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The Politics of Policy Robustness: A Central Paradox and Computational Review of Adaptive Policymaking

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ABSTRACT

Policy robustness, that is, the capacity of policies to sustain performance across diverse and uncertain futures, is increasingly considered a core objective of public policymaking. Although adaptive policymaking is widely promoted as an approach to achieving policy robustness, it suffers from a central paradox highlighted by theories of the policy process: mechanisms intended to enable ongoing adjustment can generate entrenchment and opportunistic behavior through coalition stabilization, self-reinforcing feedback, institutional friction, and strategic agenda setting. While present in all policy systems, this paradox is likely more pronounced in the Global South, where high uncertainty and constrained administrative capacity intensify the political mechanisms that undermine adaptive policymaking. Despite rapid growth in the literature on policy robustness, it remains unclear to what extent this scholarship engages with the political processes through which policy adaptation unfolds over time. This study addresses that gap through a computational review of more than 300 publications on policy robustness and adaptive policymaking. The findings show that research in this area is dominated by domain-specific applications and methodological innovation, with limited attention to political dynamics. Governance perspectives are comparatively marginal, and explicit engagement with theories of the policy process is virtually absent. As a result, policy adaptation is largely conceptualized as a design problem rather than as a contested political process. The article concludes by explaining why this omission matters for theory and practice and by identifying avenues for integrating political analysis into future research on policy robustness.

1 | Introduction

Governments are increasingly tasked with crafting policies that remain effective under conditions of deep uncertainty. Complex challenges such as climate change, demographic transitions, and rapid technological developments disrupt expectations of stable policy environments, requiring policymakers to anticipate, plan for, and navigate a wide range of plausible futures (El-Taliawi and Hartley 2021). In this context, approaches such as adaptive policymaking, dynamic policy pathways, and robust decision-making have gained traction (Haasnoot et al. 2019) (Capano and Woo 2018). These approaches share a common aim: policy robustness, that is, designing policies that can maintain performance over time while accommodating new information and emerging risks.

However, policy adaptation is not determined by technical design features alone. It unfolds as a political process shaped by the interplay of actors, events, ideas, and institutions (Howlett et al. 2020) (Migone et al. 2024). This gives rise to a central paradox: mechanisms intended to enhance adaptability, such as continuous monitoring, iterative adjustment, stakeholder engagement, and thresholds or triggers, can generate new forms of rigidity or opportunistic behavior (Capano and Toth 2022).

They may strain analytical capacities, consolidate coalitions, reinforce path dependence, or create openings for policy termination (Mirnasl et al. 2022). Without sustained attention to the political context, tools that aim to facilitate policy adaptation may instead entrench policies over time.

These dynamics, while relevant globally, are especially consequential in countries in the Global South. Governments operating in these contexts face acute uncertainty and complexity in advancing sustainable development goals, as climate change, large-scale displacement, geopolitical realignments, and rapid technological change continually reshape policy environments (El-Taliawi 2024). Yet constrained administrative capacity, fragmented institutional arrangements, entrenched power asymmetries, and centralized modes of coordination limit the scope for meaningful policy adjustment in practice (El-Taliawi and Van Der Wal 2019). Existing scholarship demonstrates that while policy adaptation and change does occur, it is frequently driven by external or political pressures such as aid conditionality, fiscal stress, leadership turnover, or vested interests, rather than by purposive adaptive policy design (John 2018) (Shearer et al. 2016). Consequently, policy adaptation often becomes largely symbolic, as flexible frameworks are circumscribed by rigid institutional and political structures (Migone et al. 2024).

Understanding the politics of adaptation is, therefore, essential for assessing whether adaptive policymaking can deliver on its promise in such settings where uncertainty is acute, adaptation constrained, and failure carries costs for sustainable development. While the broader literature on policy robustness has developed increasingly sophisticated tools for managing uncertainty (Howlett and Mukherjee 2018), whether it has incorporated the political realities that determine whether policies remain adaptive over time remains unclear. This paper addresses this gap through computational review of the policy robustness literature, assessing to what extent and how political dimensions have been considered. In particular, we examine whether and how studies in this research area engage with the political process of policy adaptation.

To this end, we use bibliometric analysis, that is, quantitative techniques for mapping a large volume of scholarship based on its publication metadata (such as sources, cited references, titles, and abstracts). For an exploratory study such as this, bibliometric analysis offers a systematic way of obtaining a broad view of the research on policy robustness without pre-emptively narrowing its scope. In addition, it enables us to identify conceptual or theoretical perspectives and influences that are not specified a priori and not explicitly foregrounded.

