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ARTICLE

Designing policy robustness: outputs and processes

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ABSTRACT

Faced with growing policy complexity and environmental uncertainty, policymakers are increasingly concerned with ensuring that policy processes retain functionality amidst shock and uncertainty. In this paper, we seek to address the ways in which robustness – or the capability of policies to maintain functionality and effectiveness in policy goal attainment – can be designed into policies, institutions or systems. We suggest that robust policy designs can be characterized by diversity, modularity and redundancy, whereas robust policy design processes require the presence of polycentric decisional process, political capacity and technical capacity. In identifying these design elements of policy robustness, we argue that robustness is a property that can be designed to ensure that policies continue to deliver, over time, its intended functions, purposes and objectives, even under negative circumstances.

KEYWORDS

Robustness; policy design; diversity; modularity; redundancy; political capacity

1. Introduction

The main aspiration of policy design as well as of policymakers is to be able to formulate durable solutions for problems perceived as collective. This means that policy decisions are expected to be capable of persisting over time, in terms of goals pursued and the capacity to maintain an acceptable level of effectiveness or functionality in the pursuit of these goals. This requires policy solutions – or the set of policy instruments adopted to deal with a policy problem through the distribution of costs and benefits, delivery of services and regulation individual and social behaviours – to be designed in a way that they can maintain functionality over time. Such functionality is especially important, in light of an increasingly complex policy environment that is fraught with 'wicked problems' and 'black swans' (Head, 2008; Ho, 2008; Taleb, 2010; Weber & Khademian, 2008).

Recent examples of such policy uncertainty include the 2007 Global Financial Crisis, the 2011 Fukishima nuclear disaster, as well as acts of terrorism and other security challenges. These instances, along with others, highlight the growing prevalence of uncertainty as a permanent fixture of policymaking today. To manage such uncertainty, policymaking needs to be capable of responding to unexpected events and their impacts, through the activation of different modes/mechanisms (ie learning, adaptation,

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improvisation) to maintain their commitment and effectiveness in pursuing the expected policy goals. This capacity of policymaking to respond to, and retain functionality amid, uncertainty can be defined as 'robustness'.

Given the need for functionality amidst an increasingly complex and uncertain policy environment, there is much need for greater attention to policy robustness, especially from a policy design perspective. This focus on designing robust policies presents a highly promising, and fascinating, way of reorienting the attention of policy scholars to the structural and procedural conditions for 'good' policy designs. While we have provided a systematic overview of policy robustness elsewhere (Capano & Woo, 2017, 2018), we will seek to further clarify the concept of robustness in the following section. This is followed by a discussion of why and how the concept of robustness should be considered relevant for policy design. Having clarified the conceptual foundations of robustness, we will then present some empirical examples of robustness in policy design, after which we will focus on how – ie under what conditions – policy robustness can be designed. In the conclusion, we present some suggestion for further research.

2. What is robustness

Owing to its wide usage across various disciplines, robustness has been imbued with multiple meanings. As a concept, robustness is more prevalent in the natural sciences than in the social sciences. Whether in engineering, biology or ecosystems, robustness has been associated with a system's ability to maintain its functions or characteristics in a relatively controlled and reliable manner in the face of external shocks or perturbations (Carlson & Doyle, 2002; Jen, 2005). This focus on ensuring functional reliability in the face of shock carries over into efforts at understanding robustness in public policy, particularly in terms of environmental policy. For instance, Anderies, Folke, Walker, and Ostrom (2013) have defined robustness as a 'reduced sensitivity of outputs to shocks', whereby the system continues to function and outputs do not change despite variations in the inputs. Such systemic stability, however, does not come without a cost, especially in terms of trade-offs between robustness and performance (Zhou & Doyle, 1997).

It should, however, be noted that robustness in the policy sense does not necessarily give rise to stability or institutional/procedural rigidity. In responding to a policy shock or uncertainty, it is natural for policymakers to adapt or adjust certain parameters of their policies, institutions or processes. However, such adjustments do not detract from the overall policy goal or direction that is emphasized in a given policy mix. For instance, the Global Financial Crisis gave rise to substantive changes in the regulatory frameworks of many developed economies, although the emphasis on systemic stability and financial sector development has not changed. Robustness therefore emphasizes the ability to maintain the consistent delivery of a desired set of policy outputs.

