

Building Resilient Regions: Complex Adaptive Systems and the Role of Policy Intervention

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Abstract The notion of resilience is being utilised by an increasing number of authors keen to understand the dynamics of local and regional economies and particularly how they deal with economic shocks and recessionary crises. Within the burgeoning literature however, fairly limited attention has been paid to date to developing a robust conceptual understanding of what role policy-makers, particularly at sub-national level, might play in building economic resilience in regions. The purpose of this paper is to address this gap. Drawing on resilience literatures which employ a complex adaptive systems perspective, the paper seeks to develop a conceptual framework within which policy action, particularly at the subnational level, can be theorised and understood. It identifies three critical dimensions which frame the role and scope for policy intervention in the management of regional economic resilience: the modes and structures of governance, the types of policy interventions which help build resilience, and the horizons or timings for appropriate intervention. The paper concludes by considering what this framing means for the nature and scope of subnational policy intervention for regional economic resilience.

Keywords Resilience · Agency · Policy · Complex systems

Der Aufbau resilienter Regionen: komplexe adaptive Systeme und die Rolle der politischen Intervention

Zusammenfassung Der Begriff Resilienz wird von einer zunehmenden Anzahl von Autoren verwendet, die ein Verständnis für die Dynamik lokaler und regionaler Wirtschaften anstreben und die nachvollziehen wollen, wie diese Wirtschaften mit ökonomischen Schocks und Rezessionskrisen umgehen. In dieser umfangreichen Literatur wird allerdings bislang wenig die Entwicklung eines tragfähigen konzeptionellen Verständnisses betrachtet, das die mögliche Rolle politischer Entscheidungsträger beim Aufbau regionalökonomischer Resilienz insbesondere auf der subnationalen Ebene beleuchtet. Ziel dieses Beitrages ist es diese Lücke zu schließen. Anhand von Arbeiten zur Resilienz, die die Perspektive komplexer adaptiver Systeme einnehmen, strebt der Beitrag an, einen konzeptuellen Rahmen für die Theoriebildung und das Verständnis von politischer Handlung unter besonderer Berücksichtigung der subnationalen Ebene zu erarbeiten. Es werden drei kritische Dimensionen identifiziert, die den Rahmen setzen für die Rolle und den Handlungsspielraum politischer Intervention bei der Steuerung regionalökonomischer Resilienz: Formen und Strukturen der Governance, Resilienz fördernde Arten politischer Intervention sowie der Horizont und die Zeitpunkte geeigneter Intervention. Der Beitrag schließt mit einer Betrachtung der Bedeutung dieses Rahmens für Art und Umfang subnationaler politischer Intervention im Zusammenhang von regionalökonomischer Resilienz.

Schlüsselwörter Resilienz · Handlungsfähigkeit · Politik · komplexe Systeme

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1 Introduction

The notion of resilience is being utilised by an increasing number of authors keen to understand the dynamics of local and regional economies and particularly how they deal with economic shocks and recessionary crises (see, for example, Christopherson/Michie/Tyler 2010; Pendall/Foster/Cowell 2010; Hill/St. Clair/Wial et al. 2011). Most people have an intuitive notion of what resilience means: the capacity to sustain a shock, recover, and continue to function and, more generally, cope with change (Walker/Holling/Carpenter et al. 2004: 5). Within the burgeoning literature however, fairly limited attention has been paid to date to developing a robust conceptual understanding of what role policy-makers, particularly at sub-national level, might play in building economic resilience in regions. A growing number of empirical studies have highlighted the role which can be played by regional and local authorities in encouraging or indeed hindering territorial adaptation to new socio-economic realities (e.g. Brookings Institution/London School of Economics/Deutsche Bank Research 2010; Hervas-Oliver/Jackson/Tomlinson 2011), whilst more theoretically-oriented papers such as that of Martin (2012) have suggested that economic and political reforms may build resilience. However, most fall short of exploring these in detail.

This gap reflects a broader critique of existing studies of regional economic resilience, largely based within a particular strand of evolutionary economic geography, which have tended to emphasise the structural factors shaping regional resilience outcomes over the role played by human action and agency (Bristow/Healy 2013). In particular, it has been recognised that “recent departures in evolutionary economic geography help us understand better the evolutionary, diverse and multi-level dimension of regional systems, but still fall short in understanding policy design and implementation” (Uyarra 2010: 117). Yet policy-makers are increasingly keen to understand what modes of governance and forms of intervention might both facilitate post-shock recovery and protect regional economies from future economic crises and change (Dawley/Pike/Tomaney 2010; McInroy/Longlands 2010; Lang 2011).