Within this framework, we specifically examine references to four prominent "theories" of the policy process: the advocacy coalition framework (ACF), the multiple streams framework (MSF), policy feedback theory (PFT), and punctuated equilibrium theory (PET). They were selected because they are among the most widely used approaches for explaining policy change and stability. Further, each theory illuminates (complementary) mechanisms directly relevant to policy adaptation. At the same time, our analysis of highly cited references allows us to capture additional theoretical influences beyond these four theories. By evaluating the thematic structure, theoretical engagement, and disciplinary orientation of the literature, this study highlights the limitations of current approaches and their implications for theory and practice. In doing so, the article contributes to ongoing debates in public policy regarding the relationship between governance, policy design, and political dynamics under conditions of uncertainty.

2 | Characteristics of Adaptive Policymaking

Policy robustness refers to the capacity of policies to perform effectively across a wide range of uncertain futures, rather than optimizing for a single predicted outcome (Howlett and Ramesh 2023). Unlike resilience, which emphasizes recovery from shocks (Comfort et al. 2010), or flexibility, which focuses on ease of change, robust policies are designed to maintain effectiveness under multiple, sometimes conflicting, scenarios. In contrast to static policies designed for a predictable environment, robust policies are crafted to be adaptable, responding effectively to changing societal needs, emerging risks, and new information. The essence of robustness lies in anticipating the unknown and enabling governance systems to navigate uncertainty without reacting impulsively or succumbing to fragility.

Several defining features characterize robust policies. Adaptiveness ensures that policies evolve through periodic adjustments informed by iterative monitoring and evaluation. Flexibility permits incremental modifications without requiring disruptive overhauls. Redundancy (i.e., the incorporation of multiple pathways or solutions), helps maintain viability when individual approaches fail. Modularity structures policies as independent components, facilitating updates without destabilizing the overall system. Together, these attributes provide a foundation for robustness and help policies withstand uncertainty.

While technical design features matter, governance structures determine whether these principles can be operationalized in practice. Polycentric governance is often advocated because distributing authority across multiple decision-making centers enhances adaptability while maintaining coherence (McGinnis 1999) (Ostrom 2010). Stakeholder participation ensures that diverse perspectives inform policymaking, reducing the risks of blind spots and rigidity. Transparency and accountability mechanisms bolster trust in the policymaking process, supporting course corrections when policies deviate from intended outcomes.

In addition to their structural components, robust policies depend on behavioral characteristics that support adaptability. Institutional learning, which involves integrating insights from past experiences, allows policies to be refined over time (Sanderson 2009). Robust policies also embrace uncertainty, prioritizing preparedness over exactness in situations where outcomes are inherently unpredictable. Scenario-based planning offers a systematic method for imagining plausible futures and developing flexible, forward-looking strategies (Chakraborty et al. 2011). Yet, the capacity to learn and adapt is not inherent; it is influenced by political motivations, organizational cultures, and power relations.

While policy robustness is often framed in technical or methodological terms, its success is fundamentally shaped by institutional and political realities. The next section examines these dynamics and the ways in which mechanisms designed to embed robustness may, in practice, create obstacles to adaptation.

3 | The Paradox of Adaptive Policymaking

Theories of the policy process provide valuable insights into how policies evolve, stabilize, and sometimes become entrenched over time. Four prominent lenses, including the advocacy coalition framework (ACF), policy feedback theory (PFT), punctuated equilibrium theory (PET), and the multiple streams framework (MSF), offer complementary explanations of these dynamics. Our focus on these theories is illustrative and not exhaustive: they are widely used, empirically developed, and directly relevant to understanding policy adaptation as a process shaped by institutional and political forces. Although proposed in the Western context, these theories have been applied to explain policy change in the context of sustainable development in the Global South (Goyal et al. 2020; Jarvis and He 2020; Cisneros 2025).

The ACF emphasizes the role of coalitions that form around shared belief systems and compete over policy changes within subsystems (Sabatier 1988). In theory, adaptive policymaking benefits from coalition-building, as stakeholder engagement fosters legitimacy and inclusivity. Yet, these same coalitions can introduce rigidity by reinforcing dominant narratives and filtering out competing perspectives. Participatory processes may inadvertently empower entrenched actors who shape learning processes on their own terms, narrowing the range of feasible adaptation. As coalitions develop vested interests in specific pathways, the policy process may become resistant to transformative shifts, limiting the flexibility that adaptive approaches seek to promote.

PFT highlights how policies shape their own political environment through interpretive and resource effects that influence future policy choices (Mettler and SoRelle 2018). Adaptive policymaking, with its emphasis on iteration and responsiveness, might seem to counteract path dependency. However, adaptive architectures, such as funding streams, decision-making processes, and institutional norms, can generate reinforcing feedback loops. Resource effects channel administrative effort and investment toward specific adaptation pathways, making alternative strategies economically or politically more difficult. Meanwhile, interpretive effects shape how actors understand risk and uncertainty, entrenching certain framings while marginalizing others. As these "adaptive" mechanisms become institutionalized, flexibility can give way to new forms of entrenchment.