It is also important to emphasize that robustness differs from other seemingly similar concepts, such as 'resilience' (Berkes & Folke, 2000; Cote & Nightingale, 2012; Folke et al., 2010; Lebel et al., 2006; Olsson, Folke, & Berkes, 2004; Timmerman, 1981; Walker, Holling, Carpenter, & Kinzig, 2004), with robustness emphasizing the retention of functionality amidst shock, whereas resilience focuses on returning to a stable

equilibrium point after shock; this focus on functionality also means greater manipulability of policy instruments and parameters (Capano & Woo, 2017) .

To reiterate, robustness directly refers to this capacity to deal with external shocks, conditions of uncertainty or imperfect external conditions in a way through which both institutional or procedural functions and the capacity of policy initiatives to attain expected goals are maintained, despite any eventual structural or procedural changes (Goodin, 1998; Leeson & Subrick, 2006; Ostrom, 1990). The emphasis is not so much on maintaining institutional form or procedural integrity, but the capacity to maintain public service delivery as well as to achieve a predetermined set of policy goals and outputs.

Robustness can therefore be thought of in terms of policymakers' capacity to respond to, and retain functionality amidst, uncertainty, with such capacity often exercised through the design of effective policies or institutions. Defined in this way, robustness becomes a characteristic or competency that allows policymakers to deal with changes and possible uncertainty without compromising the expected performance and functioning of a specific policy or set of policies. For instance, an ecosystem's understanding of robustness focuses on the capacity to maintain a desired state against fluctuations in the behaviour of either its parts or its environment, often with changes to its components in order to maintain functionality; in institutional systems, a constitution can be defined robust if both the legitimacy and functionality of its political institutions can be maintained during contested or critical times, albeit with possible amendments to some of its components (Bednar, 2016).

Robustness can therefore be seen as that property of a policy that allows the specific functions/goals of a policy – in terms of behaviour to be regulated and values to be delivered – to be maintained over time despite contingent or critical fluctuations arising from external changes or internal challenges. In line with this view, a robust policy has been defined as one that is able to perform or work well across a range of plausible futures or scenarios (Dryzek, 1983, pp. 369–361; Walker, Rahman, & Cave, 2001, p. 289). Such robustness also extends to the cognitive limitations of policymakers and designers themselves. For instance, Dryzek (1983, pp. 360–361) has defined robust policies as possessing an 'invulnerability to the weaknesses in our understanding, and to unexpected changes in the environment of policy'.

It is also important, for clarity's sake, to emphasize that robustness is not the same as stability or adaptability. Stability refers to the systemic, institutional or policy capacity to maintain the actual state (ie the specific characteristics) of a system (policy, political system, organization or institution), whereas robustness refers to the capacity to maintain its *functions* (ie ability to maintain the delivery of a set of policy outputs). This makes robustness a dynamic property: a robust institution or policy is not static. Indeed, ensuring policy functionality can also involve adaptations to policy parameters or institutions. This is evident in the regulatory reforms that were enacted post-GFC, for the purpose of ensuring financial system stability. Although parts of the regulatory infrastructure were adapted, neither the policy goals of stability nor the roles of financial regulators were substantially changed. 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).

The arguments that are presented above point to the promising possibility that robustness can be designed and thus become a fundamental element in the actions of policy designers. We will now address this significance of robustness for policy design.

3. Why robustness is relevant for policy design

The endeavour of policy design involves a deliberate commitment to improving public policy by anticipating the possible effects of governmental decisions and articulating specific courses of action towards the effective attainment of expected goals (Dryzek, 1983). In designing policies, decision makers often draw on their existing knowledge, empirical evidence and external advice to strengthen their ability to design efficient and effective policies (Bobrow, 2006; Bobrow & Dryzek, 1987; Howlett & Rayner, 2017). Policy design as a field of scholarly research has faced its ups and downs in the last few decades, and in the wake of prominent government failures such as the global financial crisis, it is now experiencing a promising resurgence as governments seek to understand how to design more effective policies (Howlett, 2011, 2014).

What is particularly relevant in this resurgence of policy design is the specific attention devoted to the double-sided nature of policy design: the actual process of 'designing' policies (where different actors try to influence the final output) and the specific set of policy instruments or policy 'designs' to be adopted (the final content of the designing process). This distinction between design as process and design as output – that echoes the distinction between design as 'verb' and design as 'noun' (May, 2003) – allows both policy scholars and practitioners to identify and focus on distinct dimensions that can be used to better understand and practice policy design.

