

Resilience and robustness in policy design: a critical appraisal

Giliberto Capano¹  · Jun Jie Woo^{2,3}

© Springer Science+Business Media New York 2016

Abstract Resilience and robustness are exciting concepts for policy researchers. Their broad use in other disciplines has motivated social scientists and policy researchers to adopt them in analyses. In the present paper, we review definitions of these concepts and the primary theoretical and empirical challenges presented by resilience and robustness as lenses for improving the understanding of policy process and policy design. The results reveal that the two concepts differ in their potential value for public policy analysis. Despite its diffusion and ‘charme’, resilience does not appear to be useful and may be misleading, whereas robustness exhibits great potential with respect to both analysis and design.

Keywords Robustness · Resilience · Policy-making · Policy design · Policy change

Introduction

The concepts of resilience and robustness have been adopted by different theoretical approaches in various scientific fields, such as complexity and chaos theory (Holland 1996), rational institutionalism (Ostrom 1990), organizational and management theories (Hamel and Valikangas 2003), macroeconomics (Kuorikoski and Lehtinen and Marchionni

✉ Giliberto Capano
giliberto.capano@sns.it

Jun Jie Woo
jjwoo@ntu.edu.sg

¹ Institute of Humanities and Social Sciences, Scuola Normale Superiore, Palazzo Strozzi, Florence, Italy

² Public Policy and Global Affairs Programme, School of Humanities and Social Sciences, Nanyang Technological University, Singapore, Singapore

³ Harvard Kennedy School, Cambridge, MA, USA

2010), engineering (Baker et al. 2008), and psychology (Zautra et al. 2010), sparking attention in policy research. First, robustness and resilience are attractive to researchers interested in understanding policy change and stability because it refers to the ability of policies to persist over time by overcoming relevant external shocks and internal perturbations. In addition, the two concepts may yield insights for policy design. Both concepts appear to provide opportunities to develop policy processes for coping with change and shocks (and, thus, with uncertainty) either by maintaining stability or by designing more effective policies. Furthermore, it must be underlined that resilience and robustness have inspired policy-makers and government policy and strategies and, thus, seem to have become ‘policy solutions’ for governing complexity and a design for public policies.

Based on an extensive review of the theoretical and empirical literature, the present paper focuses on the extent to which resilience and robustness can contribute to the primary theoretical frameworks adopted by policy researchers and, thus, make it possible to design better policies.

‘Why resilience and robustness can be interesting for policy design’ section of the paper provides a discussion of the potential usefulness of robustness and resilience as concepts in policy design. In ‘Robustness and/or resilience?’ section, we present an overview of existing understandings of the two concepts especially in social sciences. We then discuss, in ‘Resilience and robustness in the policy process’ section, the extent to which resilience and robustness can be integrated into the analysis of the policy process and how their role should be understood. ‘Relevant dimensions of policy resilience and policy robustness’ section identifies and discusses the primary theoretical challenges in adopting resilience and robustness as policy concepts. ‘Government actions for resilience and robustness’ section summarizes how these policy concepts can be applied in governmental actions to deal with policy shocks and anomalies. The concluding section presents the consequences of our arguments with respect to the theoretical and the empirical relevance of resilience and robustness for policy research.

Why resilience and robustness can be interesting for policy design

Robustness and resilience have become central in the policy strategies of many governments. In particular, resilience has become a new ‘mantra’ for many governments and international institutions. For instance, the OECD has published numerous policy briefs and recommendations for increasing resilience in economic development and disaster management (OECD 2014). The International Red Cross and the United Nations have also launched different programmes to increase resilience in local communities and in cities (IFRC 2012; UNISDR 2016); the UK has launched a ‘National Resilience Capabilities Programme’ for disaster management, in which resilience is the guiding policy principle (UK Cabinet 2014); not only has the USA established a ‘Federal Network Resilience’ organization within the Homeland Security Office, but the ‘concept’ has been institutionalized at the organizational level (see, for example, the establishment of the Office of Economic Resilience inside the Federal Department of Housing and Urban Development).

In contrast, robustness is much less popular as a concept and a policy-guiding principle, with one exception being the Dutch government’s emphasis on flood risk management (National Water Plan 2008). Rather, robustness is very often adopted as an instrument of resilience in official documents.

The mere fact that resilience and robustness have become official solutions for dealing with potential policy problems would be enough to justify an analytical interest from scholars in public policy and policy design. Obviously, there is more to be discussed. In fact, in the last three decades, there has been a rising interest in resilience and robustness in several specific policy fields (climate change, environmental policy, and risk management) and among scholars of comparative politics who are interested in institutional design (Shepsle 1989; Goodin 1998; Bednar 2009). Furthermore, one of the most prominent frameworks of public policy, the Institutional Analysis and Development framework developed by Elinor Ostrom, devotes much attention to robustness and, then, to resilience (Ostrom 1990; Janssen et al. 2007).

These streams of research and scholarly work have further inspired greater political interest in resilience and robustness.

This diffusion of resilience and robustness in social sciences has occurred through an asymmetric process, with research concentrated in specific areas of interest, such as environmental policy and risk management. However, we believe that there is much scope for a policy design approach to resilience and robustness. Rather than focusing on specific fields of social science research, there is a need to address how resilience and robustness factor into 'real' policy design. Seen in this light, resilience and robustness can be reconceptualized as the property that policies should have to reach some desired results (adaptation, resistance to external shocks, and control of uncertainty, for example). We will seek to achieve this in our paper.

This interest for resilience and robustness clearly derives from the growing uncertainty and complexity that policy-makers are faced with, and thus, there is a growing recognition of the importance of policy designs that can address or minimize the impacts of potential shocks and uncertainty. In particular, policy designers are faced with the challenges of uncertain linkages between policy actions and outcomes, a highly complex and ill-defined policy problem space that encompasses multiple interacting elements (Anderies and Janssen 2013).

These developments suggest an urgent need to assess resilience and robustness from a policy design perspective. More specifically, by assuming that policy design is that knowledge- and information-based activity through which, in a specific context, policy-makers and stakeholders try to formulate solutions for problems perceived as collective (Alexander 1982; Howlett 2011), it is quite relevant to assess whether and how resilience and robustness should be really taken into consideration by policy scholars and, thus, be part of the landscape of decision-makers.

Robustness and/or resilience?

Different literature streams employ resilience and robustness in ways that risk conceptual overlap. However, as we argue below, robustness and resilience hold different meanings for different disciplines. Thus, we must first identify the meanings of both concepts before contextualizing them from a policy perspective.

Resilience

The term 'resilience' is derived from the Latin terms *resiliere* or *resilio* for 'bounce' or 'rebound' (Alexander 2013). The action of 'bouncing back' or returning to some form of

equilibrium has come to characterize subsequent understandings of resilience, particularly in ecology, engineering, and disaster management (Holling 1973; Manyena et al. 2011; Davoudi et al. 2012). The central focus of this definition of resilience is the presence of a stable equilibrium point that systems return to after weathering and ‘bouncing back’ from some external shock (Davoudi et al. 2012; Bond et al. 2014).

As a concept, resilience has been applied to the study of individuals, especially in psychology and, recently, in neurobiology. These studies emphasize the role of resilience as an attribute that allows individuals to make positive adaptations in response to major adversity (Jacelon 1997; Luthar and Cicchetti 2000; Luthar et al. 2000; Bonanno 2004). While this paper does not address resilience at this individual level, it is nonetheless important to note that psychological resilience, along with other existing ‘popular’ psychological studies of individual resilience (Kelly et al. 2003; Reivich and Shatte 2003; Brooks and Goldstein 2004; Southwick and Charney 2012; Greitens 2016), similarly emphasize the presence of an equilibrium point towards which individuals are expected to ‘rebound’ upon facing shocks or perturbations.

This equilibrium- and response-based understanding of resilience has similarly persisted in its application to public policy, where resilience has become an increasingly prevalent metaphor for understanding the persistence and stability of social systems (Tobin 1999; Adger 2000; Chenoweth and Stehlik 2001; Chaskin 2008).

It is therefore evident that existing social research on resilience often takes on a macro-level systemic perspective that approximates the study of resilience in natural systems. Resilience, in fact, has been adopted in a consistent way in ecology and environmental studies but much less so in other disciplines such as sociology, political science, and economics (Olsson et al. 2015): in ecology and environmental studies, the object of analysis is the ‘system’, and thus, resilience is adopted as a systemic characteristic. Thus, resilience has been borrowed by social sciences with a systemic ontology.

As the situations confronted by policy-makers have increased in complexity, resilience has increasingly become a topic of interest to governments, although differences between ecological and social systems suggest that the ecological concept of resilience and, thus, its systemic ontology might not always directly apply to policy or be useful as a response to policy complexity (Duit et al. 2010; Duit 2015). For instance, the presence of human agency in social systems affects resilience in a variety of ways, whether through the purposeful postponement of the effects of ecological disruption, disproportionate distribution power and interests, or the inherent human capability to imagine, anticipate shocks, and engage in collective action, all of which result in multiple and unpredictable avenues of social adaptation to shocks (Davidson 2010). Thus, the systemic ontology of resilience does not facilitate the consideration of three essential attributes of social systems: power, knowledge, and agency (Cote and Nightingale 2012).

The inherent complexity and dynamism of social systems also raises conceptual challenges in any application of resilience thinking to the study of policies and societies, although the value of taking a resilience approach to understanding such complexity and dynamism has also been noted (Duit and Galaz 2008; Davidson 2010; Duit et al. 2010). However, this focus on complex systems also suggests a holistic dimension to resilience that is difficult to grasp and to unpack.

Consequently, the concept of resilience indicates only the broader categories of activities that should be improved (learning, adaptability, agility, self-organization, equilibrium, and thresholds) without providing any clear operative indications to policy designers.

From this point of view, although resilience seems to be a useful heuristic for assessing the extent to which specific systems, organizations, and policies are more or less resilient

when confronted with external shocks, it is difficult to use the concept in an explanatory perspective, despite its metaphoric strength (Anderies and Janssen 2013). While policy resilience can be viewed as the ability of a specific policy area to return to an earlier equilibrium with respect to certain relevant characteristics, these characteristics must be specified because an external shock might produce irreversible effects or effects that require a long time span for recovery with respect to a specific policy. For example, the 2008 financial crisis required some EU countries to drastically reduce public expenses. These cutbacks produced strong destabilizations among policy beneficiaries and decreased the quality and quantity of policy delivery. Recovery requires time, and policy resilience must be assessed based on the different potential parameters.

At the same time, however, it must be stressed that full recovery—and, thus, high resilience—might reiterate pre-existing institutions or patterns of behaviour in a specific policy field; this type of resilience might be a source of ineffectiveness in policy reforms. As MacKinnon and Derickson (2013, p. 254) have noted, efforts to establish resilience in policy processes may well serve to ‘reproduce the wider social and spatial relations that generate turbulence and inequality’.