The purpose of this paper is to address this gap. Drawing on resilience literatures which employ a complex adaptive systems perspective, the paper seeks to develop a conceptual framework within which policy action, particularly at the regional level, can be theorised and understood. The meaning of ‘region’ here is typically understood in generic, conceptual terms and does not rely on or presuppose any specific definitions of a ‘regional economy’ which might guide analysis of particular empirical regions or spatial units under observation (Martin 2012). The paper is organised as follows. The next section develops the definition of regional economic resilience as an adaptive notion shaped,

in part at least, by the actions and choices made by active human agents in the regional economic system. Section 3 draws upon complex adaptive systems literature to identify three critical dimensions which frame the role and scope for policy intervention in the management of regional economic resilience. These include the modes and structures of governance, the types of policy interventions which help build resilience, and the horizons or timings for appropriate intervention. The paper concludes by considering what this framing might mean for the nature and scope of subnational policy intervention for regional economic resilience.

2 Regional Economic Resilience: An Adaptive Concept

Within the developing literature on regional economic resilience, a broad distinction can be made between two different conceptions of the term (Pendall/Foster/Cowell 2010). The first is based on the engineering conception of resilience which focuses on the resistance of a system to shocks and the speed of its return or ‘bounce-back’ to a pre-shock state or equilibrium. The faster the system returns to equilibrium, the more resilient it is (Holling 1996). This is deployed by Hill/St. Clair/Wial et al. (2011) in a study of regional economic resilience in the US which they define as the ability of a regional or metropolitan economy to maintain or return to a pre-existing state in the presence of some kind of externally generated shock.

The second definition of regional economic resilience is based on an adaptive notion of resilience which derives from the theory of complex adaptive systems. These are systems which are characterised by complex non-linear dynamics and an adaptive capacity that enables them to re-arrange their internal structure spontaneously whether in response to an external shock or to some internal or “self-organised criticality” (Martin/Sunley 2007: 579). The adaptive notion of resilience challenges the whole idea of equilibrium and instead asserts that the seemingly stable states of nature or society can suddenly change and become something radically new, with profoundly different characteristics. Thus, resilience is not viewed as a return to normality, but rather as a dynamic, evolutionary capacity to adapt in response to stresses and strains. Furthermore, the dynamics of complex systems are non-linear, which generates path dependency or local rules of interaction that mean history shapes how the system evolves and develops into the future (Holland 1992). This definition is preferred by scholars working within evolutionary economic geography (EEG) since it has clear resonance with evolutionary economic geography thinking on the path-dependent, evolutionary and non-equilibrium dynamics of regional economic development and indeed policy. Thus, for example, following an economic shock, a return to ‘normal’ or a pre-shock state may

be neither possible (in the face of global restructuring, for example), nor desirable. Moreover, equilibrium approaches fail to say anything about how regional actors might prepare themselves to deal with future problems or learn from the mistakes made in response to previous challenges (Cowell 2013). In contrast, this adaptive notion of resilience sees it as a dynamic attribute associated with a process of continual development (Pendall/Foster/Cowell 2010). The essence of adaptive resilience is an ability to change as circumstances change, to adapt and, where appropriate, transform rather than continuing to do the same thing faster and better (Goldstein/Taufen Wessells/Lejano et al. 2013).

Whilst different, these dual conceptualisations of resilience share a common emphasis on defining resilience in terms of the functioning of the regional economy as a *system*. From this perspective regional economic resilience is conceived as a multi-dimensional property embracing not only *recovery*, but also *resistance*, or the ability of regions to resist disruptive shocks in the first place, *re-orientation*, or the extent to which the region adapts its economic structure, and finally, *renewal*, or the degree to which the region resumes the growth path that characterised its economy prior to the shock (Martin 2012). Resilience is thus defined in terms of the system's capacity to absorb, resist or respond to a disturbance and at least maintain its functioning, if not necessarily the same system structure (Carpenter/Walker/Anderies et al. 2001: 766). As well as shaping the definition of resilience, this systems-based perspective also extends to its measurement and analysis. Thus, from this perspective economically resilient and non-resilient regions are identified by examining the system's overall economic performance over a period of time, with criteria for a negative economic shock defined, and pre- and post-shock growth rates and trajectories of output and employment measured. Furthermore, analysis of the determinants of resilience then typically focuses upon the structure of the system whether through understanding how inherited regional production structures shape the sensitivity of regions to recessionary shocks and their subsequent recovery (as Hill/St. Clair/Wial et al. 2011; Martin 2012), or how these structures exhibit distinct phases or adaptive cycles of change in line with complex ecological systems such as panarchy (Simmie/Martin 2010). Regional economic resilience from a systems perspective is thus understood principally in relation to the system's structure, performance and overall functioning (Martin 2012).