In terms of the procedural dimension of policy design (the 'verb'), efforts to understand the processes that determine why and how policy is designed should focus not only on political-institutional conditions but also on the policy advisory systems and streams of policy ideas that surround and determine the formulation process. With respect to the outputs of policy design (the 'noun'), greater attention should be devoted to the possible combinations of policy instruments that are at the disposal of policymakers and the ways through which policymakers assess the potentiality, in terms of their effectiveness in attaining policy goals, of the instruments and their various combinations.

This double-sided nature of policy design is especially relevant in any robustness-based understandings of policy design, since robustness can be a valuable property both of design as process and of design as output. Although a robust policy means, on the surface at least, the capacity of a designed set of policy instruments to deal with a specific problem despite any possible uncertainty or fluctuation, there can also be a broader and more systemic understanding of robustness, with a robust design process having significant impacts on the potential robustness of the design output.

These considerations are necessary premises to underline why robustness is relevant for policy design and hence a necessary consideration to be included in the theoretical and prescriptive toolkit of policy designs.

The general landscape within which robustness has emerged as a relevant concept for policy design is represented by the contemporary complexity of policymaking. Policies are increasingly contested and 'wicked' and policy arenas overcrowded, while the need

for functional integration among different policy fields as well as the influence of multilevel dynamics represents continuing sources of challenge and potential instability, with policymakers possessing minimal capacity for controlling all the relevant factors that can influence policy dynamics (Head, 2008; Room, 2011; Weber & Khademian, 2008). Such complexity and dynamics, coupled with the limited capacity of policymakers, can give rise to high levels of uncertainty.

It is against this structural condition of policy dynamics and complexity that robustness could be considered a possible antidote or strategic tool for good policy design, in terms of designing policies with the capacity to overcome fluctuations and challenges in the implementation process and achieving expected policy goals under relative stability. It is not a case then of growing interest in robustness in several specific policy fields (climate change, environmental policy and risk management) or among scholars of comparative politics who are interested in institutional design (Bednar, 2009; Goodin, 1998; Shepsle, 1989). Rather, robustness presents a broader structural framework within which not only the outputs, but also the processes of policy design are determined. Indeed, one of the most prominent frameworks of public policy, the Institutional Analysis and Development framework developed by Elinor Ostrom, devotes much attention to robustness (Janssen, Anderies, & Ostrom, 2007; Ostrom, 1990).

Given its potential utility to existing understandings of how to make more effective policies in complex and hard times, robustness therefore presents an interesting and highly promising concept from a policy design perspective. This is evident in the increasing empirical interest in robustness in policy design.

4. Empirical cases of robust policy design

Empirical examples of robustness in policymaking tend to be limited by two reasons. First, understandings of uncertainty tend to differ across political, cultural and ideological contexts, making it difficult to operationalize and define robustness for policy design (Anderies & Janssen, 2013). Second, robustness tends to be conflated or confused with other similar concepts such as resilience or stability. As a consequence, existing efforts to understand robustness in policy design tend to either be situated within studies of resilience or lack systematic conceptualization. Hence, while some of these studies focus on resilience, they at the same time argue for the development of robust policies (eg see Cavallo & Ireland, 2014).

There is, nonetheless, growing interest in how robustness can be developed in policy processes. One area in which robustness has received much attention is climate change and environmental policy, with many of these studies focused on developing strategies to cope with ecological or environmental instability, often by reducing an ecosystem's vulnerability to climate change (Anderies, Rodriguez, Janssen, & Cifdaloz, 2007; Callo-Concha & Ewert, 2014; Jäger et al., 2015). Such efforts at understanding robustness in environmental policy also tend to involve developing more effective policies for managing natural resources such as water, energy and fuel that may be diminished or affected by the impacts of climate change (Dadson et al., 2016; Gober, Quay, & Larson, 2016; Hamilton et al., 2013; Koul, Falebita, Akinbami, & Akarakiri, 2016). The concept of robustness has also been particularly useful for research on energy transitions (Hamarat, Kwakkel, & Pruyt, 2013; Kwakkel, Eker, & Pruyt, 2016). Similar efforts

have focused on developing policy robustness in pollution control, particularly in terms of carbon emissions reduction (Böhringer, Rosendahl, & Storrøsten, 2017; Fischer, Greaker, & Rosendahl, 2014; Pedroni, Dutschke, Streck, & Porrua, 2009).

