Specifying community economic resilience – a framework for measurement

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Contributed paper prepared for presentation at the 59th AARES Annual Conference, Rotorua, New Zealand, February 10-13, 2015

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Acknowledgements

The paper was fully supported by the Murray-Darling Basin Futures Research and is supported through the Australian Government's Collaborative Research Networks (CRN) Program. We would like to thank our project's reference group including Peter O'Brien, Neil Byron, Steve Cork, David Galeano and Peter Gooday for constructive comments.

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Abstract

This paper argues for a specific and measurable definition and a comprehensive and actionable measurement framework for community economic resilience (CER). The paper focuses on how to specify CER; what attributes form CER; and how to measure CER based on its definition and attributes. The paper argues that CER can be specified through four guiding questions (‘*Resilience of what?’; ‘Resilience to what?’;* ‘*Resilience for whom?’*; ‘*Resilience for what?’)* and is formed by attributes including community capitals, diversity and accessibility. A comprehensive measurement framework is proposed that quantifies both *potential* and *emerging* CER through attributes and multiple outcomes, respectively.

Key words: resilience, economic resilience, community economic resilience

1 Introduction

In regional studies, resilience is a growing, multi-dimensional concept, and has been conceptualized in various ways to explain differences between regional economies (MARTIN and SUNLEY, 2006; PENDALL *et al.*, 2010; CHRISTOPHERSON *et al.*, 2010; HILL *et al.*, 2011; BRISTOW and HEALY, 2013). The concept of economic resilience has been applied at various scales – local, community, regional and national – in various ways, sometimes contradictorily. It has been variously applied to mean resistance to change (HILL *et al.*, 2011; MARTIN, 2012; BRISTOW and HEALY, 2013), preparedness for change or mitigation (e.g., BRUNEAU *et al.*, 2003; FOSTER, 2007; MARTIN, 2012; BRISTOW and HEALY, 2013), or ability to absorb shocks (BRISTOW and HEALY, 2013), recover (BRUNEAU *et al.*, 2003; MCMANUS *et al.*, 2012), or adapt (MARTIN and SUNLEY, 2007; BRISTOW and HEALY, 2013). Lack of specificity in the use of the term 'resilience' has ensured it is difficult to measure, thus continuing to confound the term through the misalignment between the concept and its measurement (DAVYDOV *et al.*, 2010).

The most common measures of economic resilience are related to overall performance through rates of change in output (BAILEY and BERKELEY, 2014; CELLINI and TORRISI, 2014) and employment as a direct response to a specific shock (DAVIES, 2011; FINGLETON *et al.*, 2012; MARTIN, 2012; BAILEY and BERKELEY, 2014; SENSIER and ARTIS, 2014). Whilst output-based measures reflect how closely the regional economy is approaching its desired goals, they do not provide information on the cost or speed of achieving these goals. To fully operationalize the concept of economic resilience, BRISTOW and HEALY (2013) call for studies to move beyond 'narrow and traditional metrics of regional macro-economic performance, and indeed simplistic and static comparisons of regional performance pre- or post- shocks' (BRISTOW and HEALY, 2013, p. 932).

BRISTOW and HEALY (2013) have recently highlighted that 'the relative newness of the theorizing around regional resilience' has left many gaps in our understanding and measurement of resilience, including a lack of clarity around exactly what constitutes resilience, and a lack of pre-shock measurement of resilience (BRISTOW and HEALY, 2013, p.924). However, other disciplines have conducted in-depth studies into complementary areas (e.g. ecological economics into attributes of resilience), which can provide useful insights into specifying and measuring economic resilience.

The purpose of this paper is to develop a framework for specifying and quantifying resilience at the context of a community economy, thereafter called community economic resilience (CER) building on the current literature. This framework seeks to specify points of resilience by providing a meaningful, measurable and testable framework. The paper first uses four guiding questions – '*Resilience of what?'; 'Resilience to what?';* '*Resilience for whom?*' and '*Resilience for what*?' – to specify the concept of CER so that it becomes more meaningful. It then develops several testable hypotheses on the attributes of resilience. Finally, the paper outlines measurement approaches based on the specified concept of CER and the proposed attributes of resilience.