If a policy system were to return to a prior equilibrium point, it might mean that the sources of instability or risk were not sufficiently resolved. This begs the question of whether a policy system that has encountered shock should aspire to become resilient or whether it should seek to adapt or transform into something different. Thus, it is unclear whether resilience can truly be developed from a policy perspective, either as an explanatory tool or as a focal point for improving policy design.

Robustness

Broadly understood, robustness refers to the ‘ability to withstand or survive external shocks, to be stable in spite of uncertainty’ (Bankes 2010, p. 2). More specifically, robustness has been described as the ‘ability of a system to withstand perturbations in *structure* without change in *function*’ (Jen 2003, p. 14). In all instances, robustness is associated with a complex system’s ability to remain functional in the face of shocks or disturbances (Mens et al. 2011). This focus on withstanding shocks and systemic functioning is prevalent in most applications of robustness across the various different disciplines.

In engineering, the robustness of systems refers to functional reliability in the presence of eventual failure; in biology, robustness is the ability of developmental processes to remain on course, notwithstanding the impact of environmental perturbations; in ecosystems, robustness is defined in terms of ecological resilience, which is the ability to maintain functions and control in the presence of external disturbance (Jen 2003) and ‘the maintenance of some desired system characteristics despite fluctuations in the behaviour of its component parts or its environment’ (Carlson and Doyle 2002, p. 2538).

A similar definition is found in organization theory, where robustness is defined as the ‘capacity of an organization to retain its fundamental pattern at core characteristics under changing conditions’ (van Oss and van’t Hek 2011, p. 34); from this perspective, organizational robustness is not necessarily designed, but it can emerge and become institutionalized through a specific configuration of internal routines, culture and memory. Thus, robustness is a specific characteristic of a system or organization that enables it to preserve its primary functional characteristics despite the uncertainties that are encountered. This suggests the possibility of building up, whether intentionally or organically, such characteristics within organizations or societies, even if the exact nature of the potential shock

is unknown. Similar characterizations can be found in political science and juridical studies that focus on the features of the US political system that allow for the preservation of its main constitutional goals. Bednar (2009, 2014) has defined robustness in the US Constitution as its capacity to safeguard from external shocks and internal crisis, while Schildknecht (2015) has adopted robustness as a criterion to assess the capacity of the US government 'to preserve itself endogenously while also maintaining the exogenous status quo' (p. 453).

More importantly for the purposes of this paper, robustness has also found room in various foundational works on policy and institutional design. For instance, Dryzek (1983) has called for the abandonment of optimization as a criterion or guiding principle for the design of policies and argued instead for a stronger focus on robustness because 'a robust policy alternative is one expected to perform tolerably well across the whole range of scenarios given any one of the pertinent theoretical perspectives. ... Its main virtue is its invulnerability to the weaknesses in our understanding, and to unexpected changes in the environment of policy' (pp. 360–361). Goodin (1998), in his fundamental guidelines for institutional design, suggested 'to design around the risk of accidents, seeking robust institutions that can withstand the various shocks that will inevitably befall them' (p. 27). This means that there is a need for institutions 'capable of adapting to new situations: not brittle and easily destroyed by them. But they should adapt to new situations only in the ways they are appropriate to the relevant respects in which the new situations are new' (p. 41).

The attention to the design of institutions in terms of robustness also characterizes the institutional rational choice perspective (Shepsle 1989; Ostrom 1990), where the problem of designing robust institutions and, thus, institutions capable of standing up to the test of the 'hard case' by ensuring the continued functionality of the system, is quite central. Finally, a focus on robustness also characterizes some streams of research in political economy, where robustness means 'the ability of various political economic arrangements to generate prosperity in the face of less than ideal conditions' (Leeson and Subrick 2006, p. 107).

Robustness has thus emerged as a characteristic that can ensure effectiveness over time in a specific system, institutional arrangement, or policy field. Due to such characterizations, robustness can be understood as a synonymous to stability or even an echo of the effect of the process of institutionalization, through which policies and institutions persist over time thanks to institutional or organizational adaptation and evolution (Smit and Wandel 2006), with strong connotations of adaptive efficiency (Bednar 2016).

However, it seems to us that this is not the case. Robustness is not the same as stability.

Robustness is the capacity to maintain the *functions* of a system (policy, political system, organization, or institution), while stability refers to a system's ability to maintain its actual *state*. A robust system is therefore not necessarily a static system, although a system could be kept stable thanks to the robustness of its functions. Put in other words, a 'system is robust as long as it maintains functionality, even if it transits through a new steady state or if instability actually helps the system to cope with perturbations' (Kitano 2007, p. 1). Then, 'robustness is a measure of feature persistence in systems where the perturbations to be considered are not fluctuations in external inputs or internal system parameters, but instead represent changes in system composition, system topology, or in the fundamental assumptions regarding the environment in which the system operates' (Jen 2003, p. 13).

Additionally, robustness is not the same as adaptability or the process through which institutions survive by adapting themselves to internal or external changes. Systemic,

policy, or institutional adaptation is the result of a process, while robustness is a property of the system, policy, or institution. The capacity of systems, institutions, or policies to adapt depends on various factors (distribution of power, path dependence, external pressures, etc.) and on forms of robustness.

Thus, robustness is a property of the institutional arrangements through which a system can adapt or can regain stability after having encountered periods of uncertainty and/or transformation. Unlike resilience, the stability that a robust system regains after recovering from shock and uncertainty may not resemble its pre-shock state. This nature of robustness therefore allows it to be considered a characteristic that is manipulable by agents and, thus, is subject to policy design and redesign.

Robustness and resilience are not synonymous and, hence, not related to each other

Although robustness and resilience have often been treated as synonymous, an analysis of existing interdisciplinary uses of the two terms reveals the existence of important conceptual differences between robustness and resilience.

Robustness emerges as a concept that can be used to directly assess and design policies and policy components. In particular, taking robustness as a conceptual framework can allow for the design of actionable policy decisions, plans, and strategies that are ‘insensitive’ to uncertainties (Banks 2010). In policy areas such as water management, climate change, spatial planning, business planning, and monetary policies, few decision models focus specifically on searching for robust decisions, that is, choices that envision clear trade-offs with respect to possible future events (see, for example, Lempert et al. 2013). At the same time, in political science and public policy, as we have noted above, there is a strong focus on the process through which institutional and policy design can produce robust arrangements, as well as the content of the design in terms of features of the choices to be made.

Resilience is a concept that focuses on understanding the ability of systems, organizations, policies, and individuals to persist over time against ‘external’ shocks (without, however, identifying the specific reasons for or causes of this ability). Robustness directly links the systemic/organizational/policy dynamics to the assessment of performance capacity, that is, the ability to *maintain the same performance in the face of any type of internal/external perturbation*. Resilience focuses on system recovery as a product a kind of objective and functionalistic (self-organized) process, while robustness not only emphasizes systemic functionality but also ‘relies, at least partially, on human designed elements’ (Bednar 2016, p. 169).

Seen from this point of view, then, it is understandable that resilience has received more political attention than robustness: it remains a more evocative and aspirational term (White and O’Hare 2014), with its emphasis on self-organization, learning, and prevention (without specifying how these features should be reached) facilitating the transfer of responsibility from governments to other stakeholders (Chmutina et al. 2016). In a way, resilience as a policy direction or principle de-emphasizes direct policy intervention and instead emphasizes individual responsibility, as well as the role of societal actors in building up resilience (Adger et al. 2005; Joseph 2013).

In short, resilience and robustness are not necessarily related to each other. As the discussion above has shown, they are conceptually distinct, despite a tendency in much of the existing literature to treat them as interchangeable or synonymous. Robustness makes it possible to avoid the strong impact of internal and external perturbances, whether through

direct or ad hoc policy interventions and, thus, diminishes or eliminates the role of resilience or at least the existing systemic-reactive understanding of it. In focusing on policy functions and performance, there is also a strong element of policy design in robustness and, thus, of policy adaptation and change. At the same time, the characteristics exhibited by resilience are effective when robustness is insufficient to avoid external shocks that directly affect systems, organizations or policies. A resilient society is therefore still able to rebound or recover from shock, even if it lacks the policy robustness necessary to withstand such shocks in the first place.

In this sense, what emerges from our review of the literature is that resilience appears to be a conservative property that could inhibit adaptation or change, thus maintaining actual socio-political equilibrium (MacKinnon and Derickson 2013), while robustness can be the bearer of the due changes needed to maintain the functionality and the goals of the system and, thus, its equilibrium. Thus, robustness appears to inhibit resilience, whereas resilience becomes important when robustness fails.

Resilience and robustness in the policy process

Resilience and robustness are assumed to be two different dimensions of socio-ecological systems (SESs), of institutions, of organizations, and of processes. Although these concepts might exhibit interconnections, the relationship between them is not necessarily positive. Furthermore, it emerges from our analysis of the literature that resilience could be less interesting from a policy design perspective than robustness. To better clarify the connection between the two concepts and their potential relevance for policy design, we will next discuss resilience and robustness in the context of the policy process.

Resilience in the policy process

Existing efforts to understand resilience in the policy process have tended to focus on specific policy issue areas, policy responses, or isolated parts of the policy process (Basagli 2009; Adger et al. 2011). However, due to the increasing interconnectedness of the various spheres of social and political activity, there is an emerging recognition of the need to adopt a systemic approach to resilience that focuses on the resilience of complex systems in response to shock (Fiksel 2006; Duit et al. 2010). Earlier studies have produced an understanding of resilience that is rooted in the actions of policy-makers within specialized policy spheres and, thus, is not necessarily generalizable to other aspects of the policy process or other policy issues.

What is needed is a more systematic attempt to understand the role of resilience in the overall policy process. In other words, we must think about resilience in terms of governance (Lebel et al. 2006; Duit et al. 2010). It is important to note that adopting a broad systemic approach to resilience requires that we address the concept at two levels. First, there is policy resilience at the *systemic level*, which refers to a policy's ability to produce resilience in a society. Second, there is policy resilience at the *process level*, which involves the resilience of the procedural aspects of policy-making, particularly in response to change and shocks.

Identifying the difference between policies that contribute to systemic resilience and policy processes that are themselves resilient enables us to extend the current understanding of resilience that focuses more on the first level, i.e. to policies rather than policy

processes. Although there has been considerable discussion regarding the extent to which specific policies contribute to a society's resilience—either in terms of physical or social resilience—there has been little discussion regarding the resilience of policy processes, which include institutional and procedural frameworks. In the present paper, we are particularly concerned with this second area of study.

Before discussing resilience in the policy process, however, we must first answer the question: resilient against *what*? Policy-makers now recognize that an increasingly complex policy environment often produces 'black swans' or unanticipated events that disrupt the proper functioning of a society (Ho 2008, 2012a; Taleb 2010, 2012). In light of these unanticipated shocks, resilience in public service essentially involves establishing the ability to identify these black swan events and to be prepared to address them when they occur (Ho 2008, 2012b).