Whilst valuable in highlighting the potential for resilience to illuminate how regional economies respond to economic disruptions, this system and structure emphasis has resulted in much less attention being paid to understanding the role of human agency in the adaptation at the heart of regional economic resilience. This reflects a broader critique against evolutionary economic geography studies which have tended to neglect the agency of actor-networks beyond the

firm, and to underplay the critically important role played by the state in shaping socio-spatial structures and broader evolutionary trajectories (MacKinnon/Cumbers/Pike et al. 2009; Hassink 2010).

There is a growing literature which explicitly examines how human agency interacts with complex system dynamics in a range of different settings which provides critical insights into the important role agency plays. These include the management of social-ecological systems (e.g. Berkes/Colding/Folke 2003; Lebel/Anderies/Campbell et al. 2006), as well as efforts to develop individual and community capacities to adapt to a range of adverse situations (such as natural disasters) (e.g. Berkes/Ross 2013). This literature has at its heart an understanding that complex adaptive social systems, whether they be coupled social-ecological environments, communities or economies, have a number of core defining features which critically influence how effectively and in what ways they may be governed or influenced by policy.

Complex adaptive systems are comprised of groups of heterogeneous individuals or 'agents' (such as cells, consumers, nations, atoms) between which are inherently dynamic relationships. The agents in complex adaptive systems are constantly reacting to what the other agents are doing and to the environment, and are thus continually evolving through feedback and learning. As a result of their interconnected structure, these systems exhibit unexpected emergent properties—these are structures or patterns that cannot be reduced to the properties of the agents themselves. One such emergent property is self-organisation, i.e. organisation that has no leader but is generated spontaneously from the 'bottom-up' by the individual decisions and interactions of the agents themselves. Control thus tends to be dispersed and decentralised. Furthermore, these complex self-organising systems are constantly adapting such that their adaptive capacity is not simply change in response to episodic events or conditions. It is the ability of systems—households, people, communities, ecosystems, nations—to generate *new* ways of operating, new systemic relationships (Carpenter/Walker/Anderies et al. 2001). As such, resilience is not simply an end point or performance outcome: it is a process or an ongoing development capacity to adapt to change and thrive (Magis 2010).

Critically, in social systems human agency is at work. This is defined by Davidson (2010: 1142) as the realm within which humans deliberately and consciously act, network, imagine futures and make decisions between perceived options. Acknowledging the role of human agency thus requires the analysis of resilience to be much less structurally deterministic and much more *people-oriented* and focused on understanding how human actions and behaviour interact with key structural and environmental factors and constraints (Bristow/Healy 2013; also Skerratt

2013). This is because human agents have innate capacities to imagine, anticipate and respond to change, as well as the ability to take pro-active, intentional action to build up their capacities to be resilient through, for example, social learning (e.g. Magis 2010; Berkes/Ross 2013). This human agency may function through both individual and collective forms and at multiple scales including the household, community, region and country level (Davidson 2010; Skerratt 2013). Understanding the scope for policy action for resilience at the regional level thus demands an understanding of how, in the messy complexity of real world economies, human agency is drawn into combined influence and mediated through forms of collective agency or governance. Governance refers to network-based modes of collective action which embrace a range of organised state and quasi-state actors and institutions (Pierre 2000; Benz/Fürst 2002). Cowell (2013: 213) suggests that these bodies play an important role in developing purposive policy action to improve “the chance for a healthy region in the long run”.

The burgeoning literature on regional governance and policy coupled with the emerging insights from the evolutionary literature on resilience, usefully warns of the dangers of overstating and indeed oversimplifying the capacities of regional policy-makers to act effectively in this way. Human agency generally has its limits. Whilst humans can anticipate change and use social, political and cultural means to influence resilience, control is at best partial and outcomes typically uncertain (Goldstein 2009). Capacities that assist the development of resilience vary between individuals and groups of people, and are unevenly distributed spatially (Berkes/Ross 2013). Wilson (2012) reminds us that resilience itself is multi-scalar with shocks emanating from different scales and played out with different effects at regional and local levels. Furthermore, regional governance increasingly acts within ever more complex multi-level governance contexts, where there may be significant hard (i.e. resource and power) constraints upon regional governance (Uyarra/Flanagan 2010). The capacities of governance bodies are thus likely to be highly contingent upon their available stocks of resources and their capacity to mobilise and deploy them effectively (Skerratt 2013).