Such studies of policy robustness in environmental and climate-change policies have yielded useful ways of thinking about robust policy processes, such as 'robust decision making (RDM)' approaches that emphasize adaptability in decision making (Bhave, Conway, Dessai, & Stainforth, 2016; Lempert, Groves, Popper, & Bankes, 2006; Walker, Haasnoot, & Kwakkel, 2013; Weaver et al., 2013), robustness metrics for assessing policy adaptability (Kwakkel et al., 2016), 'precautionary' policies that provide preventive measures for addressing potential environmental hazards and risks (Barrieu & Sinclair-Desgagné, 2006; Iverson & Perrings, 2012) or the use of scenario planning to pre-empt and prepare for the various potential climate-change scenarios (Chermack, 2004; Groves & Lempert, 2007; Hamilton et al., 2013; Peterson, Cumming, & Carpenter, 2003).

Another related policy area that has emphasized policy robustness is disaster management, with studies in this area tending to focus on complex thinking and systems approaches to managing the complex and interconnected risks associated with natural disasters (Carlson & Doyle, 2002; Cavallo & Ireland, 2014; Mens, Klijn, de Bruijn, & van Beek, 2011). Such growing interest in developing robust policies in the areas of environmental policy and disaster management is driven by the possibility of drawing on scientific evidence and measures to facilitate evidence-based policymaking (Desouza & Yuan, 2013). However, growing policy complexity, not simply in the natural environment but across a broad spectrum of policy areas, has also led to emerging efforts to understand how robustness can be incorporated into policy systems and processes across different policy areas.

This is particularly the case in economic policy, where policymakers tend to be focused on ensuring that economies and their regulatory systems are robust in the face of economic shocks and crises (Casey, 2015; Claessens, Kose, Laeven, & Valencia, 2014; Demirgüç-Kunt & Servén, 2010; Levine, 2012). Of particular importance to such endeavours is the notion of risk. Efforts at developing robust policies and policy systems that can withstand economic or financial shock and uncertainty have also placed a strong emphasis on risk management, especially in terms of formulating risk management strategies and removing barriers to the implementation of risk management policies (Hallegatte & Rentschler, 2015).

While economists and central bankers have tended to take a systemic approach to understanding policy robustness, there is growing emphasis on designing robust policies that can address market uncertainty (Levine, 1986). This is particularly the case after the 2008 Global Financial Crisis, with such efforts focused on the design of robust macro-prudential policy tools that can pre-empt or respond effectively to market failure and externalities (Claessens, 2015; Yellen, 2011). These efforts draw on preexisting understandings of robustness in monetary policy that emphasize central bankers' ability to manage inflation (Levin, Wieland, & Williams, 1998; Levin & Williams, 2003; Taylor, 1999), although monetary policy robustness can also be affected by the sociopolitical context within which central bankers and policymakers are embedded. For instance, it has been found that an interest-driven hegemonic paradigm has led European Central Bank policies that are quite robust in managing inflation but weak in stimulating economic growth (Kaltenthaler 2006; Laski & Podkaminer, 2012).

This focus on specific robust policies can also be found in social policy, with robust welfare policies defined as those that retain their robustness or functionality regardless of assumptions of policy target or recipient's behavioural motivations (Grand 1997). This often involves establishing clear rules of conduct, such as through a citizen's charter, which can foster greater transparency and predictability in the delivery of welfare services (Greener, 2002). Such efforts at understanding robustness in social policy are therefore focused on managing and addressing uncertainty in human behaviour rather than the external environment. Others have noted the usefulness of system dynamics modelling and simulation for ensuring policy robustness in the face of such behavioural complexity (Pruyt, 2015).

As this section has shown, there is growing interest in the design of robust policies across a broad array of policy areas. These range from environmental policy and climate change to economic governance and social policy. Given space constraints, the list of empirical studies of policy robustness provided above is far from exhaustive. However, the presence of such efforts to identify and understand empirical cases of policy robustness further suggests a need for a more systematic understanding of how robust policies can be formulated and implemented, ie how policy robustness can be designed into a given policy system. We will now seek to address this in the next section.