The rest of the paper is organised into five sections. Section 2 sets out the four guiding questions for specifying the concept of resilience. Section 3 defines CER using these guiding questions. Section 4 provides a comprehensive framework to measure CER. Section 5 discusses the advantages and disadvantages of each measurement approach. Section 6 concludes.

2 How to specify resilience?

Building on the recent literature review by BRAND and JAX (2007) and critical reflections on resilience by STRUNZ (2012), this paper acknowledges that resilience is a multi-faceted concept, with multiple meanings that are clearly distinguishable, yet clearly related. As such, it is necessary that for each application of resilience, the term needs to be specified clearly so that it is adequate and meaningful for the particular context.

Two questions – *'Resilience of what?'* and *'Resilience to what?'* – have been used to define resilience (CARPENTER *et al.*, 2001; WALKER *et al.*, 2004). These questions clarify the system focus, is it about a

community, a spatial area or a place at a point in time. (e.g., in terms of spatial, temporal, place, or practice), also it seeks to understand the shocks that the system is undergoing (e.g., CARPENTER *et al.*, 2001; SCHEFFER *et al.*, 2001). These questions focus on physical system attributes, and do not adequately address the governance attributes of change; therefore further specification is required.

LEBEL *et al.* (2006) undertook initial work to explore governance in resilience. Their work builds on longstanding work by GIDDENS (1984), TURNER (1986) and HAY (1995) that explores the importance of understanding structure and agency of a system. LEBEL *et al.* (2006) identify that two further questions need to be asked: '*Resilience for whom?*' and *'Resilience for what?'* (LEBEL *et al.*, 2006; PIKE *et al.*, 2010). These two questions are critical to determining the agency and goals of the resilient community.

In summary, four specific questions need to be addressed to specify CER:

- *Resilience of what?* To which community does CER apply?
- *Resilience to what?* What shocks is the community experiencing?
- *Resilience for whom?* Who are the beneficiaries of CER?
- *Resilience for what?* For what identity or goal does CER aim in the short and long term?

These four questions are of great value in guiding any investigation of resilience. The articulation of these questions builds on earlier work by WALKER *et al.* (2004) and LEBEL *et al.* (2006) but specifically addresses issues related to the social and economic aspects of a system.

3 Defining CER

3.1 What is CER?

The present paper is concerned with community economic resilience (CER). Economic resilience is a growing concept (BRUNEAU *et al.*, 2003; ROSE, 2009). Since the first work on economic resilience by TIERNEY (1997), the concept has evolved and has been applied in different contexts at levels ranging from the country to the region and even to the level of the household (BRUNEAU *et al.*, 2003; ROSE, 2004; 2007; BRIGUGLIO *et al.*, 2009; ROSE, 2009; MARTIN, 2012; BRISTOW and HEALY, 2013; BAILEY and BERKELEY, 2014). It has been argued that much of the literature has used a narrow definition of resilience with superficial metrics (ROSE, 2009). This paper investigates the resilience literature through a lens of creating a clearer definition and a measurable and testable framework. So far, the definition of CER is based on four guiding questions. This section answers these questions for CER by synthesizing knowledge on resilience and in particular on economic resilience. Table 1 offers a summary of how CER can be specified.

In the context of CER, the first question *'Resilience of what?'* can be answered as *'Resilience of the community economy'.* The community economy is the system to which CER applies. Building on the literature of community (MACQUEEN *et al.*, 2001; NORRIS *et al.*, 2008) and economy (HALL and LIEBERMAN, 2007), a community economy can be defined as a system of production, distribution, trade or consumption of goods and services within a geographical boundary. The key economic agents in a community economy include businesses, local government and households, which interact with each other through economic transactions using human, financial, natural, physical and social resources. People within a community economy share a similar economic structure that in turn dictates their economic activities.

For CER, the second question *'Resilience to what?'* can be answered as *'Resilience to radical disturbances or shocks'.* Radical disturbances are experienced collectively by the community economy. Disturbances can be abrupt (such as natural, technological or human-made disasters, epidemics or economic crises) or they can be gradual and predictable (such as policy changes). To be resilient, community economies must accept the inevitability of change and adapt to live with uncertainty and surprise (FOLKE *et al.*, 2003).