Finally, embracing the contingencies of human agency also requires that attention be paid to the normative and political dimensions of resilience. Human agency may be translated into different agendas for action by the agents within complex social systems and their particular cultures (see Skerratt 2013). These different agendas are likely to be shaped by the unique political, economic and social contingencies of context to ensure that resilience is always likely to be subject to normative and political debate. Resilient outcomes (such as persistent poverty cycles) may not always be desirable, for example, whilst non-resilient outcomes (such as lower growth rates) may be, depending

upon the perceptions of the agents involved and their overall goals and objectives (e.g. Hill/St. Clair/Wial et al. 2011; Shaw 2012). This leads Pike/Dawley/Tomaney (2010: 66) to ask “what kind of resilience and for whom” and to note that state authorities often exert powerful roles in “scripting” dominant resilience narratives.

A complex, adaptive view of resilience thus raises a number of critical questions around the role of governance in shaping or influencing regional adaptive capacities and outcomes. These include the scope which policy-makers have over key determinants of resilience, and what attributes of governance and policy help to enhance the capacity to manage resilience. It is to these questions that this paper now turns.

3 Framing Policy Action for Resilience

The growing literature on the management of complex adaptive human systems also provides a useful means of framing an understanding of policy action for resilience. A synthesis of available literature suggests that policy action for resilience may be understood or framed in terms of three key dimensions: the institutions through which policy actors act, namely the modes and structures of governance; the types of policy intervention or action they take; and the horizons or timing of policy intervention. These issues and, more specifically, their implications for the management of regional economic resilience are now considered in turn.

3.1 Modes and Structures of Governance: How Policy Action Is Designed and Delivered

The literature on the resilience of complex adaptive human systems suggests that policy actors act as key agents of purposive adaptation through institutions of governance which act as the setting through which their ideas have meaning, their discourse has communicative force and their collective actions make a difference (Moore/Westley 2011; Schmidt 2011). Governance refers to the structures and processes by which people in places make decisions and share power and shape the conditions for ordered rule and collective action (Folke/Hahn/Olsson et al. 2005). As such, governance is more than simply the purview of the state through government, but rather emerges from the interactions of many actors, including the private sector and not-for-profit organisations. Moreover, it can be formally institutionalised or expressed through subtle norms of interaction, or even more indirectly through influencing the agendas and shaping the contexts within which actors contest decisions and obtain access to resources (Lebel/Anderies/Campbell et al. 2006).

Crucially, this literature emphasises that institutions of governance are inherently embedded *within* their systems such that they co-evolve with all other agents and with

the environment, all of which are constantly adapting and changing (Berkes/Colding/Folke 2003). Policy intervention is thus internal to the system and constitutes one of its component parts, and is not external to it. It thus cannot be studied or developed in isolation but has to be understood in relation to its connections with the other parts of the system—firms, the labour force, consumers, advocacy groups—and with the wider environment. As such, policy-makers do not control the system or all the factors shaping resilience, but rather can help manage and support the development of appropriate capacities for self-organisation and adaptation (Folke 2006).

This means that just as important as the discrete actions of policy-makers themselves is how and in what ways their actions relate to, impact upon and include other agents in the system and the environment as a whole. In other words, the *networked* nature of governance and policy is critical in resilience. Complex adaptive systems consist of a network of component agents constantly mutually affecting each other. Any particular agent can have a link to other agents, which in turn link to others through lines of communication, common tasks, market agreements, or other relationships. This networked system thrives when there is space for experimental evolution, in which new ideas emerge and technology is constantly refined. An open network of connections between agents can help create the conditions for knowledge to be generated and fed through into policy decisions and more widespread behaviours and actions. Institutions of governance act as a unique connector inasmuch as in human systems they provide collective agency and scope for more complex communication and co-operation between multiple agents (Moore/Westley 2011).

Booher and Innes's study of California's water planning and management process, known as CALFED (Booher/Innes 2010), provides an interesting practical example of complex adaptive networked governance of environmental resources. CALFED began in 1994 as a self-organising entity without federal or state legislative structure to address the stalemate in decision-making on California's water policy. It never assumed a fixed form or definite boundary around its tables of participants, but began as a rudimentary interagency agreement among state and federal agencies. Over a 10-year period it developed a number of governance interventions to deal with its complex challenges including a distributed network structure (engaging hundreds of agents in a 'patchwork' hierarchy), collaborative heuristics of agent interactions, a nonlinear planning method (whereby some actions were implemented ahead of the completion of plans), and a self-organising system behaviour. In terms of the latter, participants thus defined and refined their task and scope along the way, adapting to new problems and information. Crucially, the system's behaviour was determined by their interactions and relationships not by the formal

roles of the agents in their agencies. Internal structures were regularly re-organised, assumptions challenged, and new and diverse ideas and information accommodated.