In addition, we need to more accurately characterize black swan events and shocks. In particular, we must distinguish between internal and external sources of shock and policy change. External shocks, which typically include events such as natural disasters and economic crises, have received considerable attention in the existing literature (Birkland 1996; Comfort et al. 2001; Baker 2009; Pelling 2012; Claessens and Kodres 2014). However, less is known about what constitutes an internal source of shock or policy disturbance. More obvious examples might include policy entrepreneurship (Kingdon 1984), administrative reform (Osborne and Gaebler 1993), or political change.

As Kingdon has noted, policy entrepreneurs can drive policy change through merging the policy, politics, and problem streams. Such internally derived and policy entrepreneur-driven change becomes a shock when existing institutions and policy configurations are drastically altered, whether for the purpose of meeting with some new policy need or to achieve the goals of specific political interests. Indeed, the joint membership of policy entrepreneurs in domestic and transnational policy communities facilitates their role in mediating policy ideas and sparking off policy 'punctuations' (Bakir 2009). However, the ability of policy entrepreneurs to stimulate policy change might also be blocked by dominant 'coalitions' within a system that are averse to change (Sabatier 1988).

Such 'punctuations' are the subject of the 'Punctuated Equilibrium Theory' proposed by Frank R. Baumgartner and Bryan D. Jones in the early 1990s (Baumgartner and Jones 1991, 1993; Jones et al. 1998). In this theory, drastic policy changes often occur as sudden 'punctuations' in what are otherwise long periods of policy stability and incremental change. Such drastic changes have also been described as 'focusing events', with their impacts being particularly prominent in the agenda-setting stage of the policy process (Birkland 1996, 1998). Focusing events shape the public discourse by focusing public attention on the event and revealing a previously unknown aspect or 'image' of a policy problem to both the public and policy-makers (Birkland 1996; Jones and Baumgartner 2005), which, in turn, mobilizes interest groups to push for policy change, as is evident during many instances of natural disaster (Birkland 1998).

Such 'punctuations' can be highly destabilizing, resulting in significant changes to the existing institutional and political landscape. It can therefore be in the interest of policy-makers and interests groups to minimize such punctuations, hence perpetuating the stable equilibrium that exists between punctuations (Givel 2006). During periods of stable equilibrium, resilience plays a role because it contributes to maintaining and extending the periods of stable equilibrium that occur between punctuations and ensures a rapid return to equilibrium in the event of a focusing event or punctuation. However, too great a focus on resilience and a heightened desire to maintain a stable equilibrium may

rule out policy change entirely (which is not to say that shocks or focusing events no longer affect a policy system).

Instead, policy actors may resist change by reinforcing existing institutional frameworks either through collective action in the form of ‘policy monopolies’ (Baumgartner and Jones 1991) or through the actions of a ‘policy dictator’ (Jensen 2011). The US tobacco industry provides an example of a strong policy monopoly that has been able to resist interest group mobilizations in response to the health risks of tobacco consumption (Givel 2006). The entrenchment of change-averse policy actors might induce extreme efforts to establish policy resilience that result in resistance to attention to pressing policy issues and the inability to effect change through agenda setting.

Resilience is a concern not only in the agenda-setting stage but also during the policy formulation stage. At this stage, policy-makers might seek to design policies to ensure resilience in society. However, more often than not, resilience becomes a way to ensure the longevity and continuance of existing ‘packages’ or ‘mixes’ of policies that reflect the goals and vested interests of policy designers. Consequently, policy designers tend to favour incremental processes of ‘layering’ or ‘patching’ in which new instruments are added to the existing mix of instruments without the need for large-scale changes rather than a complete redesign of current policy mixes (Howlett and Rayner 2007, 2013).

Policy-makers are often reluctant to abandon established ways of doing things. In part, this is due to the fear of existing policies being perceived as failures; however, this occurs primarily because overall policy goals and objectives have not changed. Taken to the extreme, this can produce ‘dynamics without change’ (Woo and Howlett 2015) in which an established subset of policy actors is resistant to change and predisposed to tinkering at the edges. Although these efforts at ensuring ‘resilience’ in the policy design process ensure that policy mixes and the policies they embody persist through shocks and adapt rather than change, there is the risk that these policy mixes eventually become obsolete and unable to respond to radical shocks. Thus, government searching for resilience can obtain the opposite.

Furthermore, the policy formulation and design process is also affected by public perceptions and expectations of the policy instruments to be formulated and implemented (Schneider and Ingram 1990, 1994, 2005). To the extent that disasters or external shocks are socially constructed, policy responses and efforts at ensuring resilience at the individual, community, and institutional levels depends on accurate definitions or perceptions of disaster and vulnerability (Baker 2009). Policy designs or instruments that foster positive perceptions are thus more acceptable to the public encounter less resistance in implementation and are more effective in addressing shocks and crises.

Once the various policy options that may be used in the attainment of policy goals or objectives have been formulated, the next step is to decide which policies should be selected. The decision-making stage of the policy process typically involves state actors (Howlett et al. 2009), although it is increasingly recognized that non-state actors also play a role in informing decisions. The role of non-state actors has implications for resilience in the policy process. Lebel et al. (2006) suggested that policy resilience can be enhanced by increasing public participation in policy decisions, establishing polycentric and multilevel institutions of governance, and ensuring institutional accountability.

Indeed, non-state actors with specialized expertise such as think tanks and research institutions enhance policy resilience by harnessing information and converting this information into actionable policies (United Nations 2003; Reinmoeller and van Baardwijk 2005). Such ‘evidence-based’ policy decision-making takes into account a diverse set of views and feedback (Head 2013), arguably contributing to policy-makers’ ability to pre-

empt shocks and co-create solutions based on the input of these non-state actors, although evidence of the effectiveness of these institutions remains mixed.

Researchers have also long noted the importance of polycentrism (Ostrom 1990, 1998) and stakeholder participation (Atkinson and Coleman 1992; Rhodes 1997; Dryzek 2000; Koppenjan and Klijn 2004a) in solving complex problems and in ensuring greater resilience in the policy process. The need for institutional and stakeholder diversity suggests that building resilience into the system requires 'designing complexity to govern complexity' (Ostrom 1998). This often involves designing institutions that are able to promote bottom-up solutions to complex policy problems (Colander and Kupers 2014). For example, a high level of stakeholder participation and consultation in financial regulatory policy has ensured the resilience and stability of Singapore's financial services sector (Woo 2015a, b). At the same time, however, the involvement of many stakeholders in implementing the UK's resilience strategy has shown many ambiguities and shortcomings and, above all, emphasized and enforced a neo-liberal approach to public policy through which more public participation in sharing or addressing a collective problem requires less public funding to address that problem (Chmutina et al. 2016).

There is also a behavioural aspect to stakeholder participation in decision-making processes. For instance, positive policy perceptions contribute to resilience in policy change, with both resilience and positive perceptions fostered by stakeholder involvement in the decision-making process (Marshall 2007). In other words, including a broader and more diverse set of stakeholders in the policy process through formal mechanisms such as constitutional checks and balances or through multiple levels of government or institutionalized consultation also enhances the resilience of a policy process by producing cognitively driven and/or socially constructed perceptions of either shocks or policy alternatives.

However, at some point, polycentricity and the actor diversity it promises can produce rigidity in the policy process, which diminishes flexibility and adaptability to shocks and paradoxically reduces the level of resilience. For instance, Senate disagreements delayed the approval and implementation of the US fiscal stimulus plan during the global financial crisis of 2008 (Herszenhorn 2008). This was not surprising; unified or one-party governments are typically seen as better able to rapidly make decisions and implement counter-cyclical economic policies with minimum resistance (Armingeon 2012).

In other words, although the US political system's multiple veto points and polycentric nature introduce dynamism to its governance system, they also often produce rigidity and gridlock, which reduce responsiveness and adaptability (particularly in times of contentious political issues), prevent the policy process from responding swiftly to external shocks, and negatively affect the resilience of the policy process. Thus, stakeholder diversity and the number of decision-makers are poor indicators of a policy process's resilience and efficacy in dealing with shocks.

Finally, the policy process's resilience is influenced by the extent to which it is able to rapidly implement policies that respond and adapt to shocks, which is related primarily to the capacity of the local-level public organizations tasked with implementing these policies. Due to the government's role in directing and guiding policy change and transition in response to shocks (Rotmans et al. 2001), capacities for policy resilience are particularly relevant for public agencies that operate at the forefront of change and transition management. To ensure the continued functioning of the policy process in times of crisis, public agencies must be capable of ensuring effective and flexible policy implementation.

Sources of administrative capacity in local-level institutions typically include clearly defined rules governing the use of collective goods and mechanisms for conflict resolution

and sanctions against misuse (Ostrom 1990). The ability to maintain persistence and adaptability at this level typically involves infrastructure maintenance, contingency planning, redundant capacity and safety measures, personnel training, effective communication, and regulatory provisions (Smith and Stirling 2010). These factors ensure that public agencies possess the ability and organizational structures to address shocks and crises and to continue to perform operations during crises, which ensures the resilience of the implementation process.

Resilience in public organizations is also enhanced by the availability of knowledge and access to expert advice (Owens 2010). Just as in decision-making, the availability of feedback and input from a diverse set of stakeholders allows policy-makers to leverage the new ideas and resources these stakeholders offer. For instance, ‘policy co-creation’ between financial regulators and bankers in Singapore has ensured higher rates of industry compliance because regulation formulation and implementation involve industry actors who provide regulators with useful input on ways to improve policy relevance and compliance (Woo 2014). This type of inter-actor or inter-agency coordination can be enhanced through information technology tools, such as the ‘interactive, intelligent, and spatial information system (IISIS)’ (Comfort 1993; Comfort et al. 2001).

Olsson et al. (2004) also noted that financial support facilitates adaptive co-management by public and private actors by providing the necessary funds for private action, public consultation, and community research. Having strong financial reserves also contributes to organizational resilience by ensuring the preservation of ‘relational reserves’ and the viability of business models and headcounts during a crisis (Gittel et al. 2006). Funding and financial reserves are thus important components of resilience in policy implementation that provide organizations with the ‘slack’ needed to address sudden shocks and facilitate collective action among public and private actors. Such ‘slack’ acts as a buffer to shocks by providing organizations with excess resources that can be devoted to managing or responding to shocks (de Walle 2014).

As the above discussion demonstrates, ensuring resilience in the policy process requires examining the role of resilience for each stage of the policy process. One unifying theme in the above discussion is the importance of stakeholder participation in the policy process to ensure resilience during the various stages of the policy process. However, despite these efforts, the reality is that policy-makers have yet to design or envision a governance system that is capable of handling every form of shock that it encounters (Duit et al. 2010). Given the multitudinous nature of shocks and complexity, it is doubtful that such a system is possible in the first place.

In fact, we argue that efforts to develop a policy process or governance system that is completely resilient to all shocks may be counterproductive. Taken to an extreme, resilience may produce rigidity or policy gridlock. Rather than the institutional reifications associated with resilience, there is instead a need to focus on the skills and resources necessary to address unanticipated shocks and, thus, future uncertainty (MacKinnon and Derickson 2013). In other words, if policy resilience means the capacity to address external shocks and, thus, allow policy to recover, we need to understand how this process of recovery is possible and, thus, to focus on the resources (bureaucratic, cultural, financial, and organizational) and governance arrangement(s) needed to steer a policy system through periods of uncertainty.