The third question *'Resilience for whom?'* can be answered for CER as *'Resilience for the community economy as a whole'*. The goal of CER is to maintain the functioning of the overall local economy rather than guaranteeing the viability of particular individuals (HOLLING, 1973; PERRINGS and WALKER, 1997). This is because community economies contain and shape different agents and their activities and are more than simply the sum of their individuals (BRISTOW and HEALY, 2013). In addition, the gains achieved from collective actions of the whole community economy would be greater than what could be achieved by an individual household or a single business acting alone (MILGROM and ROBERTS, 1994).

The fourth question *'Resilience for what?'* may be answered as *'Resilience to maintain non-declining economic standards of living'.* If non-declining economic standards of living form the goal to which CER aspires, then economic performance such as income and employment are key measures (WILKINSON, 1991; HILL *et al.*, 2008; HILL *et al.*, 2011; MARTIN, 2012; BRISTOW and HEALY, 2013). The goal of maintaining non-declining economic standards of living closely resonates with the theory of complex adaptive systems used by BRISTOW and HEALY (2013) to explain the adaptive notion of resilience. To maintain non-declining economic standards of living, community economies (considered as complex adaptive systems) can choose different dynamic and adaptive pathways rather than follow a fixed path (BRISTOW and HEALY, 2013). A community economy may bounce back to the status quo or move forward to either a gradual growth path with a higher outcome in the longer term or a quick return with lower longer term growth (HILL *et al.*, 2008; SIMMIE and MARTIN, 2010; MARTIN, 2012). Each pathway involves different costs and amounts of time, and the choices made by community economies will therefore depend on the community economy's level of resources or commitment.

Table 1: Guiding questions for specifying CER

Questions	CER
Resilience of what?	Community economy (the system of production, distribution and consumption of goods and services)
Resilience to what?	Radical disturbances (natural, economic, social and political)
Resilience for whom?	The community economy as a whole, rather than some specific individuals
Resilience for what?	Maintaining non-declining economic standards of living

Drawing on BRUNEAU *et al.* (2003), CARPENTER *et al.* (2001), MARTIN (2012), and BRISTOW and HEALY (2013), this paper argues that regardless of the pathways chosen, a resilient community economy needs to: (i) counteract negative economic impacts of disturbances; and (ii) adapt to changed economic conditions driven by disturbances. Community economies can counteract negative economic impacts of disturbances if the community economy has the strength to absorb, buffer, counteract or internalize disturbances so that the ultimate effect on the community economy is neutralized or rendered negligible (BRIGUGLIO *et al.*, 2009). Such capacities are especially important and desirable to the community economy in the very short term when there is inadequate time to change in order to adapt to a sudden and acute disturbance. This ability to counteract disturbance without change can be considered 'resistance', and is one component of resilience (CARPENTER *et al.*, 2001; MARTIN, 2012).

In the longer term, resistance without adaptation can become undesirable if it makes the community economy inflexible, cumbersome or prone to a danger of collapse. The capacity to adapt

is important for a resilient economy, as changed economic conditions are likely to open up new opportunities for development (MARTIN, 2012). Successful adaption is possible when the community economy has flexibility, innovation and creativity to change in ways that are compatible with changed availability and structures of community resources, as suggested by SONNINO and GRIGGS-TREVARTHEN (2012). While capacities to withstand disturbances rely mainly on the pre-disturbance conditions, adaptation comes from post-disturbance actions.

From the above answers to the four guiding questions, CER can be conceptualised as the capacity of a community economy as a whole to counteract negative economic impacts of disturbances and to adapt to changed economic conditions due to disturbances in order to maintain non-declining economic standards of living. This definition is similar to ones proposed by SIMMIE and MARTIN (2010) and MARTIN (2012) but is broader than the concept of 'regional economic resilience' used in the current economic literature (e.g., ROSE, 2004; ROSE and LIAO, 2005) which is narrowed down as the ability to return the previous stage.