This represents a considerable challenge to the mechanical and linear approach to place making and shaping which has tended to characterise approaches to regional economic policy. Taking this approach suggests that instead regions need to be understood as an interconnected system and governance actors need to strengthen policy networks, embrace knowledge and learning from all sources in society, and foster innovation through decreasing the rigidity of disciplinary, organisational and social boundaries. Thus, whilst the state is highly likely to play a critical role in shaping the evolution of the economic landscape (e.g. Hodgson 2009) and thus a region's economic resilience, it is likely to do this in a more maven-like role and, crucially, in collaboration with other actors (e.g. Morgan 2013, who characterises the state as amateur, innovator and procurer). This notion is beginning to take hold in some of the 'grey' literature around the economic resilience of cities and regions. Notably, in their work on local economic resilience McInroy/Longlands (2010) emphasise the importance of strong relationships between the public, private and social economy sectors, governance, institutions and environment, a strongly proactive and co-ordinating role by local institutions of governance which facilitates and brokers these key relationships, a symbiotic rather than parasitic balance between local and global activities and connections, and flexible governance structures which enable rather than constrain the formation of relationships and networks in an area. Understanding when and how these ideals can be realised in practice of course requires more detailed empirical research.

A further key insight from studies examining the challenges of planning and managing amidst ongoing dynamic change concerns the merits of *polycentric governance* or systems in which "political authority is dispersed to separately constituted bodies with overlapping jurisdictions that do not stand in hierarchical relationship to each other" (Skelcher 2005: 89). Traditionally, polycentric governance has been asserted in relation to normative arguments around the self-governing capacities and skills of local communities (Ostrom/Tiebout/Warren 1961). More recently, polycentricity has been presented as desirable in terms of institutional diversity and the advantages it proffers when complex and uncertain problems need to be addressed (Ostrom 2005). Thus, polycentric governance systems are deemed to be better equipped to foster resilience for a number of reasons. Firstly, issues with different geographical scopes can be managed at different spatial scales. Secondly, their high degree of overlap and redundancy makes them less vulnerable if one institution or approach fails. Finally, the large number of institutional entities promotes experimentation with new approaches and maximises opportuni-

ties for mutual learning. However, the vertical links of such arrangements can on occasions stifle adaptive governance as, for example, in cases where national regulations limit localised scope for informal or collaborative action (Folke/Hahn/Olsson et al. 2005).

In relation to economic resilience, there is some empirical evidence to suggest that there is a positive correlation between diverse, polycentric governance and regional economic performance (Brookings Institution/London School of Economics/Deutsche Bank Research 2010), although more research on the significance of particular structures in terms of the distribution of power and resources between nested tiers of governance is needed. Furthermore, whilst some authors have promoted the value of diverse and modular approaches to policy-making (e.g. Beinhoecker 2007; Bristow 2010), there is limited empirical evidence to date on the development of such approaches in practice.

Finally, complex adaptive systems literatures also point to important requirements for the management and leadership functions of governance. In an environment which is more unstable, accelerative and unpredictable, no single actor or institution of governance is in control or capable of influencing system dynamics alone. Thus the optimal leadership role is one of mediator and manager, one which enables interactions between agents, facilitates joint learning and leads decision-making on actions (Booher/Innes 2010).

3.2 Types of Policy Intervention

Complex adaptive systems literatures also provide significant insights into the importance of *what* types of public policy intervention, or instruments, can facilitate economic resilience. In broad terms, a triad of activities have been identified as important, namely a clear vision, appropriate reactive interventions, as well as suitable prospective actions.

The first of these concerns the provision of a vision and direction for the development of resilience—ostensibly a resilience *agenda* or ‘ethos’ (McManus/Seville/Brunsdon et al. 2007). Institutions of government are in a particularly important position here since their power and resources imbue them with significant capacity to influence and provide leadership of resilience agendas and shape the contexts within which individual and collective actors make decisions and access resources. As a number of authors observe, social systems are structured not only by rules, position and resources but also by meaning and by the entire network of communicating individuals and organisations at different levels of interaction (Folke/Hahn/Olsson et al. 2005; Goldstein/Taufen Wessells/Lejano et al. 2013). As such, changing perceptions of the environment or of development challenges can change human behaviour on a fairly large scale without the social dynamics and political behaviour involved in making and changing rules. The role of policy interven-

tions in setting and shaping these wider institutional agendas for resilience is fundamental, but remains underexplored.