As a concept, robustness may prove more amenable to such efforts at taking a resource-based and design-centric understanding of policy responses to shocks. We will discuss the policy characteristics of robustness next.

Robustness in the policy process

In contrast to resilience's focus on returning to an equilibrium point, robustness has been associated with the maintenance of 'policy strength' and the resistance of a society and its institutions to change (Lowndes and Roberts 2013; Galea et al. 2015). From this perspective, robust policies are essentially those that are underpinned by strong organizational values and effectively enforced (Galea et al. 2015). Aside from institutions and organizations, policy decisions can also be robust, particularly in terms of their long-term implementability and sustainability (Mens et al. 2011). There are hence several different scales of analysis involving different levels and components of the policy process when discussing policy robustness.

Regardless, policy robustness focuses on building up the 'strengths' or capacities necessary for the continued functioning of policy processes, institutions, and organizations in the face of shocks and perturbations. Taking a robustness approach to policy therefore suggests the possibility of imbuing institutions, organizations, policy decisions, implementation processes, or even the overall policy process with the ability to withstand shocks and disturbances with minimal disruption to policy functions. This emphasis on capacity building differs from resilience because robustness involves resisting shocks or unexpected events, not simply reacting to them, but facilitating the analysis and assessment of the capacities required to effect the needed policy changes in a specific context or time. As Guy Peters has observed, policies should be 'designed to be sufficiently robust to sustain this degree of modification and still accomplish its desired goals' (Peters 1999, p. 86).

However, the policy literature on robustness is limited, possibly because the original meaning of the concept, which addresses the development of decision strategies to control uncertainty, makes it difficult to apply in a policy context where different cultures, ideologies, interest engender different opinions regarding the nature of uncertainty. This poses difficulties in operationalizing and defining principles for robust policy design within such policy contexts (Anderies and Janssen 2013). Nevertheless, policy-makers might be assumed to search for robustness, and we can find different types of evidence for this effort. Governments might adopt different policy instruments to ensure that policies exhibit robustness, such as cost participation in health policy, inclusive policy-making processes, stakeholder consultation, and the provision of *in fieri* evaluation (Michels 2011).

Thus, from this perspective, policy robustness is a characteristic that is directly related to policy design and implementation. The search for robustness in regulating common pool sources and macro-economic policies could be regarded as equivalent to the goal pursued in policy design: determining how to decide about policy content and instruments so that they continue to operate as designed in the presence of unexpected events. Thus, robustness can fundamentally be regarded as a feature of the policy design process in which policy-makers determine how to solve collective problems and, thus, establish the rules of the game for a specific policy area, such as identifying the instruments to be adopted, the actors to be formally involved, the governmental level, the mechanisms for accountability, and implementation structures and processes. From this perspective, policy robustness depends on the specific characteristics of the policy area with respect to the capacity of the relevant institutions and actors and the related procedures through which policy processes develop over time.

The above considerations reveal that policy robustness exhibits the following characteristics:

- the capacity to maintain the original definition of the problem and to control agenda setting. Here, the governmental role of maintaining control of agenda setting is fundamental (Rasch and Tsebelis 2011; Green-Pedersen and Walgrave 2014);
- the capacity to redesign policies in a coherent way when they produce negative effects. In this case, what matters is not only the governmental capacity to politically steer the system but also the quality of the policy advisory system (Craft and Howlett 2012);
- the presence of policy procedures, information systems, and policy networks that effectively provide prompt feedback (Willis et al. 2012).

Policy robustness thus provides for a high level of policy control, as well as flexibility and agility. Flexibility involves the ability to change policy components, such as procedures and instruments, as needed, while agility involves the ability to quickly intervene when necessary.

Because policy robustness is intrinsically rooted in the institutional and political characteristics of a political system, it can be the focus of reform. For example, the continuing shift between centralization and decentralization, which characterizes public administration and policy reforms from a comparative perspective (Aucoin and Bakvis 1988; Witesman and Wise 2009), might be interpreted as different responses to the problem of increasing policy robustness. For instance, centralization allows for greater centralized control over the policy process, especially in the face of policy complexity (Painter 1981). An example of this is the formation of centralized government agencies in Singapore, such as the Municipal Services Office or the Cyber Security Agency, in response to growing complexity and unpredictability in urban and cyber security issues (Ministry of National Development 2014; Cyber Security Agency Singapore 2015; Municipal Services Office 2015).

Conversely, decentralization has also been seen as a means for addressing complex policy issues, especially under the rubrics of the New Public Management Movement, which saw decentralization and privatization as means of introducing greater responsiveness and flexibility into government agencies (Aucoin 1990; Osborne and Gaebler 1993; Dunleavy and Hood 1994; Hood 1995). The self-organization that is associated with decentralization has been seen as a means through which public agencies and public managers can address complexity and instability in the policy environment (Klijn 2008). Either way, decentralization and centralization represent possible avenues through which robust public organizations and policy processes can be established, although the decision to implement one or the other often depends on the nature of the complexity faced, as well as policy-makers' normative preference for either.

Other efforts to develop robustness in real-world policy settings include the development of SES approaches to climate change, urban planning and the regulation of natural resources (Anderies et al. 2007; Callo-Concha and Ewert 2014). Robustness is also often used as a measure of analysis in macro-economic and monetary policies (Alichi et al. 2015). In these fields, specific models have been proposed to enable policy-makers to design robust decisions (Hess and Daly 2014). However, these examples also indicate that the methods used to ensure policy robustness can vary by the context and time period.

It must also be underlined that policy design is a contextual activity, and thus, it is carried in a specific contingency with a prevailing political equilibrium, specific social values, specific distribution of power and bureaucratic competence, as well as a certain level of technical knowledge (Ingram and Schneider 1990). This means that robustness in policy design interprets the actual interaction among all these factors. However, and despite being able to potentially cover in a convincing way the prospective uncertainty,

every robust policy design could also be imbued with a certain extent of intrinsic fragility. This fragility, that is, the failure of the policy to react to some internal or external disturbance properly, could arise from an imperfect or incorrect analysis of the problem (due to the low quality of the policy advisory system), high partisan conflict, or hegemonic policy paradigm (with the consequence that any eventual redesign is based on its coherence or adherence with hegemonic ideas) (see Janssen and Anderies 2007; Alderson and Doyle 2010; Ruhl 2014).

Substantially, this means that the search for robust policy design can be conceived as an imperfect process with room for fragile reactions, with policy designers often forced to choose from different trade-offs.

For example, European Central Bank policies have been quite robust in managing inflation and, at the same time, weak in terms of re-launching and recovering the rate of growth of the EU economy—due to the hegemonic paradigm fully supported by the interest of some EU country members (Kaltenthaler 2006; Laski and Podkaminer 2012). Furthermore, the goal of pension reforms approved in the last two decades has been to maintain financial equilibrium in the long run, but this has been achieved at the risk of those new generations that will face discontinuous career lifecycles (Natali 2008; Johnson et al. 2012; Ciani et al. 2016).

Relevant dimensions of policy resilience and policy robustness

The above discussion of resilience and robustness in the policy process reveals three dimensions that characterize their roles in the policy process: (1) structure/agency; (2) policy change; and (3) manipulability. These three conceptual categories reflect important aspects of the policy process associated with resilience or robustness.

Structure and agency

Due to the interest in both resilience and robustness in addressing complexity and change in the policy environment, there is a need to consider the extent to which structure and agency in the policy process influence the ability to develop resilience or robustness. However, resilience and robustness are associated with structure and agency in very different ways. Resilience is more likely to be associated with structure due to an inherent bias towards returning to an earlier equilibrium point. Indeed, this return to systemic stability or institutional formalization may paradoxically be counterproductive in responding to shock because it precludes organizational flexibility (Pidgeon 2010; de Walle 2014). Furthermore, the systemic ontology through which it is handled in social sciences (that originates from its roots in evolutive biology) clearly does not allow a significant role for agency.

In contrast, robustness tends to be associated with specific aspects of a policy, such as specific institutions and organizations and specific procedures. Thus, it seems that robustness, unlike resilience, can overtly be involved in policy design activity and that policy-makers seek to design robust institutions, process or governance arrangements or accountability systems, such as designing fire alarms to control bureaucratic behaviour (Damonte et al. 2014); accountability systems to control specific policy areas from a distance (Elmore and Fuhrman 2004; Huisman 2009; Dubnick and Frederickson 2011); and sophisticated regulatory systems addressing all potential regulated behaviours.

This indicates that robust policies focus on individual actions, while resilient policies focus on systemic reactions.

Resilience's relationship with systemic equilibrium and stability creates an inherent bias towards structural thinking. In contrast to robustness, resilience focuses more on ensuring that the system can withstand shocks and rebound to the earlier status quo, although resilience might also involve a proactive rather than reactive response to change. For instance, the concept of 'revolutionary resilience' describes systems that change over time regardless of whether an external disturbance occurs (Scheffer 2009; Folke et al. 2010; Davoudi et al. 2012). This suggests that there are dynamic and proactive aspects of resilience that involve an unstable equilibrium that shifts in response to the implementation of projects, plans, and policies (Bond et al. 2014). However, even when resilience is proactive, the systemic or structural shifts involve slower, incremental changes over time that maintain the appearance of stability in real time. Furthermore, this perspective lacks potential room for agency (the fact that incremental changes happens can be due to conscious local actions and local redesign), and thus, this evolutionary perspective leaves aside the conscious role of policy designers.

From this point of view, the intrinsic structural nature of resilience suggests that it is the product of complex processes of learning and adaptation that are more effective when sub-components exhibit redundancy. Consequently, more complex policy areas and more numerous institutions, organizations and actors are associated with greater potential resilience against external shocks (Anderies et al. 2002; Walker et al. 2009). For example, a pension system is more resilient when it is based on a number of different pillars rather than a single pillar (Natali 2008), and a tertiary education system exhibits greater resilience with respect to deep job market shocks when it is highly differentiated rather than characterized by institutional homogeneity (Kyvik 2008). However, these features of resilience can obviously be related to robustness because the actual institutional arrangement of a policy area is due to robust policy design, which, in turn, means agency and conscious effort from policy-makers.

From this perspective, then, resilient structural capacity might be viewed as a result of the robustness of earlier policy-making. However, robust policy-making is able to prevent the disruptive effects of unexpected events and provide resilience because it provides ways to control and manage the behaviour of relevant institutions and actors. This might occur, for example, when the policy process provides a sensitive monitoring system that allows decision-makers to anticipate or become aware of a perturbation or when the regulatory component of a system is designed to prevent certain behaviours, such as financial restraints on banking activities (Caprio et al. 2001).

Policy change

Resilience and robustness present different implications with respect to policy change.

