PSJ Policy Studies Journal

Policy Studies Journal, Vol. 47, No. S1, 2019

Reconceptualizing the Policy Subsystem: Integration with Complexity Theory and Social Network Analysis

Zachary A. McGee and Bryan D. Jones

The concept of the policy subsystem is an essential building block for several of the basic frameworks of policy process studies. Over time issues have become more complex, crossing subsystem boundaries, and so subsystems have escalated in their complexity as well. It is increasingly insufficient to study just one policy subsystem and so scholars have turned to studying boundary-spanning regimes or policy networks. In this essay, we review the major contributions to developing the concept of a policy subsystem and trace its evolution into broader conceptualizations like issue and policy networks. We argue that the future for theories of the policy process is in more explicit integration of complexity theory and more effective modeling of subsystems with the utilization of social network analysis. In closing, we discuss the enduring nature of the concept of policy subsystems and highlight studies that continue using it in innovative ways.

KEY WORDS: subsystems, policy process, complex systems, governance, social networks, information processing, complexity theory, policy network

政策子系统这一概念对政策过程研究的几个基本框架而言是一个关键性组成要素。随着时间推移，问题通过穿越子系统界限而变得更为复杂，因此子系统也一定会更为复杂。仅研究一种政策子系统已变得越来越不足，因此学者转向研究政策跨界体制或政策网络。笔者在本文中评论了对发展政策子系统概念的主要贡献，并追踪了政策子系统进入例如问题和政策网络等更广的概念化的演变过程。笔者主张，政策过程理论的未来将更明确地融入复杂性理论，并用社会网络分析进行更有效的子系统建模。笔者在文末探讨了政策子系统概念的持续性质，并强调了继续用创新方法使用子系统的相关研究。

关键词: 子系统, 政策过程, 复杂系统, 治理, 社会网络, 信息处理, 复杂性理论, 政策网络

El concepto del subsistema de políticas es un componente esencial para varios de los marcos básicos de los estudios de procesos de políticas. Con el tiempo, los problemas se han vuelto más complejos, cruzando los límites de los subsistemas, por lo que los subsistemas también deben ser más complejos. Es cada vez más insuficiente estudiar solo un subsistema de políticas, por lo que los académicos se han volcado a estudiar regímenes que abarcan límites o redes de políticas. En este ensayo, revisamos las principales contribuciones al desarrollo del concepto de un subsistema de políticas y rastreamos su evolución en conceptualizaciones más amplias como redes de políticas y problemas. Argumentamos que el futuro de las teorías del proceso de políticas está en una integración más explícita de la teoría de la complejidad y

doi: 10.1111/psj.12319

en un modelado más eficaz de los subsistemas con la utilización del análisis de redes sociales. Para concluir, discutimos la naturaleza duradera del concepto de subsistemas de políticas y destacamos los estudios que continúan usándolo de manera innovadora.

PALABRAS CLAVE: Subsistemas, proceso de política, sistemas complejos, gobernanza; redes sociales, procesamiento de información, teoría de la complejidad, red de políticas

Major frameworks for understanding policy processes continue to rely on the concept of the policy subsystem (Baumgartner & Jones, 1993; Jones & Baumgartner, 2005; Sabatier, 1986; Sabatier & Jenkins-Smith, 1993), yet the concept is sorely in need of updating in light of current developments in the policymaking process and in conceptual advances in the field. Issues have become more complex as governments address more problems and these problems interact with one another. We point to ways of addressing this gap that nevertheless leave subsystems as the key organizational core of the study of policy processes.

The classic definition of subsystems focuses on the formal institutions of government and the actors they attracted. Freeman and Stevens (1987, p. 10) describe Freeman's classic definition of subsystems (or his preferred term "subgovernments") as placing "a primary emphasis upon their members and the institutions and organizations in the various part of the larger political system from which they come." Yet it may be that issues develop and policy arrangements then follow them. In recent years, policy scholars have approached the subsystem problem by instead thinking first about issues and second about the actors drawn to them. Looking at the scholarship over the past few decades underscores that the concept of a subsystem provides a useful framework for thinking about issues as the unit-of-analysis by generating analytic leverage to examine patterns of influence by different actors. While this perspective may seem commonplace today, it was revolutionary when first introduced and scholars spent years refining subsystems theory in search of a generalizable theory of actor influence.[1]

Subsystems in contemporary politics have grown into incredibly complex webs of interaction with more linkages across issues (and often actors as well) than ever before (Jones, Theriault, & Whyman, 2019). Heclo (1978) first noted this development, and introduced the concept of issue networks to describe these changes. Yet the basis for most policymaking remains firmly lodged within policy-centered subsystems. What has changed is the complexity of linkages to outside agencies, interest groups, congressional committees, and other subsystems. These developments have had consequences for policymaking and the scholarship studying these subsystems has been innovative in dealing with this evolution in turn.

A robust literature on policy networks, building on Heclo and his contemporaries, utilizes advances in social network analysis methodology to tackle this complexity. But methodology cannot answer all calls, and therefore we argue, in addition to the contributions already made by network scholars, that policy subsystems ought to be reconceptualized within a complex systems framework. That is, we suggest treating the entire policy process, and its subsystems, as a complex system and discuss the integration of complexity theory into leading policy process theories. Positioning an issue-centered approach to policy subsystems within a complex systems perspective allows for a consistent approach to policy subsystems across time, allowing us to ascertain what has changed and what has not. In fact, some scholars argue that complex systems are synonymous with networks and the parallel development of literatures on networks and complex systems will benefit from cross-fertilization (Morçöl, 2012). Developments both theoretically, with complex systems theory, and methodologically, with recent advancements in social network analysis, have allowed for scholars to continue using subsystems as the central basis for studying the policy process.

In this essay, we start by briefly tracing the evolution of the subsystem, as a concept, through the policy process literature. We then highlight its integration into the leading theories of the policy process with an emphasis on Punctuated Equilibrium Theory (PET) and the Advocacy Coalition Framework (ACF). Then, we turn to the details of complex systems and complexity theory highlighting its many advantages and how a few theories of the policy process already integrate some aspects into their foundations. We next turn to the developments made by policy networks scholars in advancing the concept of subsystems, particularly focusing on how their advances have made it easier to both visualize and analyze the complex linkages that overlay subsystems. We close the essay optimistically with a discussion of scholars who continue advancing subsystems in new ways by gathering new data and coloring our understanding of the policy process through a subsystems lens. In sum, we posit that the future of policy process theories is in more explicit integration of complexity theory and more effective modeling with the utilization of social network analysis.

Issues, Not Actors

The concept of subsystems was originally introduced when Griffith (1939) observed that certain policy problems brought together groups of men from across different branches of government, agencies, and interest groups. They were united in concern about a specific issue and the way it should be handled on the national policy stage. "Subsystem" has not always been the term used to describe this phenomenon (Freeman & Stevens, 1987). In some cases, the term subgovernment has been used and as the concept developed it gained other names such as iron triangle, issue network, etc. These terms sometimes applied to specific types of subsystems, but other times authors just had preferred terminology. Tracing the history of the concept will illuminate the checkered path of word choice and how that has contributed to the development and refinement of the subsystem as a concept, especially in understanding how open subsystems are to exogeneous influence.

One of the first, and now classic, studies of subsystems was conducted by Maas (1951), who studied the river development subsystem. He observed that subsystems tended to be closed off from any additional actors and found that decision making related to the policy area was highly centralized within the subsystem. This idea of subsystems existing as a closed-off and autonomous entity was critical and persisted in the scholarship for years to come. In fact, this idea became the foundation for the iron triangle concept. The iron triangle is essentially a map of a subsystem; each corner designates a different type of actor in the subsystem and each has a different role in monitoring and altering policy for the subsystem (Bernstein, 1955). The corners were classically defined as administrative, congressional, and industrial. This iron triangle contained only a few actors and maintained exclusive autonomy over the policy area in which it governed.