A clear and convincing vision, comprehensive narrative and strong social links and trust with other stakeholders, is critical in mobilising the self-organisation, learning and capacity-building processes deemed so critical to the governance of complex adaptive systems (Berkes/Ross 2013). Individual and collective actors within social systems need to engage with the subjective and symbolic meanings of resilience in order to decide the specifics of what should be made resilient to which disturbances, what the desired outcomes are, and whose resilience should have priority. Planners may play a particularly important role here in designing the collaborative settings in which narrative construction can take place (Goldstein/Taufen Wessells/Lejano et al. 2013). Clearly, however, resilience agendas may differ between ‘conservative’ and ‘radical’—the former viewing interventions as enabling or promoting a return to the state that existed before the shock; the latter in contrast seeing resilience as a rejection of the status quo and a need to adapt or transform the system in a more radical manner (Raco/Street 2012). Achieving the requisite collaboration and innovation in governance requires bold and transformational leadership which can overcome contradiction, engage the opinions and values of a critical mass of people and forge new alliances between knowledge and action (Folke/Hahn/Olsson et al. 2005).

Berkes/Colding/Folke (2003) highlight the importance of strategies for fostering learning, innovation and improved communication as being critical to the active development of resilience in complex adaptive human systems (see also Magis 2010). Each agent in a complex system is continually searching for new ways of adapting to the environment. Thus knowledge about the environment and how it is changing is the key to self-organisation and the ability of agents to understand how and in what ways they need to adapt in order to survive. What particularly distinguishes economic and human systems from biological ones, is the role played by learning, adaptive management and the deliberate acquisition of knowledge. Humans have a unique capacity to manipulate, store and exchange information through complex forms of co-operation and communication. Communication allows people and places to document and learn from experience, to ask for help from external relations, and to motivate popular action for change. In governance terms, this means that opening management systems to gain information and perspectives from multiple sources is a key.

In relation to subnational policy intervention for economic resilience, the imperative for adaptive governance and policy suggests a critical role for subnational actors in terms of mobilising knowledge of the economic environment, how it is changing, its territorial specificities and assessing the particular vulnerabilities, risks and oppor-

tunities of its territory in relation to these changes. This depends upon highly networked information and management systems capable of understanding specific territorial path dependencies and likely development trajectories or the region's economic 'DNA'. In this instance, the policy application of resilience is thus a search for qualities and attributes of the territory which make it adaptable and able to thrive on change (Dawley/Pike/Tomaney 2010; McInroy/Longlands 2010). In essence, a resilience perspective frames policy thinking away from off the shelf blueprints to more bespoke strategies with a defined cognisance of context and place (Shaw 2012).

Dawley/Pike/Tomaney (2010: 11 f.) point to a number of implications for local and regional development strategies. Political leadership is clearly of paramount importance at the time of a disruption or crisis. However, there also needs to be intelligent institutional leadership in framing and articulating the nature of the event or crisis and constructing a discursive narrative of strategic adaptation or adaptability to enrol key local and regional actors.

A second key policy area for resilience embraces interventions which enable the capacities of different actors in the system to react to economic shocks and to respond and adapt to change. These interventions may incorporate structural adjustment mechanisms, such as automatic fiscal stabilisers, or may involve purposive actions on the part of national, or sub-national, policy-makers. It is an area of policy that is well-studied in the field of local economic development. Activities can include policies which provide support to adversely affected firms, such as in the form of temporary wage subsidies in some German Länder, or investments in rapid redeployment initiatives to support workers' adaptability to changing labour market conditions (e.g. the PRO-ACT initiative introduced by the Welsh Government in 2008 which provided part-funding for businesses that had introduced short-term working for employees, with a view to helping them retain skilled workers and their specific on-the-job knowledge), or providing funds to support individual re-training or skill enhancement. In some cases a number of interventions can be combined to create an 'Economic Resilience Package' to "alleviate the worst effects of the recession" (Gateshead Council 2009: 7). However, much of this literature considers the role of public policy intervention as a counter-cyclical public expenditure stimulus. Rather less attention has been granted to the potential for public policy intervention in the face of public sector austerity.