Theoretically, resilience thinking retains a strong focus on surviving external shocks while simultaneously capitalizing on the experience by learning to adapt to the changed context; it is reactive in nature. In contrast, robustness is dual-faceted: while it may also contribute to rigidity and resistance to change, robustness can provide a means to design a policy that adapts to change. In other words, robustness is more proactive and design-centric. Regardless, both policy resilience and policy robustness have a tendency to maintain the status quo or provide incremental change. Deep, radical change does not appear to be possible when a policy is extremely robust because the policy maintains functional stability in response to external and internal disturbances. However, this

apparent rigidity might subsequently engender a dramatic crisis that produces radical change (the fragility problem we have sketched above). Paradoxically, efforts to manage or ‘control’ severe disturbances and changes tend to reduce the potential for policy change.

A number of researchers claim that ensuring resilience requires adopting a complex systems approach in which governance systems respond to change in an adaptive manner (Jervis 1998; Kooiman 2003; Teisman et al. 2009). The nonlinearity and functional spillovers associated with complexity require flexible policies and governance systems, responsive institutions and cross-functional policy-making (Kooiman 2003; Koppenjan and Klijn 2004b; Warner 2010). Such adaptations are required because socio-political systems, unlike ecological systems, do not exhibit a fixed equilibrium point (Young 2010).

However, incremental adaptations to shock may also result in the reinforcement of existing institutional patterns and social relations, through what is known as ‘path dependency’, which paradoxically contributes to the overall rigidity of the system with relevant social and political consequences (MacKinnon and Derickson 2013; Sjöstedt 2015). Indeed, resilience has been described as ‘conservative insofar as it privileges the restoration of existing systemic relations rather than their transformation’ (MacKinnon and Derickson 2013, p. 263). Therefore, there is very little opportunity for resilience in policy processes and systems to enact the sort of radical change that may be necessary to address fundamental sources of uncertainty.

As it stands, incremental adaptations are critical for establishing resilience in the policy process, and policy changes associated with efforts to ensure resilience are also incremental in nature and feature piecemeal and marginal adaptation rather than broad and deep change. From this perspective, marginal adaptations are due to policy design. However, due to the holistic nature of resilience, this type of design is difficult to achieve. While scholars have emphasized the need for ‘better-designed institutions’ in order to ensure resilience in a social-ecological system (Walker et al. 2009), the means through which such institutional or policy design can be achieved remain elusive. For example, although establishing distributed cognition (Hutchins 1995; Comfort et al. 2001) enhances the resilience of a community, it is difficult to determine how to pursue this strategy, which is subject to many potential counterforces.

Furthermore, resilience thinking ignores the potential for endogenous change, whether in terms of internal institutional dynamics and incentives or institutional politics (Sjöstedt 2015). Such endogenous change is related to the ‘procedural policy instruments’ that are often designed and implemented to shape the processes and behaviours *within* institutions (Howlett 2000). Therefore, from a policy design perspective, resilience thinking favours incremental and reactive policy change, largely ignoring the role of internal institutional dynamics and procedural design aspects, even as it calls for better-designed institutions and policies.

Consequently, resilience and robustness can be viewed as complementary in producing incremental policy change.

However, due to its intrinsic ability to maintain functioning in the face of surprising or unexpected events, policy robustness might also inhibit policy change, a possibility that has not been discussed by the researchers adopting an SES approach. Robust policy design, which effectively produces the ability to avoid direct and immediate effects on actual policy dynamics (particularly in terms of performance outcomes), is able to hyper-institutionalize policy responses to internal and external disturbances and, thus, produce lock-in effects (Pierson 2000, 2004). Although these effects appear to be positive, they might internally undermine policy stability and, thus, engender the deep internal disturbances that result in significant upheavals. This illustrates the critical difference between the definition

of robustness proposed in engineering and the view adopted by SES that is applied to policy-making. In both engineering and the SES approach, robustness substantially involves designing fail-safe systems to control for a well-defined range of uncertainty (Anderies and Janssen 2013; Folke et al. 2010). In engineering, these control systems are applied to contexts in which political and ideological elements are less relevant. In the case of public policies, where policy stability means the maintenance of the status quo in the equilibrium between interests and ideas, robust design is based on the specific definition of the nature of a policy problem (e.g. in health, education, or welfare) and the best way to guarantee against future uncertainty in a political equilibrium in which some individuals lose and others win. For example, a robust welfare or pension policy should be able to respond at the national level to a financial crisis by maintaining the same level of delivered goods or (at least) attributing blame to all the relevant policy-makers to maintain equilibrium in the distribution of losses among beneficiaries. A layering process might create a situation that increases salient losses for some interest groups, which might produce an unexpected break in policy stability.

We argue that policy robustness is thus normative and/or ideologically driven because it is based on the partisan framing of social problems. Thus, policy robustness might not only produce policy stability but also ultimately be the source of a deep endogenous policy crisis.

Manipulability

Due to the structural rigidity and incremental change associated with resilience, resilient policy processes or systems are generally less manipulable. In establishing a resilient system, components of the policy process are inevitably less susceptible to manipulation. Although adaptations are possible, it is not easy to revamp or replace the components of a resilient policy process. With respect to policy design, a resilience-oriented policy process facilitates more incremental adaptations to the existing policy mix, such as ‘layering’ or ‘patching’ (Howlett and Rayner 2013). In some instances, it might not be possible to ‘design’ resilient policies in an intentional manner (Howlett and Mukherjee 2014).

This is particularly true at the policy formulation stage because a resilient policy process tends to be resistant to change and, thus, poses constraints or restrictions on the range of policy instruments available or feasible to policy-makers who seek to maintain the status quo rather than make substantial changes. This suggests that there are limits to the ability of policy-makers to deliberately change a resilient policy process, regardless of their motivations. Furthermore, learning, which is the primary mechanism involved in policy resilience, is very difficult to design at the systemic level.

Unlike policy resilience, policy robustness is more sensitive to manipulation and design. Every government tries to produce policies that are able to manage uncertainty, that is, policies in which implementation is effective. This requires designing policies that are flexible enough—despite being based on partisan preferences or specific ideas and interests—to address unexpected events during the implementation stage. Different types of policy tools have been introduced in different policy areas to control policy implementation, such as regulatory impact assessment (Kirkpatrick 2008); different types of evaluation (Shaw et al. 2006); strict accountability procedures (Chinman et al. 2004); and transparency (Fung et al. 2007).

However, policy robustness directly depends on the competence of governmental policy, as well as the configuration of socio-political interests. Robust policies can be designed when the government exhibits sufficient policy analytical and managerial competence (Wu

et al. 2015). However, the rigidity or roots of future fragility can also sit in when robust institutions focus on maintaining political legitimacy rather than ensuring adaptability, as they seek to ensure the persistence of entrenched interests (Jen 2003). However, it is well known that good, and thus robust, policy design also needs ‘good’ politics.

Government actions for resilience and robustness

While the policy characteristics discussed above pose important implications for the policy process, the question remains: what can governments do to ensure resilience or robustness across these characteristics? Based on the discussions above, we highlight a few relevant points for possible policy action by governments seeking to develop more resilient or robust policy systems, focusing in particular on the three elements of structure and agency, policy change, and manipulability.

With regard to structure and agency, governments seeking to establish a more resilient policy system may consider increasing the number and diversity of institutions, organizations, and actors. This allows for greater ‘slack’ in resources available for addressing shocks and crisis. Furthermore, the diversification of stakeholders and institutions can contribute towards reducing ‘groupthink’. However, a resilient policy system is, by its very nature, more susceptible to intrinsic adaptations rather than consciously driven by policy change. Such systems are also less manipulable. Within this context, policy-makers may consider ‘patching’ or ‘layering’ new policy instruments onto the existing policy mix, focusing on how these instruments can contribute to systemic stability and at the same time, facilitate incremental change that can orient the policy system towards its equilibrium point. But, from a governmental perspective, this paper has also clearly highlighted the existence of significant weaknesses or limitations that are associated with ensuring resilience in a policy system.

All in all, to suggest that governments deliver resilient policies means substantially to push them to design more participatory, inclusive, learning, redundant and evidence-based policies without knowing how much participation or redundancy is enough or how to ensure learning takes place. Furthermore, the notion of devoting governmental attention to resilience is misleading because a focus on rebounding from external shocks assumes an intrinsic systemic capacity to do this. This systemic nature of resilience makes any governmental efforts to foster resilience highly problematic. Indeed, it is difficult to either predict or assess the impact of governmental efforts on systemic characteristics, if any at all. It is often the case that the presence of systemic capacities for resilience is obvious only after the system has been hit by a shock or crisis, rather than before. From this point of view, the trade-offs that decision-makers face are unclear and thus the possibility of designing for resilience remains quite ambiguous and evocative.

The alternative is that governments shift their attention to robustness rather than to resilience. In terms of structure and agency, policy-makers may consider focusing on designing more robust institutions, processes, governance arrangements, or organizational components that can maintain functional stability in the face of shock (internal or external). While such robust policy systems can similarly only accommodate incremental policy change, it is nonetheless more manipulable by virtue of its focus on designing flexible instruments and institutions: this will involve designing policy instruments that are sufficiently flexible and manipulable, such that policy-makers can easily adapt them and ensure their functionality under shock or new operating conditions.

Thus, a focus on robustness gives governments the chance to re-intervene on the institutional arrangements of policy and modify these in a direct and conscious way. There is, in other words, the possibility of developing or building up in advance the specific capabilities that can contribute towards the robustness of a policy system, in preparation for any future shocks. Thus, change, although incremental, is not dependent on systemic reaction to a shock, as in the case of resilience, but on direct government interventions. To focus on robustness instead of resilience allows governments direct control of the policy process, allowing them a conscious choice to pursue resilience when needed but also to push for different results rather than merely bouncing back, in accordance with their preferences and societal needs.

Concluding remarks for further research on policy robustness

In our review, by analysing a broad theoretical and empirical literature, we discussed the extent to which the concepts of resilience and robustness add value from a policy perspective. We conclude by claiming that the relevance of these two concepts is different both for public policy and for policy design. Resilience appears to be less promising for policy application. Although the concept was based originally on evidence of the intrinsic capacity of SESs and organizations and institutions to overcome deep external shocks by maintaining an earlier equilibrium and characteristics, resilience requires a holistic structural dynamic (due to the systemic ontology that underpins the SES framework¹) that is difficult to apply from a policy perspective. Furthermore, policy resilience is similar to path dependence (Torfing 2009) because the theoretical problems related to the concept appear to be evocative, normative, and unable to explain changes in a causal way (Kay 2005). Finally, operationalizing resilience as a dependent variable is difficult (Duit 2015) due to the systemic and holistic nature of the concept.

Even macroeconomists who have long focused on the importance of ‘steady-state equilibrium’ have begun to perceive the fragility associated with equilibrium-based understandings of economic systems and have chosen instead to draw upon theories of dynamic systems (Serletis 2014). Even when viewed as a more meso-micro attribute (i.e. from the perspective of institutional or organizational resilience), the concept does not appear to add much to our understanding of institutional persistence compared to neo-institutional approaches, for example.