A few years later, Redford (1960) published his study of the civil aviation subsystem and found it to be slightly more open than previous subsystems examined. But, he maintained that decision making regarding the policy area was certainly still centralized. Redford (1969), reflecting on his previous work, highlighted that iron triangles (and subsystems more generally) provide stability and tend to favor organized interests, but he argued that policy changes made by subsystems were often small-scale ones. Policy changes are minor, Redford argued, because subsystems must interact with macropolitical institutions to produce large-scale changes. Moreover, he notes that macropolitical institutions tend to delegate policymaking responsibilities to subsystems because the macropolitical institutions can only handle so many issues at a time.

Redford (1969) also joined the debate about how open subsystems were and he was considerably skeptical of how democratic the policy process really was if it were based solely on pluralistic interest group interaction centered on subsystems. He argued that the American system is democratic only insofar as different interests are represented in subsystems and those subsystems allow for some access to interests that are not dominant (still conditional upon macropolitical intervention). That is, he thought that subsystems provided continuous access and superior opportunities for influence to aggregated interests, via interest groups, and therefore subsystems were mostly closed and provided stability for policymaking. Lowi (1964, 1969) concurred and argued that subsystems were closed and that they were closed to a dangerous fault leaving them susceptible to capture by special interests. Fear of capture is an idea that stretches back to our origins in democracy and modern policy scholars have attempted to identify instances of such capture for decades (e.g., Carpenter & Moss, 2014; Huntington, 1952; Peltzman, 1976; Stigler, 1971). Like the notion of iron triangles, the notion of capture in almost every instance is an unwarranted characterization (Carrigan & Coglianese, 2016). Moreover, Congress took steps in the Administrative Procedures Act of 1946 to establish procedures for policy action that provided regularized access for citizens. The more appropriate questions concern whether specialized interests can unduly influence policy through attentiveness to the process and expertise provided during the rulemaking process. Nevertheless, Lowi certainly thought such influence occurred and Redford highlighted the undue influence of specialized publics, including the industries regulated.

Schattschneider (1957, 1960) disagreed with Lowi's interpretation. He saw subsystems as venues for battle. For Schattschneider, politics could be conceived of as a street fight where bringing in additional actors on your side could make all the difference in the conflict. Most issues, he argued, were private. That is, the issues were being discussed only among a subset of the Washington elite and the status quo was being quietly maintained with significant resources being spent to keep it that way. But, Schattschneider argued that issues could be socialized; that is, they could become public issues that everyone in the country was discussing and the scope of the conflict was thus expanded. Herein lies Schattschneider's disagreement with Lowi; for Schattschneider, expanded conflicts were an opportunity for the public usually via political parties to penetrate closed subsystems. Schattschneider's notion of conflict expansion and Redford's are two sides of the same coin.

As scholars debated the openness of subsystems, it also became clear that the iron triangle concept might be insufficient as the only way to understand subsystems. Heclo (1978) argued that "the iron triangle concept is not so much wrong as it is disastrously incomplete." To address this insufficiency, he introduces the concept of *issue networks*, which defined succinctly are loose collections of actors all concerned about the same issue. These networks are notably more open than iron triangles. Heclo never believed that subsystems could be as closed as what previous scholars had posited and he even theorized about the inclusion of additional actors into subsystems politics. Political party elites, intellectuals, and certain members of the media were now all to be considered in subsystem politics. Moreover, issue networks were one more intellectual tool in the debate about how open or closed subsystems were.

Integration into Modern Theories of the Policy Process

Leading theories of the policy process today rely heavily on notions about subsystems as the unit of analysis. Punctuated Equilibrium Theory was the first theory to combine previous advances in agenda-setting studies with the classical concept of subsystems (Baumgartner & Jones, 1993). Integrating subsystems, Baumgartner and Jones also contribute to the cornucopia of terminology. That is, they conceptualize subsystems labeled as policy monopolies, which are subsystems controlled by a set of policy actors who all favor one policy image and path for policy development for the subsystem.

Generally, Punctuated Equilibrium Theory argues that policy change is disjoint and episodic where long periods of stability and incremental change are interrupted by periods of rapid and significant changes (i.e., punctuations). It is a bottom-up theory that relies heavily on subsystems to understand policy change. Baumgartner and Jones (1993) posit that, most of the time, subsystems are controlled by policy monopolies of interested policy actors buttressed by powerful ideas. These policy monopolies rely on negative feedback systems to enact incremental changes to the policy area and maintain a positive policy image. Policy entrepreneurs, who shop policy problems and solutions, look for ways to penetrate these policy monopolies and disrupt the policy image. If the policy image begins to change, the subsystem may be subject to positive feedback, usually via increased public attention and/or media coverage. These positive feedback processes build on themselves and eventually lead to the destruction of the policy monopoly. The destruction of the policy monopoly leads to a punctuation and rapid and significant policy changes to the policy area and that subsystem. After the policy changes occur, the subsystem returns to a state of equilibrium and a new policy monopoly forms. It would be impossible to conceive of PET without the concept of a subsystem.

Punctuated Equilibrium Theory has since been expanded into a full theory of government information processing (Jones & Baumgartner, 2005). That is, Jones and Baumgartner identify the subsystem dynamics involved in actors searching for policy problems and policy solutions and expand and apply it across a variety of contexts, known as the *general punctuation thesis*. Moreover, they have worked to develop a more intricate theory to understand types of search that can be utilized by elites based on individual subsystem contexts (Baumgartner & Jones, 2015). Each of these developments requires thinking about the dynamics both within and outside of subsystems. It has become clear from this line of research that the integration of diverse viewpoints within subsystems, which can be done through both formal requirements and informal norms, improve the specification of the problem-space. More diverse viewpoints highlight different ways of framing an issue. This more precisely defined problem-space allows policymakers to anticipate objections to a regulation made within the confines of a policy subsystem and address them before regulations are issued (Baumgartner & Jones, 2015).

Punctuated Equilibrium Theory is not the only theory of the policy process that has benefitted greatly from a foundation based in subsystems. The Advocacy Coalition Framework (ACF) also examines policy change with subsystems as its venue (Jenkins-Smith, Nohrstedt, Weible, & Sabatier, 2014; Sabatier, 1986; Sabatier & Jenkins-Smith, 1993). ACF examines the actors within a subsystem, who form into what are known as advocacy coalitions. These advocacy coalitions are formed around shared belief systems and operate at the subsystem level. Within the subsystem, advocacy coalitions are made up of diverse sets of actors and their coordination reduces transaction and decision costs among actors and allows for resource sharing. Of course, coordination within coalitions varies from minimal communication and information sharing to full-fledged multi-actor campaigns.