PET explains why policy change often consists of long periods of stability punctuated by short bursts of rapid transformation due to policy monopolies, institutional friction, and limited capacities for information processing (Baumgartner et al. 2018). The principles of adaptive policymaking, including modularity, scenario planning, and trigger detection, seek to avoid stagnation by ensuring continuous learning and gradual adjustment. However, institutional inertia may limit their impact. Modular designs can still meet resistance when actors disagree on which components to revise, creating conflict and stalling adaptation. Further, information processing constraints mean that even when triggers signal the need for change, policymakers may downplay or ignore them to maintain policy stability. In some cases, adaptive policymaking may reinforce incrementalism, reducing the likelihood of more substantial policy adaptation.

The MSF examines how problem, policy, and political streams align during windows of opportunity for policy change (Kingdon 1984). Robust policies, with their frequent evaluations and iterative adjustments, may generate more such opportunities for adaptation. Yet, they can also produce instability as policy entrepreneurs use review cycles to reset the policy agenda, generating a new policy cycle rather than policy adaptation. In resource constrained settings, these dynamics may be intensified. Adaptive policies, often shaped by external donors or shifting political alignments, may become less durable over time.

Across these perspectives, a recurring paradox emerges in that although adaptive policymaking is designed to foster robustness, the institutional and political contexts in which it operates can reinforce constraints that limit genuine adaptability. Entrenched coalitions may resist disruptive shifts, feedback effects could create new path dependencies, continuous monitoring might overwhelm analytical capacities, and iterative reviews can lead to destabilization rather than resilience. The challenge, therefore, is not simply to design adaptive policies, but to understand the conditions under which their core features promote responsiveness rather than entrenchment. Recognizing these tensions is essential to ensuring that adaptive policymaking does not inadvertently contribute to the very rigidity it seeks to overcome.

Research on policy reform and implementation in the Global South shows how this paradox plays out on the ground. In many cases, adaptation arises less from intentionally designed adaptive tools and more from negotiated, ad hoc adjustments shaped by power imbalances, fragmented authority, and uneven administrative capacity (El-Taliawi 2024; Saguin and Ramesh 2025). Powerful actors often shape the direction of participatory processes, frontline officials modify externally introduced models to fit institutional realities, and learning across levels breaks down when incentives do not align or when support structures are insufficient (Dearden et al. 1999). Reform processes typically unfold gradually and in hybrid forms; influenced by shifting alliances, prevailing political bargains, population dynamics, and established informal practices (Andrews 2015). These studies demonstrate that efforts to promote flexibility are inevitably shaped by political and institutional contexts that limit when, and how, and for whom adaptation can occur; often reproducing the very rigidity and drift that adaptive policymaking aims to prevent (Gutheil 2020).

4 | Research Design

This study combines computational text analysis with a bibliometric review to systematically examine the literature on adaptive and robust policymaking.

4.1 | Data Collection

To collate the data for this study, we searched the Scopus database for publications whose title, abstract, or keywords matched the following search query: ("adaptive policy" OR "policy robustness" OR "robust policy") AND (volatility OR uncertainty OR complexity OR ambiguity). We excluded book reviews, meeting abstracts, reprints, and software reviews from our search. After an initial scan, conference publications were also removed as most of them originated from computer science and engaged with robustness primarily in the context of algorithmic optimization rather than governance or policy adaptation. This search, conducted on January 7, 2025, yielded 383 publications.

To further refine the dataset, we conducted an active learning-assisted screening using ASReview (Van De Schoot et al. 2021) (ASReview LAB developers 2025), a machine learning tool to systematically search for relevant publications. The primary objective of this step was to exclude studies that did not explicitly engage with public policy. This ensured that our analysis remained focused on the literature pertaining to public policy rather than applications of robustness in the context of, for example, corporate, hospital, or insurance policy. After this screening, our final dataset consisted of 312 publications on adaptive policymaking.

4.2 | Data Analysis

To identify the thematic clusters in the literature, structural topic modeling (STM) was conducted using the "stm" package in R (Roberts et al. 2025). Before running the topic model, the dataset underwent pre-processing through natural language processing (NLP) techniques, which included tokenization, lowercasing, punctuation removal, phrase detection, part-of-speech filtering, stop word removal, and stemming. These steps were undertaken to enhance the coherence of the resulting analysis. The appropriate number of topics—an input to *stm*—was determined by assessing the output information criteria for models ranging from 5 to 30 topics, with eight topics selected as the most interpretable and representative of the dataset.

To further assess the literature's engagement with policy process theories, we conducted a term-frequency analysis. This involved identifying references to four major theoretical frameworks—the ACF, the MSF, PET, and PFT. For this purpose, we compiled a comprehensive list of key terms associated with each theory based on existing literature, a systematic scan of terms adjacent to "framework" or "theory" in the dataset, and supplementary suggestions from ChatGPT. Our final set of terms ensured that variations in terminology, such as "policy entrepreneur" and "policy entrepreneurship," were accounted using a wildcard character (*). If any term in column 2 of Table 1 below appeared in a publication title or abstract, the corresponding theoretical framework was flagged as being mentioned in that study.