¹ It should be noted, however, that different approaches to understanding and conceptualizing resilience could have different results. For instance, the individualistic approach to the resilience of psychology and related disciplines could bear different assessments. The therapeutic implications and mission of resilience studies in these fields represent another stream of research that shows how causes of resilience can be clearly found and subsequently inform efforts to correct and enhance individual resilience. This “clinical” approach refuses any ontology and simply searches for correlation between causes and effects and, thus, focuses on the potential treatments needed to increase an individual’s capacity to be resilient. This approach holds limited transferability to social science analysis. However, a focus on the structure of incentives and sanctions through which individual behaviour can be addressed properly is central to many branches of social sciences, such as economics, political science, and sociology. From this point of view, much of the existing literature on institutional design, policy design, and policy instruments can be viewed as committed to addressing the ways through which agency (and, thus, individuals) can foster social order, effective policy implementation, and the durable enhancement of prevailing social goals. However, the focus remains very much on the ways in which policy and societal processes can retain their functionality in the face of shock and uncertainty, a point that we argue emphasizes policy designs for robustness rather than systemic resilience.

In addition, resilience appears to provide few opportunities to improve policy design. Although policy researchers are aware that learning and adaptability are effective mechanisms for improving policies (Howlett and Ramesh 1993; Sanderson 2002), better policies are not necessarily resilient policies.

In contrast to the concept of resilience, robustness appears to be more promising from a policy perspective both for improving our understanding of policy-making and for improving policy design.

Future research should focus on the explanatory and prescriptive value of policy robustness. Policy robustness, which is defined as the ability of governance arrangements in a policy to maintain performance in the presence of external/internal disturbances, should be examined in depth from an explanatory perspective. For example, future research might examine how robust the governance arrangement should be to exhibit positive effects while not exceeding the threshold at which it begins to produce negative outcomes.

In addition, the concept should be analysed jointly with the concept of policy capacity to improve our understanding of the extent to which policy robustness and capacity overlap and/or independently influence policy-making and policy performance. As MacKinnon and Derickson (2013) have noted, there is a need to elaborate the resources, skills and knowledge needed for governments and communities to respond effectively to shocks and uncertainty.

From a policy design perspective, the concept of policy robustness should be taken into account to increase the awareness of decision-makers (who should be conscious that when they design policies, they have to decide which kind of robustness they want and which kind of fragility they risk) and increase the focus on evidence-based processes (Sanderson 2002, 2009; Levin et al. 2003; Shaxson 2005; Howlett 2009). Focusing on robustness in policy design would increase attention to coping with uncertainty. Uncertainty exhibits different meanings in different policy areas. For example, partisan and ideological factors impact social issues such as education, health, and immigration differently from other more technical areas such as the environment, climate change, and technology. While social issues involve multiple and often conflicting accounts of the nature of policy issues and their socially constructed nature (Schneider and Ingram 1993, 1994; Hammond 1996), normative contestations in technical policy issues tend to revolve around the nature and suitability of scientific or technological policy solutions (Funtowicz and Ravetz 1990). Thus, in more contested policy fields, the meaning of robustness could vary according to the prevailing values and political dynamics.

In addition, researchers and policy-makers should examine the extent to which robustness produces rigidity and thus becomes a bearer of prospective policy fragility. Indeed, a growing reliance on robustness or resilience as responses to growing policy complexity may well prove counterproductive for policy-makers seeking to establish robust policy processes because over-emphasizing systemic resistance or adaptation to shocks may also in some cases mean removing or avoiding much-needed change to out-moded policy processes. Aside from focusing on developing robust policy processes, policy-makers also need to recognize such instances in which the change that may result from a particular shock or disturbance may in fact be beneficial to the overall policy process.

Definitively, working on robustness can be both a fascinating challenge for policy scholars and a promising way for policy-makers to better do their jobs.

References

- Adger, W. N. (2000). Social and ecological resilience: Are they related? *Progress in Human Geography*, 24(3), 347–364.
- Adger, W. N., Brown, K., Nelson, D. R., Berkes, F., Eakin, H., Folke, C., et al. (2011). Resilience implications of policy responses to climate change. *Wiley Interdisciplinary Reviews: Climate Change*, 2(5), 757–766.
- Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., & Rockström, J. (2005). Social–ecological resilience to coastal disasters. *Science*, 309(5737), 1036–1039.
- Alderson, D. L., & Doyle, J. C. (2010). Contrasting views of complexity and their implications for network-centric infrastructures. *IEEE Transactions on Systems, Man, and Cybernetics Part A: Systems and Humans*, 40(4), 839–852.
- Alexander, E. R. (1982). Design in the decision making process. *Policy Sciences*, 14(3), 279–292.
- Alexander, D. E. (2013). Resilience and disaster risk reduction: An etymological journey. *Natural Hazards and Earth System Sciences*, 13(11), 2707–2716.
- Alichi, A., et al. (2015). *Avoiding dark corners: A robust monetary policy framework for the United States*. IMF Working Paper No. 15/134. Washington: International Monetary Fund.
- Anderies, J. M., & Janssen, M. A. (2013). Robustness of social–ecological systems: Implications for public policy. *Policy Studies Journal*, 41(3), 513–536.
- Anderies, J. M., Janssen, M. A., & Walker, B. H. (2002). Grazing Management, resilience, and the dynamics of a fire-driven rangeland system. *Ecosystems*, 5(1), 23–44.
- Anderies, J. M., Rodriguez, A. A., Janssen, M. A., & Cifdaloz, O. (2007). Panaceas, uncertainty, and the robust control framework in sustainability science. *Proceedings of the National Academy of Sciences*, 104(39), 15194–15199.
- Armington, K. (2012). The politics of fiscal responses to the crisis of 2008–2009. *Governance*, 25(4), 543–565.
- Atkinson, M. M., & Coleman, W. D. (1992). Policy networks, policy communities and the problems of governance. *Governance*, 5(2), 154–180.
- Auccoin, P. (1990). Administrative reform in public management: Paradigms, principles. *Paradoxes and Pendulums*. *Governance*, 3(2), 115–137.
- Auccoin, P., & Bakvis, H. (1988). *The centralization–decentralization conundrum: Organization and management in the Canadian government*. Halifax: The Institute for Research on Public Policy.
- Baker, S. M. (2009). Vulnerability and resilience in natural disasters: A marketing and public policy perspective. *Journal of Public Policy & Marketing*, 28(1), 114–123.
- Baker, J. W., Schubert, M., & Faber, M. H. (2008). On the assessment of robustness. *Structural Safety*, 30(3), 253–267.
- Bakir, C. (2009). Policy entrepreneurship and institutional change: Multilevel governance of central banking reform. *Governance*, 22(4), 571–598.
- Bankes, S. (2010). Robustness, adaptivity, and resiliency analysis. *Association for the Advancement of Artificial Intelligence, Papers from Fall Symposium*. <http://www.aaai.org/ocs/index.php/FSS/FSS10/paper/view/2242/2643>. Accessed 29 Aug 2016.
- Bastagli, F. (2009). Conditionality in public policy targeted to the poor: Promoting resilience? *Social Policy and Society*, 8(01), 127–140.
- Baumgartner, F. R., & Jones, B. D. (1991). Agenda dynamics and policy subsystems. *The Journal of Politics*, 53(04), 1044–1074.
- Baumgartner, F. R., & Jones, B. D. (1993). *Agendas and instability in American politics*. Chicago: University of Chicago Press.
- Bednar, J. (2009). *The robust federation*. Cambridge: Cambridge University Press.
- Bednar, J. (2014). Subsidiarity and robustness: Building the adaptive efficiency of federal system. In J. Fleming & J. Levy (Eds.), *Federalism and subsidiarity* (pp. 231–256). New York: New York University Press.
- Bednar, J. (2016). Robust institutional design: What makes some institutions more adaptable and resilient to changes in their environment than others? In D. S. Wilson & A. Kirman (Eds.), *Complexity and evolution: A new synthesis for economic* (pp. 167–184). Cambridge, MA: MIT Press.
- Birkland, T. (1996). Natural disasters as focusing events: Policy communities and political response. *International journal of mass emergencies and disasters*, 14(2), 221–243.
- Birkland, T. A. (1998). Focusing events, mobilization, and agenda setting. *Journal of Public Policy*, 18(01), 53–74.
- Bonanno, G. A. (2004). Loss, trauma, and human resilience: Have We underestimated the human capacity to thrive after extremely aversive events? *American Psychologist*, 59(1), 20–28.