Recent work on the Advocacy Coalition Framework has addressed the dynamic components of policy subsystem development. Not all subsystems are mature (i.e., longstanding and with easily identifiable policy area(s), key actors, and boundaries) and instead some are just emerging, termed *nascent subsystems*, with little history of policy outputs (Ingold, Fischer, & Cairney, 2017; Sabatier & Jenkins-Smith, 1999). Initial propositions about these nascent subsystems suggest that they are characterized by nebulous and fluctuating belief systems (Sabatier & Jenkins-Smith, 1999). Stritch (2015) examines a nascent policy subsystem and finds that, when advocacy communities are dichotomized, communities form quickly and there are lower-level forms of collaboration despite eschewing the ten-year window generally suggested for work utilizing the ACF.[2] Ingold et al. (2017), in more recent work, point out that studying only mature subsystems has left scholars blind to how subsystems form and lead to advocacy coalitions. That is, they seek to understand "how actors begin to agree with each other to support the same policy design, before they decide to cooperate regularly to secure shared policy beliefs and preferences" (Ingold et al., 2017, p. 443). They find that, when dealing with nascent subsystems, actors will rely more on former contacts than shared policy beliefs (or ideologies) because they struggle to identify their allies and opponents. They also validate claims that belief systems in nascent subsystems are not yet well defined.

Additional work on different types of subsystems and how their structures impact the propositions laid out by ACF scholars remains to be done and will be a fruitful path for future subsystems-focused research on the Advocacy Coalition Framework. Moreover, both PET and ACF focus on dynamics *within* subsystems. This perspective, while exceptionally productive for understanding some policy changes, is also limiting. Most importantly, it limits our utility to speak to cross-subsystem dynamics caused by boundary-spanning issues. This difficulty is one that underscores the necessity of integrating complexity theory and social network analysis into the study of subsystems.

Integrating Complexity Theory

The policy subsystem as a concept has proven fruitful over the years by allowing scholars from a variety of disciplines to think more clearly about how, and who is responsible for, policy changes. The same statement could be said about the leading theories of the policy process, built using subsystems as their foundations that have been adopted by a substantial number of scholars. We argue that the next chapter in the metaphorical book on subsystems should address the shift of scholarly focus from individual parts of the policy process to a thirty-thousand-foot view of the interactions of individual subsystems, which are complex systems in their own right. One way to accomplish this lofty goal is to conceptualize the policy process as a complex system as well and begin to integrate complexity theory into how we understand subsystems and those theories that rely on them.

Put simply, a complex system is a large collection of simpler components and that system's behavior is difficult to explain, predict, or engineer (de Marchi & Page, 2014; Mitchell, 2009; Page, 2011). It is not, however, merely the presence of many different components in a given system that make it complex. That is, if the policy process were made up of many organizations all governed by the same rules the description of their interactions would be simple (Morçöl, 2012). A complex system cannot be understood simply by breaking the system down into its component parts because the components are interdependent and the system is prone to nonlinear behavior caused by feedback loops and local interactions that scale-up to system-level behavior (Cairney, 2012; Morçöl, 2012). Because of these attributes of complex systems, they are difficult to control or understand and are sometimes characterized as being "between ordered equilibrium regimes and pure randomness" (de Marchi & Page, 2014, p. 2). The nonlinearity of interactions within the system lies at the heart of complexity theory and the coevolution of different components, and the feedback loops among them, can help to characterize these interactions in more meaningful ways (Morçöl, 2012). Nonlinearity here does not only mean the negation of linearity in the interactions among component parts of a complex system, but it also means that the system will move around in a particular pattern that can be characterized by plotting different aspects of the system (Morçöl, 2012). As Morçöl (2012, p. 34) puts it "whether there is a pattern in data or not depends on how you look at it and how you analyze it." Put another way, characterizing meaningful patterns in complex systems is easier said than done, but it is possible, especially with attention to the coevolution of component parts of the system and the pervading feedback loops therein.

An example may be useful in clarifying why complex systems are distinct and the proper conceptualization for subsystems and the policy process moving forward. In the U.S. context, take the institution of Congress alone. Each chamber of Congress is governed by its own distinct rules and subunits. Each chamber has a different number of committees and subcommittees and the jurisdiction therein is different too (Baumgartner, Jones, & MacLeod, 2000). Even the rules that govern the members are brought about in different ways with the Senate's rules continuing from one Congress to the next and the House's rules being adopted anew at the start of each Congress. Watching bills move through the legislative process (certainly a mere subset of activity within the larger policy process) requires characterizing complex interactions between the two chambers.[3] Zooming out from Congress alone to the traditional conceptualizations of subsystems is not even necessary to understand why complexity theory is the clear next step for studying the policy process. Subsystems, which are already complex systems made up of members of Congress, interest groups, bureaucrats, and many others, interact and their nonlinear interactions characterize the larger policy process, which is also a complex system. In other words, subsystems remain the key units of interest and complexity theory, instead of shying away from the nonlinear interactions among subsystems by confining them to error terms, embraces the nonlinearity and attempts to characterize it (Morçöl, 2012). Interestingly, the behaviors discussed in complexity theory that complex systems exhibit are already theorized about in modern policy process studies, such as punctuated equilibria behavior (Baumgartner & Jones, 1993), path dependence (Pierson, 2000), and local (instead of centralized) actors interacting to cause system-level behavior (Cairney, 2012; Ostrom, 1998).

At the broadest level, "complexity theory identifies instability and disorder in politics and policy making, and links them to the behavior of complex systems" (Cairney, 2012, p. 346). More specifically, the goal of complexity theory is to identify types of systemic output that occur when actors follow the same sets of basic overarching rules and then evaluate how sensitive the system is to rule changes (i.e., how much do rules need to be changed to produce significant shifts in systemic outputs?) (Cairney, 2012). One way to plot changes and patterns, explored in more detail by Morçöl, is plotting return maps (also known as phase diagrams) that generate patterns to allow for the definition of different phases of change in complex systems across time. These plotted system patterns may seem random, but substantive theory can be developed to characterize what might be causing these systematic shifts in subsystem interactions.

From this exposition it is hopefully easy to see how subsystems might be ideal candidates for complexity theory development while keeping the policy subsystem central to policy process studies. Subsystem actors, from diverse branches of government and groups governed by different rules, interact to shift public policy in a given issue area. And, increasingly these issue areas span multiple subsystems. What will be difficult is identifying the overarching sets of rules that these diverse sets of actors all follow and developing consistent theories for characterizing shifts in these complex systems.

Complexity Theory: Hiding in Plain Sight

We are not starting from scratch on this journey of uniting complex systems and complexity theory with policy process theories. As Jochim and May (2010) point out, policy process scholars do discuss the interdependence of subsystems when attempting to identify disruptions in their subsystem-of-interest or when studying spillovers of policymaking activities.[4] In an effort to start scaling up scholars' level of analysis beyond subsystems Jochim and May (2010, p. 308) argue that the focus should shift to boundary-spanning policy regimes, which can be understood as "governing arrangements that span multiple subsystems." These boundary-spanning policy regimes allow scholars to study more complex problems and to integrate elements of multiple subsystems working toward common policy goals (Jochim & May, 2010; May & Jochim, 2013). May, Jochim, and Sapotichne (2011) adopt a boundary-spanning policy regime perspective when studying United States homeland security policy following the terrorist attacks of September 2001. They identify eight subsystems and find that each subsystem's actors pursued homeland security policy agendas reflective of their particular concerns and historic ways of doing business (i.e., path dependence). The policy regime failed to unite around a shared purpose that was well understood across subsystems. Therefore, in conducting this study, the authors quickly encountered multiple attributes of complex systems. In addition to path dependence, the authors also found that it can be extremely difficult for a centralized actor (like the Department of Homeland Security) to produce predictable behavior when diverse sets of actors interact and are driven by multiple independent (and interdependent) goals. While May and his colleagues do not explicitly utilize the language of complex systems in their studies, they are in fact studying a complex system. In fact, Cairney (2012, p. 348) observes that it is common for public policy scholars to "highlight complex system characteristics without necessarily using the language of complexity." Similar studies have been applied to other policy areas as well, especially climate change, which easily lends itself to an international conceptualization of interdependent policy regimes (Henstra, 2017; Keohane & Victor, 2011).