5. How policy robustness can be designed

As we have seen, robust policies can be designed, although our understanding of them remains far from complete. Efforts to design robustness into policies are particularly prevalent in the realm of financial sector policy. For instance, inflation targeting policies allows central bankers to maintain inflation within a predetermined range in response to shifts in the macroeconomic environment. As another example, policymakers also rely on what are known as 'automatic stabilizers', such as income taxes and welfare expenditures, that allow a society to adjust its expenditures in response to an economic downturn. For instance, unemployment and welfare benefits autonomatically accrue to those who are affected by a recession, whereas progressive taxation ensures that households pay lower taxes on their income in the event of a fall in household income.

However, such efforts to design robustness into policies and policy processes remain restricted to the realm of financial sector policy, with applications to other policy domains limited. To design robust policies, then, is possible but difficult. It involves the capacity to imagine a plausible solution, based on a coherent causal theory, and then to proceed to design it in a way that the expected goals can be reached. But designing robust policies is quite demanding because it asks for robustness not only in the design output but also in the design process. In fact, the process of design is not simply a neutral means of achieving a robust design output, but part of a broader robust policy dynamics.

Designing policy robustness is a complex task whose viability, constraints and opportunities depend on the characteristics of the issue/policy involved as well as the sociopolitical and institutional context within which policy design occurs. It is not a case then that, as we have reported above, robustness is considered a fundamental component in the design of policies in fields like network infrastructure (like in energy or in public transport), environmental and climate-change policies, natural sources and

disaster management, and macroeconomic and monetary policies. Rather, all these policy fields are characterized by elements that can facilitate a design approach that is focused on robustness.

First of all, many of these studies remain focused on the design of the output, with the process of design often neglected or deemed less relevant by scholars. Put in other words, designing a robust system of water management or of metropolitan transport network is, notwithstanding the technical complexity of the issues at stake, more simple and straightforward than designing a robust welfare or education policy. This difference is due to the nature of the policy to be designed: where the social/value dimension prevalent or where the role of the human behaviour plays an important role in determining policy outcomes, it can be much more complex to design robust policies. From this point of view, robustness, in its full conception, remains under-explored and under-specified in the existing public policy literature, although there are several exceptions in welfare policy (Le Grand, 1997) and in gender policy (Galea, Powell, Loosemore, & Chappell, 2015).

Second, the nature of the issue at stake can determine the reliability of forecasts about the possible uncertainty that can develop over time. For instance, there are many formal models that have been developed to assess different possible scenarios on the basis of specific assumptions (Chermack, 2004; Mietzner & Reger, 2005; Peterson et al., 2003). These exploratory models can help decision makers systematically assess the consequences of an alternative set of decisions (Auping, Pruyt, & Kwakkel, 2015; Bankes, 1993; Bankes, Walker, & Kwakkel, 2013; Thissen, Kwakkel, Mens, van der Sluijs, & Stemberger, 2017). Yet at the same time, these highly sophisticated analytical tools seem to be more applicable to specific policy fields than others. This is especially the case where the definition of the problem to be solved is clearly defined and widely agreed upon. We are not saying, then, such exploratory models of decision making are not useful for designing robust policies but simply that they could be a useful and supporting tool in specific decisional contexts.

From our point of view, it is more relevant to focus on and grasp those factors that are necessary, although not sufficient, conditions to designing robust policies.

Seen from this perspective, then, we shall focus on those conditions that can allow for both robust design processes and robust design outputs. The linkage between process and output is relevant for us, since robust design processes can also contribute to the formulation of robust design outputs. This linkage is based also on existing empirical evidence that the process of design is neither a linear nor a 'one shot' activity; on the contrary, it is an unfinished ongoing dynamic that can also be reversed over time and between the different stages of the policy process. For instance, design processes occur not only in policy formulation, but also during the implementation phase, as policymakers seeking to achieve a robust design output intervene during the various stages of the policy process to make the (re)adjustments needed to maintain the expected functionality of the policy process.

Thus, we can distinguish among the characteristics that allow for the design of robust policies and the maintenance of policy functionality.