In some instances, economic resilience may be enhanced through prospective actions that seek to strengthen economic structures and systems, such as by fostering system diversity and encouraging modularity so that system shocks can be contained (Berkes/Colding/Folke 2003). For example, in a study of the ceramics industrial district in North Staffordshire in the UK, Hervas-Oliver/Jackson/Tomlinson (2011)

draw attention to the challenges for industrial policy in developing resilience in mature industrial districts. In particular, their study highlights the need for industrial policy to be co-ordinated, particularly in drawing links between firms and institutions. In the North Staffordshire case, industrial policy has generally tended to be ad-hoc and limited, often reacting to events rather than anticipating them. Menzel/Fornahl (2007) consider that adapting policies at various stages of the cluster's life cycle—such as through selective (small firm) start-up policies—might be useful to militate against decline and facilitate the emergence of new development paths. Others have pointed to the importance of 'platform' policies which facilitate innovation through making and supporting unusual (cross-sectional) connections and the generation of new ideas and novelty (Uyarra 2010; Cooke 2012).

3.3 Horizons for Intervention

As well as understanding *what* sub-national policy-makers can do to build resilience, it is also important to understand *when* they can do it. Complex adaptive systems thinking emphasises the dynamic nature of development trajectories and policy responses and resilience is concerned with multiscale temporal processes of change. Policies for resilience thus need to be sensitive to the various principles of complexity such as feedback, nonlinearity, unpredictability, renewal cycles, memory in the system, and the significance of windows of opportunity during which innovative changes can be made to the system (Berkes/Ross 2013). In particular, complex system thinking focuses attention in particular not on why change happens, but instead on how revealed outcomes emerge. Change is thus the constant and to be expected, if not necessarily accurately predicted, such that the focus for policy needs to be on "responsive adaptation" rather than "predictive avoidance" (Hartzog 2005: 22). Folke (2006: 263) asserts that the implication for policy is profound, requiring a shift away from policies based on steady-state thinking and the design of policies that stimulate adaptive responses to change in the short- and long-term. In short, what is required is a readiness to accept change, and the development of policies that work with the grain of evolutionary trajectories that were becoming clear before shocks and crises, as well as clear plans for alternative futures or scenarios (see, for example, Wrigley/Dolega 2011; Berkes/Ross 2013).

Achieving this new way of framing policy-making may be easier said than done of course. Levin/Barrett/Aniyar et al. (1998: 228) highlight the challenges in managing resilience in complex systems, observing that "policy should be concerned with more than the immediate consequences of incremental actions. It should recognize the potential for an accumulation of small actions, each on their own perhaps quite harmless, to destabilize important natural and

social systems". They go on to state that "the difficulty is that, while we can predict with reasonable confidence the immediate consequences of an incremental action, we cannot predict the consequences of an entire sequence of actions without understanding the systems potentially being affected by them" Levin/Barrett/Aniyar et al. (1998: 228). Change is thus a constant process of action, reaction and interpretation, with policy-makers just one actor within a complex interplay of agents. Developing an acute sensitivity to system dynamics is all the more challenging where institutional structures have ossified or become locked-in to particular development trajectories, or where strategies have been tied into rigid planning horizons which are difficult to break.

One way of distinguishing the different horizons for policy intervention is according to when they occur relative to the shock or stimulus. First there is the immediate reaction to a crisis. These may be short term, temporary measures which seek to mitigate the emerging effects of the crisis. The wage subsidies referred to earlier may be one example of such an approach for economies. These reactive policy interventions help firms, or households, to combat the immediate impact of an economic shock and seek to prevent negative short-term responses by these agents, which, in aggregate, might have more detrimental long-term impacts. Such interventions may help to ensure that an economy does not become locked-in to a longer-term economic decline and so facilitates a rapid recovery from the initial economic downturn.

As the full effects and magnitude of the shock becomes apparent over time, policy-makers may then start to develop and deploy additional types of intervention in response to the crisis. This may be particularly pertinent where an economic shock, for example, proved too significant for the reactive measures immediately available to counteract. This more responsive mode can take many forms and involve both interventions that seek to respond to the effects of the shock itself, such as through stimulating increases in demand, and interventions that are aimed at a longer-term transformation of the economy (the reorientation which Martin (2012) speaks of). Such actions might signal both an attempt to formulate routes by which the territory can exit from its post-crisis circumstances and an attempt to better prepare for the possibilities of future economic shocks.

In learning from the lessons of the past crisis, policy-makers may also begin to consider a range of anticipatory actions. These embrace actions which are designed to build a stronger understanding of system dynamics, its existing strengths and vulnerabilities to shocks—as part of a desire to be better prepared for potential shocks in the future. These may consist of seeking to transform the system to build better resilience in the future and of actions to monitor the particularities of the system in order to track performance, identify strengths and potential risks and vulnerabilities. In

doing so, the agenda which has been adopted as a form of 'resilience narrative' becomes particularly important, for it is this agenda which sets the tone of the policy interventions to follow. This necessarily implies the development of a long-term perspective for policy-making and an emphasis upon investing in preparing for the future. Whether such a perspective fits easily with shorter-term political objectives and cycles constitutes a potentially significant challenge.