By deploying a complex systems perspective, we are able to trace processes through time as an evolutionary process that is prone both to incremental adjustments but also rapid punctuated policy changes when positive feedback related to an issue previously contained within one isolated subsystem spills over into others. This spillover can happen through changes in the external environment or through deliberate legal intervention. Mandating that agricultural run-off be monitored for harmful chemicals would link agricultural and environmental subsystems, for example.

Jones et al. (2019) utilize a complex systems framework to study and explain what they term "the Great Broadening," which refers to government getting larger, not by doing more of what it already was doing, but by getting involved in new issues where it had only limited presence before. Using an issue-centered analytic perspective and relying on the U.S. Policy Agendas Project, these authors trace changes in this broadening from World War II to the present. Their approach clearly delineates a period during the late 1950s through the late 1970s in which the process of broadening accelerated. This accelerated broadening fostered spillovers among subsystems, often caused by the fast pace of statutory development. Statutes became more complex, in part because adding new issues meant more spillovers among issues. As new issues accessed the policymaking agenda, the system changed structurally. Subsystems were destroyed, modified, and constructed as this intense period of policy activity proceeded. As the intensity subsided, more complex administrative state remained, with increased patterns of issue networking and more complex interchanges among subsystems.

The trace of subsystem development, change, and even destruction through modern U.S. political history seems to have occurred in bursts, with both creation and destruction occurring within the same time frame. As we focus on the development of subsystems as a major component of policy process theories, we should attend to the likelihood that policy spillovers from one subsystem to another during the creation (and destruction) period occur quickly and simultaneously. This possibility is best viewed through the lens of complex systems and complexity theory.

Expanding Concepts: Policy Networks

One way to allow for the interdependence of issues, and actors, to begin playing a role in our analyses of subsystems is to adopt a social network perspective. In fact, Morçöl (2012) sees networks and complex systems as one in the same and uses the terms interchangeably throughout his book. He declares, "Systems are networks, and networks are systems" (Morçöl, 2012, p. 50) and goes on to note that the literatures on policy networks and complexity theory developed in parallel and will benefit from conceptual and methodological cross-fertilization. We echo his sentiment precisely. Inferential models of social networks directly account for the interdependence in complex systems and while network theories are broader today than when Hugh Heclo was sketching his initial set of attributes for issue networks, his pathbreaking study still informs the work done in this area. Let's first take a closer look at Heclo's issue networks and then delve into why networks provide a compelling framework for integrating complexity theory and studying policy change and governance.

Heclo (1978) was frustrated by the way scholars pursued studies of subsystems, "looking for the few who are powerful, we tend to overlook the many whose webs of influence provoke and guide the exercise of power." Observing that American politics was becoming increasingly technical and specialized at all levels, and the ever-important presence of interest groups in subsystems, Heclo wanted to provide scholars with a more granular way of thinking about influence within subsystems. Issue networks, and policy networks more broadly, are not meant to replace subgovernments or iron triangles conceptually. Instead, issue networks should be seen as a structure that overlays onto the once stable political reference points with new forces that complicate calculations and predictability (Heclo, 1978). Put another way, the scholarly focus on a few predetermined actors is insufficient for picking up the vast number of sources of influence that ultimately lead to policy change. Networks, with their ability to map actors based on their relationships, provide a new way to theorize about and model many actors and analyze their influence—conditional on their connections to one another. And, complexity theory is ready-made for postulating about the general patterns that might emerge when large and diverse sets of actors pursue interdependent goals across multiple subsystems. Herein lies the ideal next generation of subsystems scholarship.

Theoretically a network perspective is clearly advantageous, but in practice it is more difficult to implement. Heclo (1978) knew immediately that it would be difficult to identify issue networks. He provides some guidance to scholars arguing that issue networks are defined by some aspect of public policy or a policy problem with actors having specialized knowledge (Heclo, 1978). He goes on to provide a variety of attributes that issue networks should have. A few of the key attributes are that (i) the network contains a large number of actors with variable degrees of mutual commitment or dependence on each other, (ii) actors may enter or exit the network at any time, (iii) actors may be powerful interest groups or individuals (with specialized knowledge) who are internal or external to government, (iv) direct material interests are often secondary to intellectual or emotional commitment, and (v) the network may operate at many levels from local planning to the White House. The large number of loosely connected actors and the explicit requirement that actors have specialized knowledge help differentiate issue networks from other types of policy networks studied by scholars today (Leifeld & Schneider, 2012; Rhodes, 2008).

What are these various policy networks that modern scholars study then? R.A.W. Rhodes (1990, 2008) has noted frequently that "policy network" is a term often used very vaguely. In a special issue of the *Policy Studies Journal,* scholars utilize R.A.W. Rhodes's (1997) conceptualization of policy networks as "meso-" level concepts that bridge the causal relationships between micro and macro political institutions and actors (Lubell, Scholz, Berardo, & Robins, 2012). Identifying networks as a method for meso-level analysis is ideal for studying subsystem politics because, true to Heclo's original theory, individuals, groups, and institutions can all be active players in subsystems and feedback from their policy decisions will dynamically interact with all actors in the subsystem and the structure of their relations will impact how feedback effects come to be. Of course, there are many ways to interpret and classify a policy network and Rhodes addresses this issue as well. Rhodes (2008) argues that policy networks vary along a continuum according to the closeness of the actors' relationships (see also Marsh & Rhodes, 1992). He suggests that policy communities and issue networks bookend the spectrum from closest to loosest relationships, respectively.

Building on Heclo: Modern Theoretical Policy Networks and Interdependent Subsystems

It is clear that the initial contribution from Heclo (1978), after interdisciplinary work (especially from sociology, economics, and political science), spurred a vast literature for thinking about subsystem-induced policy changes in a much broader way. The question that remains now is where has the scholarship on policy networks and subsystems gone in recent years? To answer this question, we must confront both theoretical and methodological developments.[5] Rhodes has served scholars well on the theoretical front by sketching a typology and spectrum for policy networks. In practice, the choice between theoretical approaches applied to policy networks mainly depends on what aspect of the network a scholar seeks to highlight.

Our focus here is scholars who, noting the literature's increasing focus on complex systems, choose to focus on the exchange of resources among subsystem members. Frequently, this means drawing on polycentric governance theory (Ostrom, 2010) or other related theories (e.g., network governance or the ecology of games framework), which have all coalesced under a general label of the study of collaborative governance regimes (CGRs) (Scott & Thomas, 2017).[6] Put briefly, these theories highlight patterns of collective action within broader systems involving networks of actors, institutions, and policy issues that frequently overlap (Lubell, 2013; Scott & Thomas, 2017). Of course, scholars have also utilized networks to extend ACF theory, especially with respect to the composition of coalitions and the costs of coordination therein (Fischer & Sciarini, 2016; Henry, Lubell, & McCoy, 2011; Parsons, 2018). Subsystems in a network perspective easily serve any of these theories because of their ability to represent multiple independent centers of decision making and the interactions between public and private actors—even across different stages of the policy process (Hayes & Scott, 2018; O'Toole, 1997; Ostrom, Tiebout, & Warren, 1961). And, importantly, recent advances in social network analysis make it increasingly practical to map these complex systems and advocacy coalitions.