Finally, to assess whether policy process theories—and, more broadly, political science—influences research on adaptive policymaking even if it is not mentioned explicitly in publication titles and abstracts, an analysis of cited references was conducted. The Scopus dataset includes a field for cited references, but entries in this field lack standardization, often containing inconsistencies in formatting, spelling variations, and source names. To address this, a systematic citation normalization process was implemented using the CrossRef API and citation metadata (Hendricks et al. 2020), by retrieving the metadata (authors, title, year, and journal name) for the most relevant standardized entry for each cited reference in our dataset. This enabled more accurate identification of references and journals cited by the literature on adaptive policymaking. Further, this allowed identification of theoretical influences beyond the selected policy process theories and not mentioned explicitly in publication titles or abstracts.

5 | Findings

5.1 | Key Themes in Policy Robustness

The topic model reveals eight key themes within the policy robustness literature, which fall into three broad clusters: technical approaches, domain applications, and governance and evidence (Figure 1).

Four themes focus primarily on approaches for decision-making under uncertainty, reflecting conceptual and computational innovation. These include *Robust optimization* (Theme 1), *Dynamic adaptive policy pathways* (Theme 6), *Tools for adaptive policy design* (Theme 7), and *Modeling complex systems* (Theme 8). *Robust optimization* emerges as the most prevalent theme, emphasizing computational techniques such as stochastic optimization and reinforcement learning to enhance decision-making under uncertainty. These methods are frequently applied to practical domains, including automated transportation systems and energy management, where robust performance across varying scenarios is critical (Gómez-Pérez et al. 2024) (He et al. 2023). Complementing this focus, *Dynamic adaptive policy pathways* approach highlights the integration of near-term actions with long-term objectives through strategies guided by signposts and triggers. This approach, often applied to climate adaptation, enables dynamic responses to deep uncertainty (Haasnoot et al. 2013) (Stephens et al. 2018).

Closely related to *Dynamic adaptive policy pathways*, the theme on *Tools for adaptive policy design* examines frameworks such as adaptive policymaking and decision-making under deep uncertainty. These frameworks provide structured approaches to iterative and adaptive decision-making, addressing challenges in contexts such as project management and traffic safety (Godinho and Branco 2012) (Van der Pas et al. 2013). In contrast, the theme on *Modeling complex systems* delves into the dynamics of emergent phenomena under uncertainty. Studies within this theme use methods such as simulation and exploratory modeling to investigate system-level interactions in socio-technical, environmental, and economic systems (Papachristos 2014) (Pruyt and Kwakkel 2014). While the technical approaches share a common focus on enhancing policy robustness, they vary in their emphasis. Themes such as *Robust optimization* and *Tools for adaptive policy design* center slightly

TABLE 1 | Key terms for identifying policy process theories in the policy robustness literature.

Theory	Term
Advocacy coalition framework	Advocacy coalition*; policy subsystem*; subsystem actor*; belief system*; coalition dynamic*; deep core belief*; policy core belief*; process broker*; coalition competition*; coalition stability*; policy-oriented learning*; policy mediator*; policy broker*
Multiple streams framework	kingdon's stream*; multiple stream*; policy entrepreneur*; policy stream*; problem stream*; politics stream*; window* of opportunity; policy window*; coupling*; coupling strateg*; agenda setting; softening up; focusing event*; garbage can model; political stream*
Policy feedback theory	Policy feedback*; resource effect*; interpretive effect*; policy legac*; path dependence*; institutional effect*; vested interest*; policy durability; policy resilience; policy retrenchment*; self-reinforcing feedback; mass mobilization*; collective action; positive feedback*; negative feedback*; reform resistance*; policy inertia*; stakeholder incentive*
Punctuated equilibrium theory	Punctuated equilibrium*; policy image*; policy monopol*; information processing; attention shift*; institutional friction*; punctuation*; equilibrium period*; rapid policy change*; incrementalism*; critical juncture*; venue* shopping; issue redefinition*

more on optimization techniques and tools, while *Dynamic adaptive policy pathways* and *Modeling complex systems* prioritize a more integrated and systemic approach.

Three other themes focus on applications, reflecting the principles of adaptiveness and robustness in specific policy domains: *Climate change and water management* (Theme 2), *Robust monetary policy* (Theme 3), and *Natural resource management* (Theme 5). The theme on *Climate change and water management* emphasizes strategies for mitigating and adapting to climate change, with a particular focus on water systems. Examples include flood management, afforestation, decarbonization, and wastewater treatment, which collectively underscore the need for integrated, adaptive solutions (Moors et al. 2011) (Haasnoot et al. 2018). In contrast, *Robust monetary policy* explores economic decision-making under uncertainty, particularly in relation to central banks' efforts to balance inflation control, financial stability, and economic growth amidst economic shocks and imperfect information (Leitemo and Söderström 2008) (Gerke and Hammermann 2016).