- Bond, A., Morrison-Saunders, A., Gunn, J. A. E., Pope, J., & Retief, F. (2014). Managing uncertainty, ambiguity and ignorance in impact assessment by embedding evolutionary resilience, participatory modelling and adaptive management. *Journal of Environmental Management*, 151C, 97–104.
- Brooks, R., & Goldstein, S. (2004). *The power of resilience: Achieving balance, confidence, and personal strength in your life* (1st ed.). McGraw-Hill Education: New York, London.
- Callo-Concha, D., & Ewert, F. (2014). Using the concepts of resilience, vulnerability and adaptability for the assessment and analysis of agricultural Systems. *Change and Adaptation in Socio-Ecological Systems*, 1(1), 40–50.
- Caprio, G., Honohan, P., & Stiglitz, J. (Eds.). (2001). *Financial liberalization. How far? How fast?*. Cambridge: Cambridge University Press.
- Carlson, J. M., & Doyle, J. (2002). Complexity and robustness. *Proceedings of the National Academy of Sciences*, 99(S1), 2538–2545.
- Chaskin, R. J. (2008). Resilience, community, and resilient communities: Conditioning contexts and collective action. *Child Care in Practice*, 14(1), 65–74.
- Chenoweth, L., & Stehlik, D. (2001). Building resilient communities: Social work practice and rural Queensland. *Australian Social Work*, 54(2), 47–54.
- Chinman, M., Imm, P., & Wandersman, A. (2004). *Getting to outcomes. Promoting accountability through methods and tools for planning, implementation, and Evaluation*. Santa Monica: RAND.
- Chmutina, K., et al. (2016). Unpacking resilience policy discourse. *Cities*, 58, 70–79.
- Ciani, E., et al. (2016). Policy uncertainty about state pension reform. In *Paper presented at the 3rd Mannheim workshop in quantitative macroeconomics, University of Mannheim, 19–21 May*. www.csef.it/IMG/pdf/ciani.pdf. Accessed: August 29, 2016.
- Claessens, S., & Kodres, L. (2014). *The regulatory responses to the global financial crisis: Some uncomfortable questions*. IMF Working Paper No. WP/14/46. Washington, DC: International Monetary Fund.
- Colander, D., & Kupers, R. (2014). *Complexity and the art of public policy: Solving society's problems from the bottom up*. Princeton, NJ: Princeton University Press.
- Comfort, L. K. (1993). Integrating information technology into international crisis management and policy. *Journal of Contingencies and Crisis Management*, 1(1), 15–26.
- Comfort, L. K., Sungu, Y., Johnson, D., & Dunn, M. (2001). Complex systems in crisis: Anticipation and resilience in dynamic environments. *Journal of Contingencies and Crisis Management*, 9(3), 144–158.
- Cote, M., & Nightingale, A. J. (2012). Resilience thinking meets social theory: Situating social change in socio-ecological systems (SES) research. *Progress in Human Geography*, 36(4), 475–489.
- Craft, J., & Howlett, M. (2012). Policy formulation, governance shifts and policy influence: Location and content in policy advisory systems. *Journal of Public Policy*, 32(2), 79–98.
- Cyber Security Agency Singapore (2015). *Our organisation* [online]. Cyber Security Agency. <http://www.csa.gov.sg/about-us/our-organisation>. Accessed July 21, 2016.
- de Walle, S. V. (2014). Building resilience in public organizations: The role of waste and bricolage. *The Innovation Journal*, 19(2), 1–18.
- Damonte, A., Dunlop, C. A., & Radaelli, C. (2014). Controlling bureaucracies with fire alarms: Policy instruments and cross-country patterns. *Journal of European Public Policy*, 21(9), 1330–1349.
- Davidson, D. J. (2010). The applicability of the concept of resilience to social systems: Some sources of optimism and nagging doubts. *Society and Natural Resources*, 23(12), 1135–1149.
- Davoudi, S., Shaw, K., Haider, L. J., Quinlan, A. E., Peterson, G. D., Wilkinson, C., et al. (2012). Resilience: A bridging concept or a dead end? 'Reframing' resilience: Challenges for planning theory and practice interacting traps: Resilience assessment of a pasture management system in Northern Afghanistan urban resilience: What does it mean in planning practice? Resilience as a useful concept for climate change adaptation? The politics of resilience for planning: A cautionary note. *Planning Theory & Practice*, 13(2), 299–333.
- Dryzek, J. S. (1983). Don't toss coins in garbage cans: A prologue to policy design. *Journal of Public Policy*, 3(4), 345–367.
- Dryzek, J. S. (2000). *Deliberative democracy and beyond: Liberals, critics, contestations*. Oxford: Oxford University Press.
- Dubnick, J., & Frederickson, G. H. (Eds.). (2011). *Accountable governance: Promises and problems*. London: Routledge.
- Duit, A. (2015). Resilience thinking: Lessons for public administration. *Public Administration*. doi:10.1111/padm.12182.
- Duit, A., & Galaz, V. (2008). Governance and complexity—Emerging issues for governance theory. *Governance*, 21(3), 311–335.
- Duit, A., Galaz, V., Eckerberg, K., & Ebbesson, J. (2010). Governance, complexity, and resilience. *Global Environmental Change*, 20(3), 363–368.

- Dunleavy, P., & Hood, C. (1994). From old public administration to new public management. *Public Money & Management*, 14(3), 9–16.
- Elmore, R., & Fuhrman, S. (Eds.). (2004). *Redesigning accountability*. New York: Teachers College Press.
- Fiksel, J. (2006). Sustainability and resilience: Toward a systems approach. *Sustainability: Science, Practice, & Policy*, 2(2), 14–21.
- Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society*, 15(2), 20–28.
- Fung, A., Graham, M., & Weil, D. (2007). *Full disclosure: The perils and promise of transparency*. Cambridge: Cambridge University Press.
- Funtowicz, S. O., & Ravetz, J. R. (1990). Science for policy: Uncertainty and quality. In N. L. Amsterdam (Ed.), *Uncertainty and quality in science for policy* (pp. 7–16). Dordrecht: Springer.
- Galea, N., Powell, A., Loosemore, M., & Chappell, L. (2015). Designing robust and revisable policies for gender equality: Lessons from the Australian construction industry. *Construction Management and Economics*, 33(5–6), 375–389.
- Gittel, J. H., Cameron, K., Lim, S., & Rivas, V. (2006). Relationships, layoffs, and organizational resilience airline industry responses to September 11. *The Journal of Applied Behavioral Science*, 42(3), 300–329.
- Givel, M. (2006). Punctuated equilibrium in limbo: The tobacco lobby and U.S. state policymaking from 1990 to 2003. *Policy Studies Journal*, 34(3), 405–418.
- Goodin, R. (Ed.). (1998). *The theory of institutional design*. Cambridge: Cambridge University Press.
- Green-Pedersen, C., & Walgrave, S. (Eds.). (2014). *Agenda setting, policies, and political systems: A comparative approach*. Chicago: Chicago University Press.
- Greitens, E. (2016). *Resilience: Hard-won wisdom for living a better life* (Reprint ed.). Boston: Mariner Books.
- Hamel, G., & Valikangas, L. (2003). The Quest for resilience. *Harvard Business Review*, 81(9), 52–63.
- Hammond, K. R. (1996). *Human judgment and social policy: Irreducible uncertainty, inevitable error, unavoidable injustice*. Oxford: Oxford University Press.
- Head, B. W. (2013). Evidence-based policymaking—Speaking truth to power? *Australian Journal of Public Administration*, 72(4), 397–403.
- Herszenhorn, D. M. (2008). Senate G.O.P. blocks additions to stimulus bill. *The New York Times*, 7 February.
- Hess, S., & Daly, A. (Eds.). (2014). *Handbook of choice modelling*. London: Edward Elgar.
- Ho, P. (2008). *Governing at the leading edge: Black swans, wild cards, and wicked problems*.
- Ho, P. (2012a). *Coping with complexity*. Singapore: McKinsey.
- Ho, P. (2012b). *Governing for the future: What governments can do* (Vol. 248).
- Holland, J. H. (1996). *Hidden order: How adaptation builds complexity*. Boston: Addison-Wesley.
- Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, 4, 1–23.
- Hood, C. (1995). The ‘new public management’ in the 1980s: Variations on a theme. *Accounting, Organizations and Society*, 20(2–3), 93–109.
- Howlett, M. (2000). Managing the ‘hollow state’: Procedural policy instruments and modern governance. *Canadian Public Administration*, 43(4), 412–431.
- Howlett, M. (2009). Policy analytical capacity and evidence-based policy-making: Lessons from Canada. *Canadian Public Administration*, 52(2), 153–175.
- Howlett, M. (2011). *Designing public policies*. London: Routledge.
- Howlett, M., & Mukherjee, I. (2014). Policy design and non-design: Towards a spectrum of policy formulation types. *Politics and Governance*, 2(2), 57–71.
- Howlett, M., & Ramesh, M. (1993). Patterns of policy instrument choice: Policy styles, policy learning and the privatization experience. *Review of Policy Research*, 12(1–2), 3–24.
- Howlett, M., Ramesh, M., & Perl, A. (2009). *Studying public policy: Policy cycles and policy subsystems* (3rd ed.). Oxford: Oxford University Press.
- Howlett, M., & Rayner, J. (2007). Design principles for policy mixes: Cohesion and coherence in ‘new governance arrangements’. *Policy and Society*, 26(4), 1–18.
- Howlett, M., & Rayner, J. (2013). Patching vs packaging in policy formulation: Assessing policy portfolio design. *Politics and Governance*, 1(2), 170–182.
- Huisman, J. (Ed.). (2009). *International perspectives on the governance of higher education. Alternative frameworks for coordination*. London: Routledge.
- Hutchins, E. (1995). *Cognition in the wild*. Boston: MIT Press.

- IFRC. (2012). *Understanding community resilience and program factors that strengthen them: A comprehensive study of red cross red crescent societies tsunami operation June 2012*. Geneva: International Federation of Red Cross and Red Crescent Societies.
- Ingram, H., & Schneider, A. (1990). Improving implementation through framing smarter statutes. *Journal of Public Policy*, 10(1), 67–88.
- Jacelon, C. S. (1997). The trait and process of resilience. *Journal of Advanced Nursing*, 25(1), 123–129.
- Janssen, M. A., & Anderies, J. M. (2007). Robustness trade-offs in social ecological systems. *International Journal of the Commons*, 1(1), 43–65.
- Janssen, M. A., Anderies, J. M., & Ostrom, E. (2007). Robustness of socialecological systems to spatial and temporal variability. *Society and Natural Resources*, 20(4), 307–322.
- Jen, E. (2003). Stable or robust? What's the difference? *Complexity*, 8(3), 12–18.
- Jensen, C. (2011). Focusing events, policy dictators and the dynamics of reform. *Policy Studies*, 32(2), 143–158.
- Jervis, R. (1998). *System effects*. Princeton, NJ: Princeton University Press.
- Johnson, R. W., Steuerle, C., & Quakenbush, C. (2012). *Are pension reforms helping states attract and retain the best workers?* Program on Retirement Policy Occasional Paper No. 10. Washington, DC: Urban Institute.
- Jones, B. D., & Baumgartner, F. R. (2005). *The politics of attention: How government prioritizes problems*. Chicago: University of Chicago Press.
- Jones, B. D., Baumgartner, F. R., & True, J. L. (1998). Policy punctuations: U.S. budget authority, 1947–1995. *The Journal of Politics*, 60(01), 1–33.
- Joseph, J. (2013). Resilience as embedded neoliberalism: A governmentality approach. *Resilience*, 1(1), 38–52.
- Kaltenthaler, K. (2006). *Policymaking in the European Central Bank: The masters of Europe's money*. Lanham: Rowman & Littlefield.
- Kay, A. (2005). A critique of the use of path dependency in policy studies. *Public Administration*, 83(3), 553–571.
- Kelly, M., Hoopes, L., & Conner, D. (2003). *Managing change with personal resilience: 21 keys for bouncing back & staying on top in turbulent organizations*. Raleigh, NC: Mark Kelly Books.
- Kingdon, J. W. (1984). *Agendas, alternatives, and public policies*. Boston: Brown Little.
- Kirkpatrick, C. (2008). *Regulatory impact assessment: Towards better regulation?* Cheltenham: Edward Elgar.
- Kitano, H. (2007). Towards a theory of biological robustness. *Molecular Systems Biology*. doi:10.1038/msb4100179.
- Klijin, E.-H. (2008). Complexity theory and public administration: What's new? *Public Management Review*, 10(3), 299–317.
- Kooiman, J. (2003). *Governing as governance*. London: SAGE.
- Koppenjan, J. F. M., & Klijin, E.-H. (2004a). *Managing uncertainties in networks: A network approach to problem solving and decision making*. New York, NY: Routledge.
- Koppenjan, J., & Klijin, E.-H. (2004b). *Managing uncertainties in networks: Public private controversies*. London: Routledge.
- Kuorikoski, J., Lehtinen, A., & Marchionni, C. (2010). Economic Modelling as Robustness Analysis. *The British Journal for the Philosophy of Science*, 61(3), 541–567.
- Kyvik, S. (2008). *The dynamics of change in higher education. Expansion and contraction in an organizational field*. Dordrecht: Springer.
- Laski, K., & Podkaminer, L. (2012). The basic paradigms of EU economic policy-making need to be changed. *Cambridge Journal of Economics*, 36(1), 253–270.
- Lebel, L., Anderies, J., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T., et al. (2006). Governance and the capacity to manage resilience in regional social-ecological systems. *Ecology and Society*, 11(1), 1–21 (art. 19).
- Leeson, P., & Subrick, J. R. (2006). Robust political economy. *Review of Austrian Economics*, 19(2–3), 107–111.
- Lempert, R. J., et al. (2013). *Making good decisions without predictions: Robust decision making for planning under deep uncertainty*. Santa Monica: RAND Corporation: http://www.rand.org/pubs/research_briefs/RB9701.html.
- Levin, A., Wieland, V., & Williams, J. C. (2003). The performance of forecast-based monetary policy rules under model uncertainty. *The American Economic Review*, 93(3), 622–645.
- Lowndes, V., & Roberts, M. (2013). *Why institutions matter: The new institutionalism in political science*. Houndmills, Basingstoke, Hampshire: Palgrave Macmillan.