Recent work on CGRs in particular has begun to address a longstanding question raised by Elinor Ostrom (1998) in her presidential address to the American Political Science Association: which institutional features lead to cooperation in the face of collective action problems? Some scholars argue that preference similarity shapes policy networks (Ingold & Fischer, 2014), but preference similarity does not explain all tie formation among actors. In fact, Leifeld and Schneider (2012) find that the effect of preference similarity is absorbed by institutional, relational, and social opportunity structures in policy networks. In particular, the authors highlight that it is costly to make contacts in policy networks (drawing from the work of North, 1990) and that the type of information (i.e., political or technical) being exchanged in these networks will impact whether or not preference similarity predicts tie formation or not (Leifeld & Schneider, 2012).[7] In this same vein, Fischer, Ingold, and Ivanova (2017) recently reported findings indicating that the separation of technical and political information is useful for understanding what drives information exchange in policy networks. They find that technical information exchange is driven by scientific expertise whereas political information exchange is driven by ideology and public authority (Fischer et al., 2017). Both types of information exchange benefit from existing collaboration among actors, which is consistent with previous findings. Of course, as Elinor Ostrom would likely stress, the scale of these interactions matters as well. Hamilton and Lubell (2018) take this caveat to task and argue that spatial and institutional variance within networks (i.e., scale-dependent transaction costs) will impact collaboration too. They find support for their theory and discover that policy forums meant to encourage collaboration on a shared policy issue can be effective, but that collaboration is conditional on the spatial scale of actors and the institutional roles of those attending the policy forum (Hamilton & Lubell, 2018). As scholars ponder further integration of complexity theory into the study of subsystems then these issues of scale will be critical to future scholarship.

If we are to accept that networks are an effective way to study subsystems and complex systems via polycentric governance theory (or other related theories) then it seems appropriate to capitalize on all that social network analysis has to offer. Ingold and Leifeld (2014) do just this by conceptualizing power in two ways: (i) formal power derived from institutional roles (vertical integration) and (ii) structural power derived from network configurations (horizontal integration). They use the analytic leverage gained from being able to map connections among actors to try and understand how structural positioning in the subsystem's web of influence can allow actors to impact the development of policy outcomes. They find that actors in adversarial policy networks can gain influence by occupying structural holes in subsystems or by gaining formal authority or access (Ingold & Leifeld, 2014). Ulibarri and Scott (2017) extend this research agenda and examine a variety of network terms (i.e., configurations of actors connected to one another) linked to polycentric governance hypotheses about the impact of network structures on collaboration in subsystems (see also Scott & Thomas, 2017). They find that patterns of individual-level collaboration can impact more general levels of collaboration, such as more two-way communication and fewer dominating actors in high-collaboration networks (Ulibarri & Scott, 2017). Much research remains to be done in this area, such as Ulibarri and Scott's suggestion that similar studies be conducted longitudinally. Key to each of these studies is that they take Heclo's point. That is, singular disconnected subsystems are no longer sufficient for understanding policy change. Scholars must map multiple subsystems and characterize the complexity that comes with this increase in scale.

This essay began by asserting that subsystems are so critical because they focus on issues and not actors. Much of the network scholarship covered thus far fails to utilize issues, instead of actors, as the unit-of-analysis. Shaffer (2018), pioneering a different approach entirely, comes closer by studying policy networks where the relational links are laws connecting implementing actors or agencies. That is, he views laws, and consequently the policy issues therein, as networks of institutional relationships. He extracts implementing networks to create an original dataset consisting of all enacted U.S. legislation passed from 1990 to 2016 and then deploys this dataset to study patterns of complexity in American enacted legislation.[8] In contrast with the existing literature, Shaffer demonstrates that the complexity of formal institutions is primarily driven by the issues and policy areas under consideration. The key point here is that the nature of the issue dictates the institutional structure that governs its implementation. While Shaffer did not start out from a policy subsystems perspective, he ends up with exactly that and he demonstrates an effective application of an issues-focused subsystems study along the way.

Methodological Advances: Increasingly Flexible Network Models

Subsystem studies from a policy network perspective, and especially the work on CGRs and polycentric governance, has exploded in recent years thanks, in part, to the rapid development of social network analysis methodology over the past decade or two. We will provide a brief overview of the most popular model used in policy network studies and will argue that these developments make work on complex systems and policy networks very appealing for future research. Classic social network studies are notable for their heavy reliance on descriptive statistics instead of inferential methodology. The workhorse for modern quantitative analyses of networks is the Exponential Random Graph Model (ERGM), which has been extended in a variety of ways since Robins, Lewis, and Wang (2012) highlighted it in the *PSJ* special issue.[9]

Classically, the ERGM assumes that networks are the product of a stochastic process, where the presence or absence of ties is influenced by local social processes (Robins, Pattison, Kalish, & Lusher, 2007). Actors in the network are assumed to be fixed and the possible networks and their probability of forming ties in the model are represented by a probability distribution on the set of all possible networks with the same number of actors (Cranmer, Leifeld, McClurg, & Rolfe, 2017; Robins et al., 2007). Monte Carlo Markov chain maximum likelihood estimation (MCMC-MLE) is used to simulate a large number of possible networks and produces statistics, which can then be used to evaluate the probability that the observed network occurred by chance (Robins, 2011).[10] The true power of the ERGM lies in the specification of the endogenous network terms that can represent important social and power dynamics (e.g., reciprocity, mutuality, or transitivity).[11] But, the ERGM is flexible as well and allows for the inclusion of exogenous covariates too. Recent work already detailed here is increasingly tying these endogenous network terms to arguments and hypotheses put forward in leading theories of the policy process like ACF or polycentric governance theory. Furthermore, there is nothing stopping scholars from using issues as the unit-of-analysis in their social networks and applying ERGMs still. But where has this model gone in recent years that makes subsystems and complex systems research from a social networks perspective so promising? The key advancement has been flexibility in nearly every aspect of the model, from allowing valued connections between actors, to integrating temporal aspects, and even to accounting for unobserved heterogeneity.

The original ERGM was designed for binary networks, that is, networks where there either is a connection between two actors or there is not. Many networks, however, have continuous-valued connections between actors, such as Scott's (2016) examination of the varying strength among a regional network of organizations involved in collaborative groups. In response to this binary-connection problem, Desmarais and Cranmer (2012b) developed the Generalized Exponential Random Graph Model (GERGM) to allow for continuous or integer-valued connections. They were not alone in tackling this problem. Krivitsky (2012) also developed support for integer-valued connections but takes a different approach for addressing the computational challenges of a model with infinite possible values for the connections between actors. These advancements have proven useful and the model continues to be improved. For example, Wilson, Denny, Bhamidi, Cranmer, and Desmarais (2017) developed a more flexible model specification for the GERGM that allows for the use of nonlinear network statics and Box-Steffensmeier, Christenson, and Morgan (2018) developed the Frailty-ERGM, which addresses the problem of unobserved heterogeneity and avoids the need for MCMC-MLE (and the potential for degeneration that comes with it).

To this point we have said nothing of temporal variation in networks. Time is a critical issue for the study of policy change and therefore it is important to be able to model time appropriately within the Exponential Random Graph Model family.[12] Robins and Pattison (2001), followed by Hanneke, Fu, and Xing (2010), proposed the explicit inclusion of time via discrete steps (i.e., Temporal ERGM, TERGM) and Snijders (2006) proposed a continuous-time model of network dynamics. The discrete model has been bootstrapped to assess uncertainty and continues to be improved and added to (Desmarais & Cranmer, 2010, 2012a). Campbell (2018) provides an excellent example of an extension of the TERGM proposing the ego-TERGM to assess latent roles in longitudinal networks. And, Falzon, Quintanec, Dunna, and Robins (2018) recently introduced three temporal equivalents to common positional network measures that incorporate both time and sequence.