Meanwhile, *Natural resource management* addresses long-term sustainability challenges, such as biodiversity conservation, greenhouse gas mitigation, and resource use efficiency. This theme frequently focuses on robust policy design to navigate trade-offs between economic development and environmental sustainability (Zhang et al. 2022) (Wang and Li 2024). Although there is overlap between this theme and *Climate change and water management*, the former spans a broader range of environmental resources, extending beyond water systems. Approaches such as *Dynamic adaptive policy pathways* and *Tools for adaptive policy design* often underpin strategies for *Climate change adaptation* and *Natural resource management*, while techniques from *Robust optimization* often support economic resilience in *Robust monetary policy*.

Only one theme in the dataset, *Evidence and governance* (Theme 4), explicitly engages with governance and the institutional dimension of policymaking under uncertainty. This theme examines aspects such as collaborative governance, leadership strategies, and monitoring systems, often with an emphasis on institutional adaptability rather than the politics of policy adaptation. Illustratively, Karamidehkordi et al. (2024) emphasize the role of leadership and social capacities in mobilizing stakeholders for wetlands conservation. However, some studies within this theme explicitly acknowledge the political dimension of governance, particularly in relation to epistemic uncertainty and power asymmetries. For example, Yadav and Bhaduri (2021) interrogate the contested nature of evidence in rare disease policymaking in India, demonstrating how certain forms of knowledge are privileged while others are marginalized. Similarly, Bull et al. (2016) highlight ambiguities in biodiversity policies, such as the notion of "no net loss", which different actors interpret in conflicting ways (Bull et al. 2016). These works underscore how evidence itself can become a site of contestation, shaped by political interest rather than neutral technical assessment.

Taken together, the policy robustness literature remains dominated by approaches (Themes 1, 6, 7, and 8) and domain applications (Themes 2, 3, and 5), emphasizing methodological innovation and problem-solving. While these are highly pertinent, governance-oriented studies (Theme 4) are less prevalent and, despite their contributions, demonstrate limited engagement with institutional inertia, policy process, and power dynamics that shape decision-making under uncertainty. As a result, policy adaptation is largely conceptualized as a matter of institutional design rather than as a political process.

5.2 | Engagement With the Theories of Policy Change

As the policy process does not emerge as a prominent theme in the topic modeling analysis, we examine the extent to which studies in the dataset engage with concepts from four key theories of the policy process: ACF, MSF, PET, and PFT. These