5.1. *Characteristics for robust design outputs*

Robust policies are characterized by their capacity to maintain functionality, and thus effective delivery of their intended objectives, under unexpected circumstances or conditions of uncertainty. According to Howlett et al. (2017), robust policies should be capable of dealing with surprise by reacting in an agile and flexible way when disturbances happen. To be capable of effectively addressing uncertainty and surprise, robust policies by design possess the following characteristics (Goodin 1998 ; Bednar, 2016; Lowndes & Roberts, 2013):

- diversity
- modularity and
- redundancy.

Finally, redundancy means the presence of different institutions and/or organizations in charge of managing, and deciding on, the same policy issue (Landau, 1969; Perrow, 1999). As Hammon (2007: 417) points out, 'the errors and failures of organizational units – which are inevitable – can be corrected, or at least compensated for, by the existence of one or more of the other organizational units'. Thus, redundancy allows for a policy's main functions to work even if some of its parts (institutions, organizations, policy instruments, etc.) fail to deliver due to some unexpected event or development. To design redundancy into a policy requires the strategic introduction of duplication and overlapping functions or properties. For instance, the raising of more 'pillars' in pension policy (Natali, 2008) presents a way of designing and planning redundancy to ensure pension coverage in the long run. At the same time, the adoption of competition-driven policies in many policy fields, in the last decades, can be read as a way through which inter-organizational policy redundancy can be introduced (Miranda & Lerner, 1995). Finally, the presence of different decision-making centres on the same domain is fundamental for governing natural resources systems (Low, Ostrom, Simon, & Wilson, 2003).

Perhaps most importantly, the design of diversity, modularity and redundancy into policies should be carried out in an integrated and calibrated manner, as an excessive focus on each characteristic could give rise to policy failure or disruption. For instance, excessive diversity could result in gridlock, especially if contestations occur between different decision nodes. Similarly, policy designs that are too modular could result in a lack of integration in the overall design, with policy outcomes either disrupted or only partially achieved. Lastly, overly catering for redundancy can be costly, as resources are unnecessarily devoted to maintaining an excessive level of slack that is rarely, or even never, utilized. As the saying goes, all things in moderation.

Ensuring the right amount of diversity, modularity and redundancy requires policy designers to take a 'bird's eye' view in ensuring that policies designed retain a fine balance of the three characteristics. There is therefore a need for some level of coordination and general arrangement of these characteristics and the introduction of hierarchy (or ordered priority of the three characteristics) into the designed output. However, and as we have discussed above, designing robustness into policy also depends on a certain level of flexibility, both in policy designs and in the design process

itself. Such flexibility ensures that policy functions are maintained, or their components adapted in order to maintain such functionality, in the face of disturbance.

Such flexibility is also possible when policy designers have at their disposal new ideas, good information, opportunity and motivation for learning as well as functional substitutes, ie a well-designed mix of policy diversity, modularity and redundancy. In other words, there is both rigidity and flexibility involved in the design of diversity, modularity and redundancy into policies – 'external' rigidity in terms of the centralized and hierarchical coordination needed to maintain a suitable mix of the three characteristics and 'internal' flexibility in terms of these three characteristics' role in ensuring a policy's ability to adapt and adjust in order to maintain functionality in uncertainty. There is therefore a dual aspect of diversity, modularity and redundancy that, when managed well, gives rise to robust design, but if managed badly, could give rise to problematic policy designs.

Finally, what emerges from our analysis is that, all in all, robust design should be based more on procedural instruments than on the substantive ones. From this point of view, then, the proper mix of diversity, modularity and redundancy can be designed by establishing borders for actors' behaviour, assigning roles and establishing specific procedures for coordinating, evaluating, monitoring and revising the actual design.

5.2. *Conditions for robust design process*

The production of design outputs capable of guaranteeing robust policy also depends on the features of the design process, both at the stage of formulation and at the stage of implementation. This means the policy process should possess certain characteristics that can allow policymakers and designers to (re)design and revise an existing design, especially in the face of abrupt shifts and changes, to maintain an expected grade of policy robustness.

This means that, all in all, robust policy designs are driven by robust design processes. These processes include the structural and procedural features through which decision makers design policies. Designing robust policies needs specific attributes to be present in the process of design itself. Unlike robust policy design outputs, robust design processes require more than the two characteristics discussed above. While these conditions are by no means exhaustive or definitive, we argue that they constitute important conditions that, once fulfilled, can contribute immensely to policy robustness.