Naturally these models are not without their methodological critics (Block, Koskinen, Hollway, Steglich, & Stadtfeld, 2018). And, like any other statistical methodologies utilized, a model cannot correct for bad measurement. Hayes and Scott (2018) take this reality to task by comparing traditional survey instruments to Twitter interactions (and hyperlinks) for constructing policy networks. They point out that there is likely a cap in size for mapping a policy network via survey instruments because as the network size increase so does the number of possible ties, which increases the burden on the survey respondent's recall (Hayes & Scott, 2018, p. 328). This point is particularly concerning for the mapping of complex systems, which can be exceptionally large. They conclude that there is a small correlation between surveys and online interactions, which indicates that these online interactions can complement survey measures but are likely measuring a different aspect of the policy network (Hayes & Scott, 2018). These statistical and measurement critiques remind us that a networks perspective, while advantageous for advancing the study of subsystems and complex systems, does not provide a silver-bullet solution. Policy networks can help scholars test longstanding theories of the policy process and better understand overlapping subsystems, but these networks must be created and analyzed with great care to avoid invalid inferences.

Conclusion: The Endurance of Subsystems

Subsystems, as a concept, have come a long way from the simple, yet powerful, observation that policy problems organize actors from across branches of government, agencies, and interest groups according to the issue under consideration. The concept of the policy subsystem and the mechanisms developed around it have provided for rich theoretical advancement in the study of the policy process. In this essay, we have traced the concept's history, illuminated the first theories of policy subsystems, and highlighted recent work utilizing modern policy process theories built using subsystems. We then argued that scholars should begin thinking more broadly about subsystems by adopting a complex systems approach. In arguing for this change, we encourage scholars to consider more general studies where they examine more than a single subsystem as applied to a single theory of the policy process and instead integrate these modern theories more explicitly with elements of complexity theory. We then highlighted one prominent way scholars have already started utilizing complex systems to study subsystems by looking at the burgeoning scholarship on policy networks. And, given Morçöl's (2012) argument that networks and complex systems are essentially synonymous, we also highlighted advances in social network analysis methodology that has produced more flexible models and made studying these complex systems more reliable for drawing inferences.

From our brief history of the concept, we see that the standard story of subsystems development has been that regulatory subsystems started out fairly open during the period of initial creation during the New Deal, then closed into iron triangles in the 1950s as regulated interests "captured" government mechanisms, only to open up again as policymaking became more complex after the burst of policymaking activity that Jones et al. (2019) term the Great Broadening. But as we have shown here, this story has never been fully accepted. Few if any regulatory subsystems conformed to the classic closed "capture" model, and public administrators were not and never have been simple tools of interests. On the other hand, there seems little doubt that the multiple overlapping statutory requirements imposed on policymaking during the 1960s and 1970s added complexity and eroded boundaries among previously more isolated subsystems. And now, in contemporary studies of the policy process, we almost require that multiple subsystems or networks are studied to learn about how policy change occurs across diverse sets of actors (e.g., May et al., 2011).

Nodes of a network in policy studies are likely to correspond to policy whirlpools in which various actors coalesce around a policy objective. The more isolated the nodes, the more independent the subsystem. The more connections that can be mapped among nodes, the more porous the subsystem. Shaffer's (2018) use of laws to address the legal structures constructed to deal with policy issues, for example, is a breakthrough in the use of datasets to isolate such subsystems. It doubtlessly will be possible in the future to integrate different datasets assessing the actions of participants within formal implementing structures, hence mapping informal networks on top of the legal structures that in principle can be isolated from a study of statutes and rules. This is but one example of future mappings of complex systems across multiple subsystems that seek to redefine how we think about theories of the policy process and policy change more generally.

Much work remains to be done in the explicit integration of complexity theory with the study of subsystems. But, most importantly for this essay, we predict that the trend of impressive scholarship utilizing subsystems as their foundation will likely continue for many years as scholars utilize complex system conceptualizations, advances in social network analysis methodology, and new datasets to study just how government produces public policies.

Zachary A. McGee is a Ph.D. candidate in government at the University of Texas at Austin. His research focuses on the U.S. Congress, intraparty organizations, agenda setting, and social network analysis.

Bryan D. Jones is professor of government and the J.J. "Jake" Pickle Regents Chair in Congressional Studies at the University of Texas at Austin. He is the author of numerous books and articles on public policy processes, American governing institutions, and the connection between human decision making and organizational behavior.

Notes

1. For clarity, note that a subsystem is a concept. But the subsystem has been utilized to produce what can be called subsystem theories. When we refer to subsystems theories, we are referring to the propositions about how actors within subsystems operate to enact policy changes and how subsystems interact with outside actors.
2. Advocacy communities are defined as a group of "advocates [who] share ideological beliefs, but do not engage in coordinated activity" (Stritch, 2015, p. 438). They are, in essence, less effectively organized advocacy coalitions.
3. Note that some interactions among component parts of a complex system may be linear. Complex systems need not be made up entirely of nonlinear interactions, but complex systems are defined, in part, by an inability to break the system down into just its component parts and their sets of linear interactions (Cilliers, 1998; Morçöl, 2012).
4. Michael Jones and Hank Jenkins-Smith (2009) provide an exception to this pattern by considering "trans-subsystem" change among subsystems linked by overlapping issues and interests.
5. Certainly, there is not sufficient space for a full literature review of this burgeoning field within this subsystems-focused essay. Therefore, we direct interested readers to recent work by Knoke and Kostiuchenko (2018) for a recent review of policy networks.
6. On a broader level, some scholars debate whether policy networks and governance networks are synonymous or distinct types of networks (Bevir & Richards, 2009; Blanco, Lowndes, & Pratchett, 2011). Ultimately, this debate boils down to disagreements about which types of actors are appropriate to include in a given network, which is critical when mapping complex systems. The debate remains unresolved and outside of the scope of this paper, but see Knoke and Kostiuchenko (2018) for a more detailed review of this debate.
7. Their argument is consistent with developments made in the agenda-setting literature in recent years highlighting the cost of searching for policy information and the role that political or professional bias can have in the use of that information for policy outcomes (Baumgartner & Jones, 2015; Jones & Baumgartner, 2005).
8. Shaffer (2018) uses a strategy that leverages both case-specific knowledge regarding the Congress' internal legal drafting standards and a neural network-based named entity extraction procedure drawn from computational linguistics.
9. The Exponential Random Graph Model is not the only tool available for network inference. Many models exist and are utilized regularly in scholarship across numerous disciplines. See Cranmer et al. (2017) or Silk et al. (2017) for reviews of other prominent models for network inference.
10. A full technical detailing of this complex model is not possible here. There are many comprehensive ERGM reviews and we refer readers to Robins et al. (2007) or Cranmer and Desmarais (2011) for particularly useful ones.
11. Endogenous network terms specify the way that sets of actors relate to one another. That is, whether they are connected in the network. If connections are directed, these terms can also specify asymmetric connections. Cranmer et al. (2017) provide an example of reciprocity and transitivity in their Figure 1.
12. Due to our focus on ERGMs, this manuscript excludes the stochastic actor-oriented model, another class of models used to study network change over time. See Snijders, van de Bunt, and Steglich (2010) for an overview of these models.

References

Baumgartner, Frank R., and Bryan D. Jones. 1993. *Agendas and Instability in American Politics*. Chicago, IL: University of Chicago Press.

———. 2015. *The Politics of Information: Problem Definition and the Course of Public Policy in America*. Chicago, IL: University of Chicago Press.

Baumgartner, Frank R., Bryan D. Jones, and Michael C. MacLeod. 2000. "The Evolution of Legislative Jurisdictions." *The Journal of Politics* 62 (2): 321–49.