- Luthar, S. S., & Cicchetti, D. (2000). The construct of resilience: Implications for interventions and social policies. *Development and Psychopathology*, 12(4), 857–885.
- Luthar, S. S., Cicchetti, D., & Becker, B. (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development*, 71(3), 543–562.
- MacKinnon, D., & Derickson, K. D. (2013). From resilience to resourcefulness: A critique of resilience policy and activism. *Progress in Human Geography*, 37(2), 253–270.
- Manyena, B., O'Brien, G., O'Keefe, P., & Rose, J. (2011). Disaster resilience: A bounce back or bounce forward ability? *Local Environment*, 16(5), 417–424.
- Marshall, N. A. (2007). Can policy perception influence social resilience to policy change? *Fisheries Research*, 86(2–3), 216–227.
- Mens, M. J. P., Klijn, F., de Bruijn, K. M., & van Beek, E. (2011). The meaning of system robustness for flood risk management. *Environmental Science & Policy*, 14(8), 1121–1131.
- Michels, I. (2011). Innovations in democratic governance: How Does citizen participation contribute to a better democracy? *International Review of Administrative Sciences*, 77(2), 275–293.
- Ministry of National Development. (2014). *Municipal services office to improve service delivery* [online]. Ministry of National Development website. <http://www.mnd.gov.sg/mso/press-municipal-services.htm>. Accessed February 23, 2015.
- Municipal Services Office. (2015). *About us* [online]. Singapore Government. <http://www.mnd.gov.sg/mso/about-us.htm>. Accessed February 21, 2015.
- Natali, D. (2008). *Pensions in Europe, European pensions*. Bruxelles: PIE-Peter Lang.
- National Water Plan. (2008). *National water plan*. Le Hague: Ministry of Transport, Water Management and Public Works.
- OECD. (2014). *Boosting resilience through innovative risk governance*. Paris: OECD.
- Olsson, L., et al. (2015). Why resilience is unappealing to social science: Theoretical and empirical investigations of the scientific use of resilience. *Science Advances*. <http://advances.sciencemag.org/content/1/4/e1400217.full>.
- Olsson, P., Folke, C., & Berkes, F. (2004). Adaptive comanagement for building resilience in social–ecological systems. *Environmental Management*, 34(1), 75–90.
- Osborne, D., & Gaebler, T. (1993). *Reinventing government: How the entrepreneurial spirit is transforming the public sector*. New York, NY: Plume.
- Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge: Cambridge University Press.
- Ostrom, E. (1998). Scales, polycentricity, incentives: Designing complexity to govern complexity. In L. D. Guruswamy & J. McNeely (Eds.), *Protection of global diversity: Converging strategies* (pp. 149–167). Durham, NC: Duke University Press.
- Owens, S. (2010). Learning across levels of governance: Expert advice and the adoption of carbon dioxide emissions reduction targets in the UK. *Global Environmental Change*, 20(3), 394–401.
- Painter, M. (1981). Central agencies and the coordination principle. *Australian Journal of Public Administration*, 40(4), 265–280.
- Pelling, M. (2012). *The vulnerability of cities: Natural disasters and social resilience*. London: Routledge.
- Peters, G. (1999). *Institutional theory in political science*. London: Pinter.
- Pidgeon, N. (2010). Systems thinking, culture of reliability and safety. *Civil Engineering and Environmental Systems*, 27(3), 211–217.
- Pierson, P. (2000). Increasing Returns, path dependence, and the study of politics. *American Political Science Review*, 94(2), 251–267.
- Pierson, P. (2004). *Politics in time: History, institutions, and social analysis*. Princeton: Princeton University Press.
- Rasch, E., & Tsebelis, G. (Eds.). (2011). *The role of governments in legislative agenda setting*. London: Routledge.
- Reinmoeller, P., & van Baardwijk, N. (2005). The link between diversity and resilience. *MIT Sloan Management Review*, 46(4), 61–65.
- Reivich, K., & Shatte, A. (2003). *The resilience factor: 7 keys to finding your inner strength and overcoming life's hurdles* (Reprint ed.). New York: Harmony.
- Rhodes, R. A. W. (1997). *Understanding governance: Policy networks, governance, reflexivity, and accountability*. London: Open University Press.
- Rotmans, J., Kemp, R., & van Asselt, M. (2001). More evolution than revolution: Transition management in public policy. *Foresight*, 3(1), 15–31.
- Ruhl, J. B. (2014). Managing systemic risk in legal systems. *Indiana Law Journal*, 89(2), 560–603.
- Sabatier, P. A. (1988). An advocacy coalition framework of policy change and the role of policy-oriented learning therein. *Policy Sciences*, 21(2–3), 129–168.

- Sanderson, I. (2002). Evaluation, policy learning and evidence-based policy making. *Public Administration*, 80(1), 1–22.
- Sanderson, I. (2009). Intelligent Policy making for a complex world: Pragmatism, evidence and learning. *Political Studies*, 57(4), 699–719.
- Scheffer, M. (2009). *Critical transitions in nature and society*. Princeton, NJ: Princeton University Press.
- Schildknecht, W. (2015). Designing for robustness: Overcoming systemic risk in the political branches. *California Law Review*, 103(2), 433–466.
- Schneider, A., & Ingram, H. (1990). Behavioral assumptions of policy tools. *The Journal of Politics*, 52(02), 510–529.
- Schneider, A., & Ingram, H. (1993). Social construction of target populations: Implications for politics and policy. *The American Political Science Review*, 87(2), 334.
- Schneider, A., & Ingram, H. (1994). Social constructions and policy design: Implications for public administration. *Research in Public Administration*, 3, 137–173.
- Schneider, A. L., & Ingram, H. M. (2005). *Deserving and entitled: Social constructions and public policy*. Albany: State University of New York Press.
- Serletis, A. (2014). Introduction to macroeconomic dynamics special issue on complexity in economic systems. *Macroeconomic Dynamics*, 1(2), 1–5.
- Shaw, I., Greene, J., & Mark, M. (Eds.). (2006). *The Sage handbook of evaluation*. Beverly Hills: Sage.
- Shaxson, L. (2005). Is your evidence robust enough? Questions for policy makers and practitioners. *Evidence & Policy: A Journal of Research, Debate and Practice*, 1(1), 101–112.
- Shepsle, K. (1989). Studying institutions: Some lessons from the rational choice approach. *Journal of Theoretical Politics*, 2(1), 31–47.
- Sjöstedt, M. (2015). Resilience revisited: Taking institutional theory seriously. *Ecology and Society*, 20(4), 1–8 (art. 23).
- Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16(3), 282–292.
- Smith, A., & Stirling, A. C. (2010). The politics of social–ecological resilience and sustainable socio-technical transitions. *Ecology and Society*, 15(1), 11.
- Southwick, S. M., & Charney, D. S. (2012). *Resilience* (1st ed.). Cambridge: Cambridge University Press.
- Taleb, N. N. (2010). *The black swan: The impact of the highly improbable: With a new section: 'On Robustness and Fragility'* (2nd ed.). New York: Random House Trade Paperbacks.
- Taleb, N. N. (2012). *Antifragile: How to live in a world we don't understand*. London: Allen Lane.
- Teisman, G., van Buuren, A., & Gerrits, L. M. (Eds.). (2009). *Managing complex governance systems* (1st ed.). New York, NY: Routledge.
- Tobin, G. A. (1999). Sustainability and community resilience: The holy grail of hazards planning? *Global Environmental Change Part B: Environmental Hazards*, 1(1), 13–25.
- Torfig, J. (2009). Rethinking path dependence in public policy research. *Critical Policy Studies*, 3(1), 70–83.
- United Kingdom Cabinet. (2014). *Resilience in society: Infrastructure, communities and businesses*. <https://www.gov.uk/guidance/resilience-in-society-infrastructure-communities-and-businesses>.
- UNISDR. (2016). *Making cities resilient*. <https://www.unisdr.org/we/campaign/cities>.
- United Nations. (2003). *Thinking the unthinkable: From thought to policy. The role of think tanks in shaping government strategy*. Washington, DC: United Nations.
- Van Oss, L., & Van 't Hek, J. (2011). *Why organizations fail? Robustness, tenacity, and change in organizations*. London: Routledge.
- Walker, B., et al. (2009). Looming global-scale failures and missing institutions. *Science*, 325(5946), 1345–1346.
- Warner, K. (2010). Global environmental change and migration: Governance challenges. *Global Environmental Change*, 20(3), 402–413.
- White, I., & O'Hare, P. (2014). From rhetoric to reality: Which resilience, why resilience, and whose resilience in spatial planning? *Environment and Planning C: Government and Policy*, 32(5), 934–950.
- Willis, C. D., et al. (2012). Strengthening health systems through networks: The need for measurement and feedback. *Health Policy and Planning*, 27(suppl. 4), 62–66.
- Witesman, E., & Wise, C. (2009). The centralization/decentralization paradox'. *Public Administration Review*, 69(1), 116–127.
- Woo, J. J. (2014). Singapore's policy style: Statutory boards as policymaking units. *Journal of Asian Public Policy*, 8(2), 120–133.
- Woo, J. J. (2015a). Policy relations and policy subsystems: Financial policy in Hong Kong and Singapore. *International Journal of Public Administration*, 38(8), 553–561.

-
- Woo, J. J. (2015b). Beyond the neoliberal orthodoxy: Alternative financial policy regimes in Asia's financial centres. *Critical Policy Studies*, 9(3), 297–316.
- Woo, J. J., & Howlett, M. (2015). Explaining dynamics without change: A critical subsector approach to financial policy making. *Journal of Asian Public Policy*, 8(3), 312–328.
- Wu, X., Ramesh, M., & Howlett, M. (2015). Policy capacity: A framework for analysis. *Policy & Society*, 34(3–4), 165–171.
- Young, O. R. (2010). Institutional dynamics: Resilience, vulnerability and adaptation in environmental and resource regimes. *Global Environmental Change*, 20(3), 378–385.
- Zautra, A., Hall, J. S., & Murray, K. (2010). Resilience: A new definition of health for people and communities. In J. W. Reich, A. J. Zautra, & J. S. Hall (Eds.), *Handbook of adult resilience* (pp. 3–34). New York: Guildford Press.