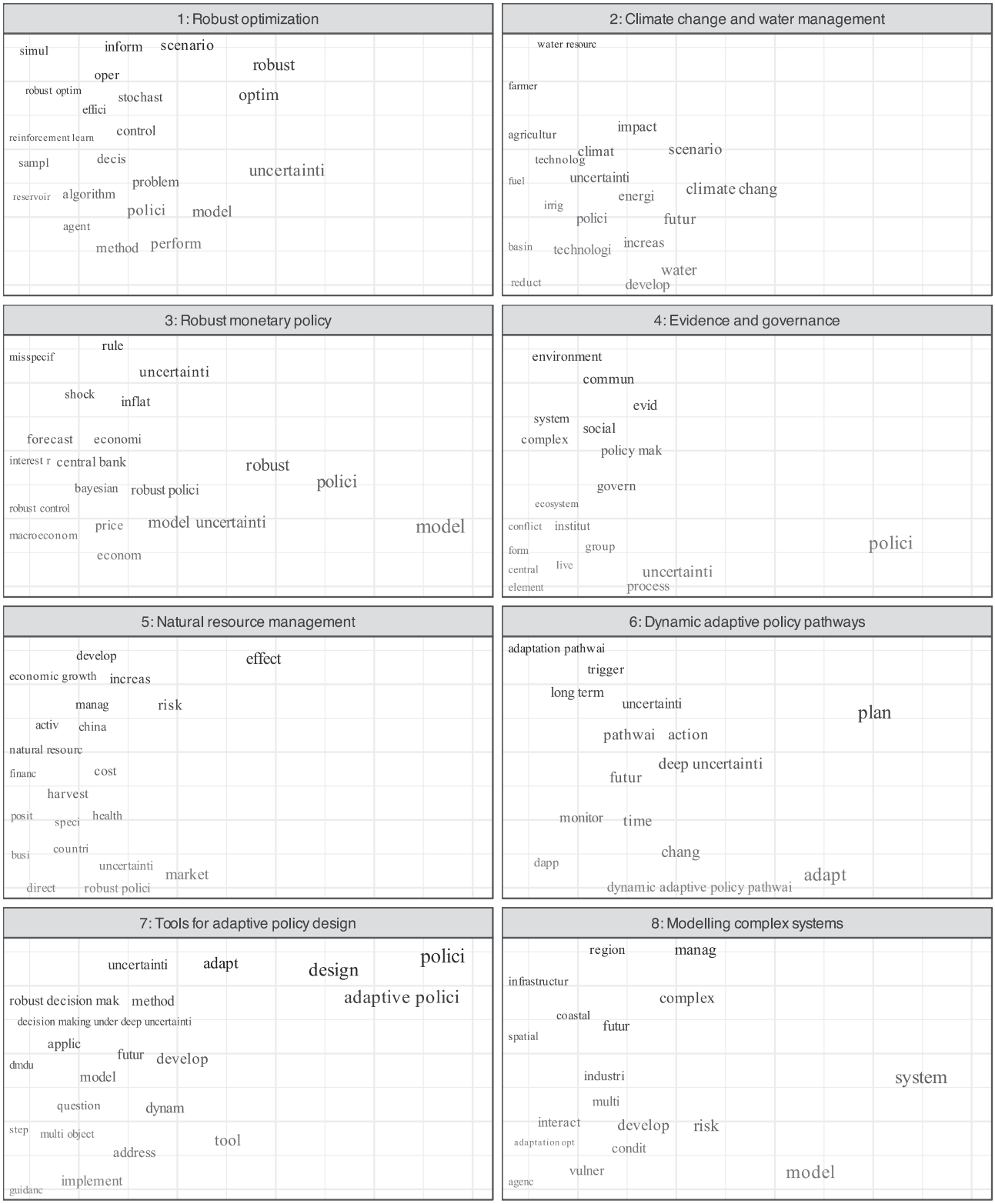

FIGURE 1 | Themes in the literature on policy robustness. Each sub-graph shows terms associated with a theme. The position of a term on the *x*-axis (as well as its size) is indicative of the probability of occurrence of the term within that theme while its position on the *y*-axis (as well as its color intensity) is indicative of the exclusivity of occurrence of the term to that theme. The themes are numbered in descending order of prevalence in the dataset.

theories provide valuable tools for understanding how policies emerge, persist, and adapt over time, yet their presence in the literature on policy robustness is surprisingly limited. Fewer than five percent of the publications in the dataset—15 studies in total—mention terms associated with these theories in their titles or abstracts. Of these, eight reference concepts from policy

feedback theory, six engage with the multiple streams framework, and only one mentions a concept related to the advocacy coalition framework. Punctuated equilibrium theory finds no mention in the dataset. This low engagement suggests that policy robustness research largely overlooks insights from policy process scholarship, reinforcing a view of adaptation as a technical challenge rather than a fundamentally political process.

Studies referencing PFT often do so indirectly, sometimes because of the broad search parameters employed. For instance, while Adamson and Loch (2014) and Scott et al. (1990) employ the terms "negative feedback" and "resource effects", respectively, but not in the context of PFT (Adamson and Loch 2014). Other studies make a more explicit contribution to understanding policy adaptation through a policy feedback lens. Ramm et al. (2018) identify path dependence as a constraint on coastal adaptation planning and suggest participatory approaches to address this. Meanwhile, Nair and Howlett (2016) analyze policy traps created by non-linear changes in the policy context, proposing strategies to avoid, design against, or overcome such traps. Yet, while these studies acknowledge structural constraints on adaptation, they stop short of interrogating the dynamics of policy adaptation or investigating whether adaptive policies may themselves create new forms of rigidity.

Ayers and Kittinger (2014) come closest to examining the institutional dynamics central to policy feedback theory. Their study of the emergence of co-management arrangements in Hawaii's coral reef fisheries identifies resource depletion and conflict as drivers of change and highlights self-organization and consensus-building as critical social responses. By tracing these dynamics, the study offers valuable insights into how institutions evolve under conditions of environmental change. However, it stops short of addressing how these institutional arrangements may become entrenched or contested over time, leaving questions about the longer-term implications of adaptive policymaking unanswered.

Studies referencing the multiple streams framework similarly vary in their depth of engagement. Brouwer and Biermann (2011), for example, explicitly examine strategies employed by policy entrepreneurs in adaptive co-management of Dutch water systems, aligning their analysis with key MSF concepts such as windows of opportunity and coupling. They identify four types of strategies, including attention and support-seeking, linking, relational management, and arena strategies, which entrepreneurs use to influence the timing and venue of decision-making. Their study, thus, highlights a key contention of our study: that policy adaptation is a political process and theories of policy change can shed light on whether and how adaptive policymaking is realized in practice.

Other studies engage with MSF concepts more tangentially. Straub (2024), for example, employs the concept of focusing events alongside a "risk society" analytical framework to analyze how publics construct risk narratives following extreme climate events. Slob and Gerrits (2007) explore how chance events create opportunities for coupling issues and engaging new actors in sediment management policy processes. However, while their work highlights the role of adaptive capacities in shaping responses to these events, it does not address how entrepreneurial actors might strategically exploit such events to advance their policy proposals rather than adaptive policymaking, a key finding of the MSF.