Bernstein, M. H. 1955. *Regulating Business by Independent Commission*. Princeton, NJ: Princeton University Press.

Bevir, Mark, and David Richards. 2009. "Decentring Policy Networks: A Theoretical Agenda." *Public Administration* 87: 3–14.

Blanco, Ismael, Vivien Lowndes, and Lawrence Pratchett. 2011. "Policy Networks and Governance Networks: Towards Greater Conceptual Clarity." *Political Studies Review* 9: 297–308.

Block, Per, Johan Koskinen, James Hollway, Christian Steglich, and Christoph Stadtfeld. 2018. "Change We Can Believe in: Comparing Longitudinal Network Models on Consistency, Interpretability And Predictive Power." *Social Networks* 52: 180–91.

Box-Steffensmeier, Janet M., Dino P. Christenson, and Jason W. Morgan. 2018. "Modeling Unobserved Heterogeneity in Social Networks with the Frailty Exponential Random Graph Model." *Political Analysis* 26 (1): 3–19.

Cairney, Paul. 2012. "Complexity Theory in Political Science and Public Policy." *Political Studies Review* 10 (3): 346–58.

Campbell, Benjamin W. 2018. "Detecting Heterogeneity and Inferring Latent Roles in Longitudinal Networks." *Political Analysis* 26 (3): 292–311.

Carpenter, Daniel, and David A. Moss. 2014. "Introduction." In *Preventing Regulatory Capture: Special Interest Influence and How to Limit It*, ed. Daniel Carpenter and David A Moss. New York: Cambridge University Press, 1–22.

Carrigan, Christopher, and Cary Coglianese. 2016. *Capturing Regulatory Reality: Stigler's Theory of Economic Regulation*. Philadelphia, PA: University of Pennsylvania Law School.

Cilliers, Paul. 1998. *Complexity and Postmodernism: Understanding Complex Systems*. London: Routledge.

Cranmer, Skyler J., and Bruce A. Desmarais. 2011. "Inferential Network Analysis with Exponential Random Graph Models." *Political Analysis* 19 (1): 66–86.

Cranmer, Skyler J., Philip Leifeld, Scott D. McClurg, and Meredith Rolfe. 2017. "Navigating the Range of Statistical Tools for Inferential Network Analysis." *American Journal of Political Science* 61 (1): 237–51.

de Marchi, Scott, and Scott E. Page. 2014. "Agent-Based Models." *Annual Review of Political Science* 17 (1): 1–20.

Desmarais, Bruce A., and Skyler J. Cranmer. 2010. "Consistent Confidence Intervals for Maximum Pseudolikelihood Estimators." *Proceedings of the Neural Information Processing Systems 2010 Workshop on Computational Social Science and the Wisdom of Crowds*.

———. 2012a. "Statistical Mechanics of Networks: Estimation and Uncertainty." *Physica A: Statistical Mechanics and its Applications* 391 (4): 1865–76.

———. 2012b. "Statistical Inference for Valued-Edge Networks: The Generalized Exponential Random Graph Model." *PLoS ONE* 7 (1): e30136.

Falzon, Lucia, Eric Quintanec, John Dunna, and Garry Robins. 2018. "Embedding Time in Positions: Temporal Measures of Centrality for Social Network Analysis." *Social Networks* 54: 168–78.

Fischer, Manuel, Karin Ingold, and Svetlana Ivanova. 2017. "Information Exchange Under Uncertainty: The Case of Unconventional Gas Development in the United Kingdom." *Land Use Policy* 67: 200–11.

Fischer, Manuel, and Pascal Sciarini. 2016. "Drivers of Collaboration in Political Decision Making: A Cross-Sector Perspective." *The Journal of Politics* 78 (1): 63–74.

Freeman, J. Leiper, and Judith Parris Stevens. 1987. "A Theoretical and Conceptual Reexamination of Subsystem Politics." *Public Policy and Administration* 2: 9–24.

Griffith, Ernest. 1939. *Impasse of Democracy*. New York: Harrison-Hilton.

Hamilton, Matthew, and Mark Lubell. 2018. "Collaborative Governance of Climate Change Adaptation Across Spatial and Institutional Scales." *Policy Studies Journal* 46 (2): 222–47.

Hanneke, Steve, Wenjie Fu, and Eric P. Xing. 2010. "Discrete Temporal Models of Social Networks." *Electronic Journal of Statistics* 4: 585–605.

Hayes, Adam L., and Tyler A. Scott. 2018. "Multiplex Network Analysis for Complex Governance Systems Using Surveys and Online Behavior." *Policy Studies Journal* 46 (2): 327–53.

Heclo, Hugh. 1978. "Issue Networks and Executive Establishment." In *The New American Political System*, ed. Anthony King. Washington, DC: American Enterprise Institute, 115–24.

Henry, Adam Douglas, Mark Lubell, and Michael McCoy. 2011. "Belief Systems and Social Capital as Drivers of Policy Network Structure: The Case of California Regional Planning." *Journal of Public Administration Research and Theory* 21 (3): 419–44.

Henstra, Daniel. 2017. "Climate Adaptation in Canada: Governing a Complex Policy Regime." *Review of Policy Research* 34 (3): 378–99.

Huntington, Samuel P. 1952. "The Marasmus of the ICC: The Commission, the Railroads, and the Public Interest." *The Yale Law Journal* 61 (4): 467–509.

Ingold, Karin, and Manuel Fischer. 2014. "Drivers of Collaboration to Mitigate Climate Change: An Illustration of Swiss Climate Policy Over 15 Years." *Global Environmental Change* 24 (1): 88–98.

Ingold, Karin, Manuel Fischer, and Paul Cairney. 2017. "Drivers for Policy Agreement in Nascent Subsystems: An Application of the Advocacy Coalition Framework to Fracking Policy in Switzerland and the UK." *Policy Studies Journal* 45 (3): 442–63.

Ingold, Karin, and Philip Leifeld. 2014. "Structural and Institutional Determinants of Influence Reputation: A Comparison of Collaborative and Adversarial Policy Networks in Decision Making and Implementation." *Journal of Public Administration Research and Theory* 26 (1): 1–18.

Jenkins-Smith, Hank C., Daniel Nohrstedt, Christopher M. Weible, and Paul A. Sabatier. 2014. "The Advocacy Coalition Framework: Foundations, Evolution, and Ongoing Research." In *Theories of the Policy Process*, 3rd ed., ed. Paul A. Sabatier, and Christopher M. Weible. Boulder, CO: Westview Press, 183–224.

Jochim, Ashley E., and Peter J. May. 2010. "Beyond Subsystems: Policy Regime and Governance." *Policy Studies Journal* 38 (2): 303–27.

Jones, Bryan D., and Frank R. Baumgartner. 2005. *The Politics of Attention*. Chicago, IL: University of Chicago Press.

Jones, Bryan D., Sean M. Theriault, and Michelle C. Whyman. 2019. *The Great Broadening: How the Vast Expansion of the Policymaking Agenda Transformed American Politics*. Chicago, IL: University of Chicago Press.

Jones, Michael D., and Hank C. Jenkins-Smith. 2009. "Trans-Subsystem Dynamics: Policy Topography, Mass Opinion, and Policy Change." *Policy Studies Journal* 37 (1): 37–58.

Keohane, Robert O., and David G. Victor. 2011. "The Regime Complex for Climate Change." *Perspectives on Politics* 9 (1): 7–23.

Knoke, David, and Tetiana Kostiuchenko. 2018. "Power Structures of Policy Networks." In *The Oxford Handbook of Political Networks*, ed. Jennifer Nicoll Victor, Alexander H. Montgomery, and Mark Lubell. New York: Oxford University Press, 91–114.

