case of the two climate networks, the framework explicitly states that their effects cannot be reduced to adapting to and learning from the policies of other network members. Rather, it is argued that networks also provide, for example, consulting services and legitimacy for policy action. Finally, it should be noted that spatial diagnostics from a fully specified model (i.e., including all control variables) using connectivity matrices constructed from membership in the two climate networks, membership in the same county, neighborhood, and geographical proximity revealed no evidence of spatial error or spatial lag dependence (see Appendix Table A8). This suggests that a nonspatial approach can be used (Darmofal, 2015).

[19] More precisely, the KRL funds the preparation of climate mitigation and integrated climate mitigation and adaptation strategies as well as climate (protection) managers. In 2021, after the survey, federal funding lines were adjusted to fund specifically the development of adaptation strategies and, since 2022, the appointment of adaptation managers.

[20] Technically, the selection rule may introduce collider bias if membership in the *Klima-Kommunen* and adaptation policy activity is both impacting the response rate, making it less likely to find a positive association between the two variables.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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