4 Conclusions

This paper has sought to provide a stronger conceptual basis for understanding the role and scope for policy intervention in the development of resilient regional economies. In so doing, it has presented a complex adaptive systems perspective on regional economic resilience and highlighted the role of human agency, particularly in collective forms of governance, in shaping the evolutionary trajectories of regional economies. It has also sought to identify the critical attributes of governance and policy likely to help to build and enhance resilience. In summary, a number of conclusions relating to the challenge of policy-making for resilience may be drawn.

First and foremost, research on adaptive governance of complex social systems highlights that building resilience in such systems is a complex and challenging task and one that is not easily subject to planning and control by a single, central organisation such as a government body. For regional and local governments seeking to build territorial resilience to economic shocks, the clear implication is that they need to work collaboratively with a range of other actors and thus develop responses as part of a strategically co-ordinated, yet fluid network of governance. Notwithstanding this, government bodies remain good candidates for articulating requisite resilience agendas and developing the management, brokering and leadership necessary for effective self-organisation (Folke/Hahn/Olsson et al. 2005).

Regional and local governments may be particularly well-placed to develop these roles given their greater understanding of territorial specificities and the importance of place-based 'capitals' or resources in building resilience (Bristow/Healy 2013). However, they may also be faced with limited capacities in terms of legislative and/or fiscal resources. The development of effective and co-ordinated polycentricity in governance is thus critical and whilst there is some empirical evidence to suggest that there is a positive correlation between diverse, polycentric governance and regional economic performance (Brookings Institution/London School of Economics/Deutsche Bank Research 2010), more research is needed to understand why this is, how it might vary in different national contexts and how appropriate degrees of cross-level and cross-scale co-ordination and support can be achieved in practice.

Second, developing appropriate policies for resilience demands the development of more sophisticated and agile governance networks. The resilience challenge requires complex and networked policy responses that embrace diverse ideas, innovations and institutions. The CALFED example discussed in the paper demonstrates how more fluid and flexible forms of collaborative governance are required to respond to the complex and accelerating pace of environmental change. It is reasonable to argue that this applies in equal measure to regional economies which are increasingly exposed to highly pernicious winds of global economic change, financial crises and restructuring. Understanding the various interactions and connections in territorial economies is thus critical to effective policy design, as is combining diverse agents and groups in ways to create opportunities for new interactions and learning (see McInroy/Longlands 2010; Graugaard 2012). This is heavily dependent upon the existence or creation of trust. As Levin/Barrett/Aniyar et al. (1998: 232) observe, “reciprocal altruism is an important stabilizing force, and its evolution and maintenance are enhanced by the local nature of interactions”. In other words, there are strong opportunities for developing the requisite interactions and relationships at sub-national level in place-based interventions. However, it is relatively straightforward to state the importance of developing open, networked and highly participatory forms of governance in regional economies. It is rather more challenging to create them in practice, particularly in an era of fiscal austerity and constraint, so that much more empirical work is required to find examples of such networks and understand how they succeed in mobilising the power of others.

Third and finally, a complex adaptive systems perspective suggests that to develop resilience demands a policy approach which is sensitive to the various principles of complexity, notably nonlinearity, unpredictability, the importance of feedback and learning. This represents a considerable challenge to traditionally linear forms of policy-making for economic development in regions and requires policy interventions which are based upon strong monitoring and evaluation of system dynamics and, in particular, of the behaviour and choices of people and organisations in relation to economic shocks and change. This requires the development of strong data management systems, speedy transfers of knowledge and learning between key organisations, and flexible institutions (Folke/Hahn/Olsson et al. 2005: 443). It also requires a diversity of approaches, modular thinking and the development of policy buffers or contingencies, all of which are highly demanding in terms of human, financial and organisational capital—resources which are also likely to be highly stretched where crises are also accompanied by fiscal constraints. Resilience also demands that attention be paid to the temporal nature of development trajectories, crises and appropriate policy responses. Having the capacities

to react quickly to economic crises is important and as such these need to be built in advance so that they can be mobilised as and when required. More considered and bespoke responses can be developed over time as the nature and effects of the crises are understood, whilst a continuous process of forecasting, assessment of vulnerabilities and risks is critical in developing the knowledge required to develop longer-term strategic imperatives for resilience. How such responses can be designed and delivered in practice represents a considerable challenge. This is particularly the case where institutional cultures or resource constraints work to inhibit agility in governance, policy and planning. This is a challenge worthy of further empirical research.

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