Krivitsky, Pavel N. 2012. "Exponential-Family Random Graph Models for Valued Networks." *Electronic Journal of Statistics* 6: 1100–28.

Leifeld, Philip, and Volker Schneider. 2012. "Information Exchange in Policy Networks." *American Journal of Political Science* 56 (3): 731–44.

Lowi, Theodore J. 1964. "American Business, Public Policy, Case-Studies, and Political Theory." *World Politics* 16 (4): 677–715.

———. 1969. *The End of American Liberalism: The Second Republic of the United States*. New York: Norton.

Lubell, Mark. 2013. "Governing Institutional Complexity: The Ecology of Games Framework." *Policy Studies Journal* 41 (3): 537–59.

Lubell, Mark, John Scholz, Ramiro Berardo, and Garry Robins. 2012. "Testing Policy Theory with Statistical Models of Networks." *Policy Studies Journal* 40 (3): 351–74.

Maas, Arthur. 1951. *Muddy Waters: The Army Engineers and the Nation's Rivers.* Cambridge, MA: Harvard University Press.

Marsh, David, and R. A. W. Rhodes. 1992. *Policy Networks in British Government*. Oxford, UK: Clarendon Press.

May, Peter J., and Ashley E. Jochim. 2013. "Policy Regime Perspectives: Policies, Politics, and Governing." *Policy Studies Journal* 41 (3): 426–52.

May, Peter, Ashley Jochim, and Joshua Sapotichne. 2011. "Constructing Homeland Security." *Policy Studies Journal* 39 (2): 285–307.

Mitchell, Melanie. 2009. *Complexity: A Guided Tour.* Oxford: Oxford University Press.

Morçöl, Göktug. 2012. *A Complexity Theory for Public Policy*. New York: Routledge.

North, Douglass C. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge, UK: Cambridge University Press.

Ostrom, Elinor. 1998. "A Behavioral Approach to the Rational Choice Theory of Collective Action: Presidential Address, American Political Science Association, 1997." *American Political Science Review* 92 (1): 1–22.

———. 2010. "Beyond Markets and States: Polycentric Governance of Complex Economic Systems." *American Economic Review* 100 (3): 641–72.

Ostrom, Vincent, Charles M. Tiebout, and Robert Warren. 1961. "The Organization of Government in Metropolitan Areas: A Theoretical Inquiry." *American Political Science Review* 55 (4): 831–42.

O'Toole, Laurence J. 1997. "Treating Networks Seriously: Practical and Research-Based Agendas in Public Administration." *Public Administration Review* 57 (1): 45–52.

Page, Scott E. 2011. *Diversity and Complexity*. Princeton, NJ: Princeton University Press.

Parsons, Bryan M. 2018. "The Effects of Risk, Beliefs, and Trust in Education Policy Networks: The Case of Autism and Special Education." *Policy Studies Journal*. https://doi.org/10.1111/psj.12246

Peltzman, Sam. 1976. "Toward a More General Theory of Regulation." *Journal of Law and Economics* 19: 211–40.

Pierson, Paul. 2000. "Increasing Returns, Path Dependence, and the Study of Politics." *American Political Science Review* 94 (2): 251–67.

Redford, Emmette S. 1960. "A Case Analysis of Congressional Activity: Civil Aviation, 1957–58." *The Journal of Politics* 22 (2): 228–58.

———. 1969. *Democracy in the Administrative State*. New York: Oxford University Press.

Rhodes, R. A. W. 1990. "Policy Networks." *Journal of Theoretical Politics* 2 (3): 293–317.

———. 1997. *Understanding Governance: Policy Networks, Governance, Reflexivity and Accountability*. Philadelphia: Open University Press.

———. 2008. *Policy Network Analysis*. Oxford: Oxford University Press.

Robins, Garry. 2011. "Exponential Random Graph Models for Social Networks." In *The SAGE Handbook of Social Network Analysis*, ed. Peter J. Carrington, and John Scott. London: SAGE, 484–500.

Robins, Garry, Jenny M. Lewis, and Peng Wang. 2012. "Statistical Network Analysis for Analyzing Policy Networks." *Policy Studies Journal* 40 (3): 375–401.

Robins, Garry, and Philippa Pattison. 2001. "Random Graph Models for Temporal Processes in Social Networks." *The Journal of Mathematical Sociology* 25 (1): 5–41.

Robins, Garry, Pip Pattison, Yuval Kalish, and Dean Lusher. 2007. "An Introduction to Exponential Random Graph (p*) Models for Social Networks." *Social Networks* 29: 173–91.

Sabatier, Paul A. 1986. "Top-Down and Bottom-Up Approaches to Implementation Research: A Critical Analysis and Suggested Synthesis." *Journal of Public Policy* 6 (1): 21–48.

Sabatier, Paul A., and Hank C. Jenkins-Smith. 1993. *Policy Change and Learning: An Advocacy Coalition Framework*. Boulder, CO: Westview Press.

———. 1999. "The Advocacy Coalition Framework: An Assessment." In *Theories of the Policy Process*, ed. Paul A. Sabatier. Boulder, CO: Westview Press, 117–66.

Schattschneider, E. E. 1957. "Intensity, Visibility, Direction and Scope." *American Political Science Review* 51 (4): 933–42.

———. 1960. *The Semi-Sovereign People*. New York: Holt, Reinhardt, and Winston.

Scott, Tyler A. 2016. "Analyzing Policy Networks Using Valued Exponential Random Graph Models: Do Government-Sponsored Collaborative Groups Enhance Organizational Networks?" *Policy Studies Journal* 44 (2): 215–44.

Scott, Tyler A., and Craig W. Thomas. 2017. "Winners and Losers in the Ecology of Games: Network Position, Connectivity, and the Benefits of Collaborative Governance Regimes." *Journal of Public Administration Research and Theory* 27 (4): 647–60.

Shaffer, Robert. 2018. *Power in Texts: Extracting Institutional Relations from Natural Language*. PhD diss., Department of Government, University of Texas at Austin.

Silk, Matthew J., Darren P. Croft, Richard J. Delahay, David J. Hodgson, Nicola Weber, Mike Boots, and Robbie A. McDonald. 2017. "The Application of Statistical Network Models in Disease Research." *Methods in Ecology and Evolution* 8 (9): 1026–41.

Snijders, Tom A. B. 2006. "Statistical Methods for Network Dynamics." In *Proceedings of the XLIII Scientific Meeting, Italian Statistical Society*. Number 1994, Padova, Italy: CLEUP, 281–96.

Snijders, Tom A. B., Gerhard G. van de Bunt, and Christian E. G. Steglich. 2010. "Introduction to Stochastic Actor-Based Models for Network Dynamics." *Social Networks* 32 (1): 44–60.

Stigler, George. 1971. "The Theory of Economic Regulation." *Bell Journal of Economics and Management Science* 2: 3–21.

Stritch, Andrew. 2015. "The Advocacy Coalition Framework and Nascent Subsystems: Trade Union Disclosure Policy in Canada." *Policy Studies Journal* 43 (4): 437–55.

Ulibarri, Nicola, and Tyler A. Scott. 2017. "Linking Network Structure to Collaborative Governance." *Journal of Public Administration Research and Theory* 27 (1): 163–81.

Wilson, James D., Matthew J. Denny, Shankar Bhamidi, Skyler J. Cranmer, and Bruce A. Desmarais. 2017. "Stochastic Weighted Graphs: Flexible Model Specification and Simulation." *Social Networks* 49: 37–47.