The advocacy coalition framework is represented by only one study in the dataset. In examining Swedish fish stocking policy as a case of adaptive policymaking, Sandström (2011) highlights that differences in policy beliefs, interpretation of formal regulation, and implementation resources of actors involved can result in regional variations in handling environmental and institutional uncertainties. Their finding reiterates the importance of studying the process of policy adaptation and acknowledging the role of policy beliefs and, presumably, advocacy coalitions in influencing change. Yet, it leaves questions around whether and how adaptive policies influence coalition formation, resources, and competition unanswered.

Taken together, these studies reveal limited and uneven engagement with theories of policy change in the literature on policy robustness. Few studies explicitly mention the concepts associated with these theories in their titles or abstracts, and even fewer engage with the key political dynamics investigated by them. This reinforces the broader pattern observed in the topic modeling results: adaptation is primarily conceptualized as a matter of institutional design rather than as a contested political process. However, research that has delved into this process, such as Ayers and Kittinger (2014), Brouwer and Biermann (2011), and Sandström (2011), emphasizes the need for understanding how actors, ideas, and institutions facilitate, or inhibit, policy adaptation.

5.3 | Cited References and Journals

The most frequently cited references underscore the prominence of approaches for decision-making under deep uncertainty. Foundational works such as Haasnoot et al. (2013) on dynamic adaptive policy pathways, Walker et al. (2001) on adaptive policies, and Lempert et al. (2003) on long-term policy analysis exemplify the centrality of adaptive and robust decision-making frameworks in this body of work. These references, along with others focused on exploratory modeling (Bankes 1993), scenario discovery (Bryant and Lempert 2010), and robust optimization (Kasprzyk et al. 2013), highlight the methodological sophistication in addressing uncertainty. They also reflect the field's strong emphasis on developing tools for adaptive planning, rather than exploring the institutional or political dimension of the process.

Yet, the extent to which this literature engages with policy and political studies once again reveals a gap. Key theoretical contributions on policy change, for example, are rarely cited. Kingdon's MSF is cited only five times, while Sabatier's work on the ACF is cited a similarly limited number of times. Pierson's influential work on policy feedback, which directly speaks to the mechanisms through which policies become entrenched or difficult to adapt, is referenced only twice (Pierson 1993). These low citation counts align with the finding that only 15 studies in the dataset explicitly mention concepts associated with policy

process theories. Together, these results suggest a limited uptake of theoretical perspectives that examine how institutional inertia, political environment, and stakeholder dynamics influence the long-term trajectory of policies.

A similar pattern emerges in the analysis of the most frequently cited journals. The dataset is heavily influenced by scholarship published in technical and applied sources, with leading journals including *Environmental Modeling & Software, Global Environmental Change*, and *Climatic Change*—all of which are central to environmental science, modeling, and climate adaptation research. These journals, along with others such as *Technological Forecasting and Social Change*, *Water Resources Research*, and *Energy Policy* provide a platform for studies advancing computational techniques, environmental assessments, methodological innovation, and applied policy analysis. While these sources have contributed significantly to the development of robust decision-making frameworks, they do not typically prioritize theoretical debates on governance, institutional change, or the politics of policy adaptation.

In contrast, journals dedicated to public administration, policy studies, and political science appear far less frequently. *Journal of Political Economy* is the most frequently cited among them, with just 37 citations, followed by *Policy Sciences* ($n = 29$), *Policy and Society* ($n = 26$), *Policy Studies Journal* ($n = 16$) and *Journal of Public Policy* ($n = 14$). Other established sources, such as *Public Administration Review, Public Administration, Review of Policy Research*, and *American Political Science Review*, are each cited in fewer than 10 publications. The relatively few references to these journals further reinforce the idea that the literature on policy robustness has not substantially engaged with broader debates in public administration, policy studies, and political science.

6 | Discussion and Conclusion

Uncertainty has increasingly been recognized as a defining feature of policymaking in complex environments. In response, adaptive and robust policymaking approaches have been proposed as frameworks for navigating uncertainty. However, this study has contended that policy adaptation is not merely a technical challenge: it is fundamentally a political process of policy change shaped by ideas, interests, and institutions. The paradox at the center of adaptive policymaking is that the very strategies designed to enhance flexibility and robustness can, under certain conditions, contribute to rigidity or opportunist overhaul.

This paradox operates through several interrelated mechanisms. First, adaptive policies can generate interpretive and resource effects that shape the expectations and interests of key stakeholders, narrowing the range of politically viable policy trajectories. Second, broad coalitions supporting adaptive policy making may, over time, consolidate around preferred pathways, resisting changes that threaten their core beliefs. Third, institutional friction and limited information processing capacity may blunt the impact of signposts and triggers, reducing the likelihood that desirable adaptations are realized. Fourth, the iterative review cycles can create openings for strategic intervention, enabling policy entrepreneurs to steer adaptation towards their own policy preferences. Together, these mechanisms show how flexibility can become a constraint.