At this level of the policy design process, diversity, modularity and redundancy culminate in the property of 'polycentricity'. As is well known, polycentricity is a concept on which a huge literature has developed in the last few decades after the seminal work of Ostrom, Tiebaut and Warren (1961), who pointed out that 'polycentric connotes many centers of decision making which are formally independent of each other' (p. 831). Then, polycentricity has become a central concept in the analysis of common pool resources (Andersson & Ostrom, 2008; Bixler, 2014; Nagendra & Ostrom, 2014; Ostrom, 1990), in terms of polycentric governance that 'requires a complex combination of multiple levels and diverse types of organizations drawn from the public, private, and voluntary sectors that have overlapping realms of responsibility andfunctional capacities… . In addition, private corporations, voluntary

associations, and community-based organizations play critical supporting roles in a polycentric system of governance, even if they have not been assigned public roles in an official manner' (McGinnis & Ostrom, 2011, p. 15).

Polycentricity in turn refers to the presence, with various and different roles, of a plurality of actors as well as organizations in the design process. This pluralism, if well governed, can lead to a favourable configuration of interest, ideas, information and learning attitudes (Blomquist, 2009) that can in turn give rise to a 'variance' of possible policy responses necessary for ensuring flexibility in the face of unexpected disturbances.

Polycentricity does not mean, obviously, absence either of hierarchy or of strong coordination, as we know from the huge literature on governance arrangements (Capano, Howlett, & Ramesh, 2015a, 2015b). Rather, the focus of polycentricity is to ensure greater capacity, and legitimation, to deal with the multifaceted challenge of defining problem and solutions (McGinnis, 2000; Ostrom, 2010). Seen from this point of view, the relevance and strength of polycentricity as condition for robust policy design encompass as well the adoption of participatory tools; for instance, Michels (2011) has found that policy instruments that foster citizen participation, such as referendums, deliberative surveys, participatory policymaking or interactive governance, and deliberative forums can give rise to more robust policy outcomes and procedures.

However, a polycentric decisional structure is only one of the conditions needed for robust design processes.

As we know from a more recent literature on policy design, good design processes need to be characterized by a significant political capacity as well as by a high level of technical capacity (Capano, Regini, & Turri, 2016; Howlett, Mukherjee, & Woo, 2015). Both political and technical capacities are important for designing robust policies. For instance, political or 'legitimation' capacity, or the strength of government in building up consensus around a specific design, not only is crucial for facilitating timely and efficient decision making, but also is an important factor in ensuring the presence and functioning of the polycentric decision processes that are so crucial for robustness (Woo, Ramesh, & Howlett, 2015).

Technical capacity directly refers to 'the ability of governments to make intelligent choices' (Painter & Pierre, 2005), which implies the ability to set the right strategic directions (Howlett & Lindquist, 2004), weigh and assess the implications of policy alternatives (Bakvis, 2000) and base decisions on a dense and appropriate use of evidence-based policymaking (Parsons, 2004). Technical capacity then directly refers to a specific set of skills or competencies necessary for the nourishment of analytical capacity, which relates to the effective assessment and use of policy advice in support of the decision process (Xun, Howlett, & Ramesh, 2017).

Hence, there is a need to establish the capacities for evaluating and utilizing the various available informational resources – whether these are data collected by the government or provided by policy advisory organizations – in support of policy robustness. It is quite clear that analytical capacity depends on various factors like the institutional and bureaucratic characteristics of a political system, the features of the related policy advisory system, the level of openness of the decision-making process to external interest groups and advocacy coalitions, etc.

To summarize our argument, robust design process can be developed by establishing a *polycentric decisional structure*, ensuring sufficient *political capacity* to ensure the legitimacy of the design process as well as the relevant *technical capacity* necessary for effective policymaking. The presence of these conditions is necessary for the initial design as well as for the subsequent stages of the design process when, faced with evolving policy dynamics and shifting circumstances, the content of a specific policy could need to be revised and eventually redesigned to maintain expected policy functions and retain its focus on intended goals.

The initial design is fundamental because it, at the very inception of the policy, imbues it with the necessary attributes of a robust policy design, as discussed above. The characteristics of a robust policy (diversity, modularity and redundancy) can subsequently be calibrated through the application of deep analytical capacity and the garnering of political consensus and legitimacy from its multiple stakeholders. Such robustness in the design process can therefore ensure that timely and relevant interventions are formulated and applied to ensure continued policy functionality should any disturbances emerge to disrupt or challenge existing policy activities.