Against this backdrop, a key question is whether and how existing scholarship on adaptive policymaking has engaged with the political process of policy adaptation. Our bibliometric analysis revealed that the field is dominated by methodological and domain-specific research, with limited engagement with the scholarship on policy change. Among the eight themes identified in our topic modeling analysis, only one focused explicitly on governance, and even that did not substantially delve into the politics of adaptation. Further, only 15 studies in our dataset mentioned terms associated with four prominent theories of policy change, and just two analyzed how adaptive policymaking unfolds over time. Finally, an examination of cited references and journals reinforced this pattern, highlighting limited engagement not only with theories of policy change but also the broader work in political science, public administration, and public policy.

These findings underscore a more fundamental tendency observed in public policy scholarship: a strong emphasis on domain-specific and methodological work, often at the expense of analyzing the political processes that shape the presence, timing, and substance of public policy. Similar tendencies have been observed in other reviews of policy-relevant studies. In their review of policy integration literature, for example, Cejudo and Trein (2023) found that while the policy design perspective has been emphasized the political dimension of the phenomenon has been largely neglected in existing scholarship. Similarly, in a review of policy relevant literature on the energy transition, Goyal et al. (2022) argued that despite the frequent mention of policy in the literature, the political process of poli cy innovation was seldom studied empirically (Goyal and Howlett 2023).

One explanation for this disconnect is the "theoretical" nature of policy process scholarship. Weible and Cairney (2018), for instance, argued that studies on the policy process "often assume, rather than demonstrate, that policy process research contains insights that add cumulative and comparable knowledge to the field". This inward tendency can make it difficult for applied policy researchers, policy analysts, and practitioners for identify, extract, and implement lessons relevant to adaptive policymaking. For example, while punctuated equilibrium theory clarifies why and how some systems witness long periods of stability followed by short bursts of rapid policy change, rather than periodic policy adaptation, it offers little explicit, practi cal guidance on designing policies that can navigate deep uncertainty.

A second explanation is that theories of policy change have largely been developed and applied in the context of a relatively stable institutional environment, often within single policy domain at one level of government. Adaptive policymaking, in contrast, arises in complex, dynamic, multi-level settings that involve emerging technologies (Lovell 2007), multiple policy domains (Lovell et al. 2009), and changes in entire policy mixes rather than isolated policy instruments (Kern and Rogge 2018).

In such contexts, mainstream theories may appear ill-suited or only partially applicable.

A further explanation is the separation between research communities working on adaptive policymaking and those analyzing policy dynamics. While scholars of adaptive policymaking tend to publish in domain and methods focused journals, those studying policy change typically publish in journals in political science, policy studies, and public administration. This disciplinary fragmentation has likely hindered sustained dialog, resulting in sparse integration of political dynamics in policy robustness research.

Addressing these gaps presents an opportunity to advance both theory and practice. Future research could explore the long-term political dynamics of adaptive policymaking through longitudinal studies that trace when and why adaptive policies become entrenched or remain flexible. More systematic engagement with theories of the policy process would sharpen this agenda. Research could examine whether and how coalitions emerge or stabilize around adaptive policy designs; how interpretive and resource effects generated by robust policy instruments influence policy adaptation; whether adaptive policymaking alters institutional friction and information processing dynamics; and how signposts, thresholds, and triggers structure opportunistic behavior. Such research would also broaden the empirical foundations of policy process theories and clarify the conditions under which their claims hold.

A related line of inquiry concerns the adoption of adaptive policymaking as a meta-instrument (Simons and Schniedermann 2021), particularly in pursuit of sustainable development in the Global South. Identifying where and why adaptive policymaking is introduced, and where it is resisted, would clarify how institutional context, policy capacity, and political incentives shape its uptake (Andrews 2015) (Brinkerhoff and Brinkerhoff 2015). This would shed light on whether the dynamics hypothesized to limiting policy adaptation here impede its introduction and expand the empirical basis for assessing how theories of the policy process travel in settings marked by deep uncertainty. Moreover, such research would specify the conditions under which adaptive policymaking functions as a governance strategy rather than a policy proposal.

Insights from applied path-dependence analysis also offer a useful complement (Levin et al. 2012). Drawing on mechanisms such as fixed costs, learning effects, coordination effects, and adaptive expectations, Pierson (1993) showed how policy choices generate self-reinforcing processes that make reversal difficult (Nieto Morales et al. 2014). Adaptive policymaking, by contrast, seeks to embed flexibility without creating premature lock-in. Bringing these perspectives together would clarify how to design adaptive instruments that remain durable where stability is necessary while preventing the flexible components from becoming entrenched (Simon and Muñoz 2025). This requires anticipating when benefits, emerging constituencies, and routines created by adaptive policy instruments may generate resistance to later adjustment. Examining these dynamics would help identify the conditions under which policies can be both robust and capable of adaptation.

Without appropriate incorporation of the political dimension into research policy robustness, adaptive strategies risk either failing to take hold under conditions of deep uncertainty or being adopted in forms that are adaptive in name only, embedding new sources of lock-in or enabling opportunistic behavior.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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