The three conditions for robust design processes we have just presented, set together, offer a general framework that needs to be operationalized in order that it can be used either as an explanatory tool to understand why some design processes are less robust than others or as a practical applied tool for redesigning the features of actual policy processes, with the aim of improving their robustness. This will, as we discuss next, require further research and conceptualization.

5.3. *Trade-offs*

As the discussion thus far has shown, the merits of designing robustness into policies are clear. Policymakers are increasingly placing a strong premium on maintaining policy functionality amidst uncertainty. However, this is not to say that policy robustness is in itself 'perfect' or unproblematic. As with many other aspects of policymaking, there are trade-offs and challenges that may emerge with designing robustness into policies.

For instance, policies that are robust, and hence able to maintain their functionality no matter what, can also be detrimental to public sector innovation. Indeed, it has often been noted that public sector innovation depends as much on environmental and contextual complexity as well as on 'bottom-up' efforts of public managers and citizens, as it does on top-down policy processes (Hartley, 2005), with 'policy entrepreneurs' often excelling by combining the various intertwined components of primordial soup of policies, problems and solutions within which they are embedded (Kingdon, 1984). Thus, from this point of view, robust policies can become over-institutionalized and thus very problematic to be changed. Ironically, by eliminating the 'negative' aspects of uncertainty, robust policies may close off potential opportunities for policy entrepreneurs or other stakeholders to rethink or reinvent existing policy processes and procedures. Although there are important implications of such trade-offs between robustness and innovation, we also argue that the benefits of ensuring policy functionality amidst shock and uncertainty cannot be understated, especially in areas of strategic importance or in the provision of essential public services. Certainly, efforts to

understand and possibility address such trade-offs will require further research into policy robustness. We will now discuss these areas of potential future research.

6. Concluding remarks for further research

In this paper, we have sought to provide the reasoning and conceptual basis for policy robustness, with the assumption that this concept can be useful for policy design. In doing so, we argue that robustness is a property that can be designed to ensure that policies continue to deliver, over time, its intended functions, purposes and objectives, even under negative circumstances. We have tried to show how robustness applies to both design processes and design outputs, imbuing both with the capability to react to shock and uncertainty by maintaining functionality. In other words, robustness can be a powerful driver of policy effectiveness and functionality over time. As we have discussed in our introduction, this role of robustness is particularly important in light of the increasingly complex and unstable policy environment that policymakers are faced with.

There is therefore much scope for further and deeper research, both theoretical and empirical, on policy robustness from a policy design perspective.

From the theoretical point of view, there is a need to establish stronger linkages among the various streams of literature that aim to understand how robust and effective policies can be formulated and implemented (such as public policy, policy design, institutional analysis, public management) as well as to better understand how the different conditions for robust design processes and outputs can be operationalized and set in different possible configurations. The establishment of such an integrated understanding of policy robustness, and the operationalization of its various components and aspects, can contribute to more accurate applications of policy robustness to empirical cases.

From the empirical point of view, further research can focus on understanding whether and how the intrinsic features of different policy fields require specific configurations of the proposed conditions of robustness that we have discussed in this paper. In this sense, for example, there is a need to know more about the different configurations of diversity, modularity and redundancy and of polycentricity, political and technical capacity that are required in different policy fields, each with its unique sociopolitical context. While we have identified these important determinants of policy robustness, there remains the question of: how much (of diversity, modularity, redundancy, etc.) is enough. In order to answer this question, there needs to be more empirical testing of the theoretical concepts that we have discussed in this paper.

Furthermore, existing understandings of robustness in policy design remain limited by the completely unexplored issue of the role of agency in robust policies. Should robust policy design be based on different individual motivational and behavioural assumptions in different policy fields? How much room of freedom should be left to policy actors to maintain policy robustness over time? What role can policy entrepreneurs play in establishing policy robustness? In short, there is a need to address the role of specific actors in building policy robustness and how these roles differ in accordance with the nature and motivations of the actors involved.

While we have sought in this paper to establish a clearer conceptualization of policy robustness, more work needs to be carried out in order to make our knowledge of robustness in policy design more robust.

Disclosure statement

No potential conflict of interest was reported by the authors.

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