3.2 What makes a community economy resilient?

The four guiding questions help to specify CER, but they do not provide any suggestions about the sources of CER or how to achieve or implement CER. So a further question '*Resilience due to what?*' needs to be addressed in order to translate the concept of CER from theory to practice. While resilience constructs such as capitals, flexibility and adaptability have been studied and developed in many disciplines (MAGIS, 2010; MCMANUS *et al.*, 2012), they are under-researched in the context of community from economic perspectives (ROSE, 2009; MARTIN, 2012). Extending MAGIS's (2010) work on community resilience dimensions from a social sciences perspective and WALKER and SALT's (2006) vision about resilient thinking, three hypotheses of components of CER are postulated here.

Hypothesis 1: A community economy is likely to be resilient if it has a strong base of community capitals in use and has a high level of factor mobility.

Building on the current literature on resilience and community capitals (e.g., BUCKLE *et al.*, 2001; FOLKE, 2003; FLORA and FLORA., 2004; ROLFE, 2006; MCINTOSH *et al.*, 2008; NORRIS *et al.*, 2008; KIRMAYER *et al.*, 2009), this article hypothesizes that CER is operationalized through community capitals. This paper will explore five kinds of capital that are particularly important in CER: human capital, financial capital, natural capital, physical or built capital, and social capital (ELLIS, 1998; GOODWIN, 2003). Definitions of these capitals are provided in Table 2.

Community capitals are collective resources invested as inputs for production activities of the local economy and thus provide an essential base of a resilient community economy (ROSE, 2004; MCINTOSH *et al.*, 2008; MCMANUS *et al.*, 2012). The more robust, redundant and diverse its resources, the more likely it is that a community economy will be able to buffer or counteract the effects of disturbance for a return to functioning, adapted to the environment (LEVIN *et al.*, 1998; BRUNEAU *et al.*, 2003; NORRIS *et al.*, 2008). In addition, a continuing process of investment of community resources creates a spiral improvement in both quality and quantity of resources, thus enhancing the local economy's capacities to respond quickly to disturbances (MAGIS, 2010). Drawing on the literature on inter-sectoral factor mobility (CORDEN and FINDLAY, 1975; NEARY, 1981; GROSSMAN and SHAPIRO, 1982), this article argues that greater mobility of the factors of production among industries, or within or between communities, lowers adjustment costs and enables faster recovery and adaptation, as resources can be mobilized quickly and cheaply for economic activities.

Among community capitals, *human capital* is central to advancing recovery efforts as this kind of capital is used to access and develop other capitals (GRILICHES, 1997; GUNDERSON and HOLLING, 2002; FLORA and FLORA., 2004). It is also fundamental to resilience in that economic development and capacity building require a skilled, trained, healthy and innovative workforce (SCHULTZ, 1961;

GRILICHES, 1997; CALLAGHAN and COLTON, 2008). Skilled workers are more mobile and adaptive than unskilled workers (SHIELDS and SHIELDS, 1989; MARTIN and SPILIMBERGO, 1999; GIANNETTI, 2003; COULOMBE and TREMBLAY, 2009; FRATESI, 2014), so the more skilled workers in a community economy, the quicker it adapts to disturbances (MARTIN, 2012).

Financial capital dictates how a community economy utilizes external resources and makes future projections (FEY *et al.*, 2006), such as building new infrastructure, starting up new businesses and supporting social or civic entrepreneurship.

Natural capital is influenced by human actions but presents both opportunities and constraints on other forms of capital (RODRÍGUEZ-POSE, 2013). Natural resource endowments are considered to be one of the most obvious sources of regional differences in comparative advantages and thus in promoting economic growth (NORTH, 1955; SCHMIDT, 1989; GUNTON, 2003).

Physical or built capitals contribute to resilience directly through their role as production inputs and indirectly by reducing transaction costs. Public infrastructure enhances other community capitals through connecting local people with outside regions (FLORA and FLORA., 2004).

Social capital generally enhances a community economy's ability to work toward collective goals (e.g., WESTERN *et al.*, 2005; WALKER and SALT, 2006; MURPHY, 2007; MAGIS, 2010; WOLFE, 2010), which is necessary for economic recovery by enhancing sense of belonging, strengthening bonds between individuals and groups, and affording the connections needed to solicit and leverage external support. Institutional capital, a component of social capital (RAISER, 1997; RAISER, 1999; RAISER *et al.*, 2001), contributes to CER through reducing uncertainty, stimulating adaptive efficiency (i.e. the ability of a system to adapt to changing conditions) and stimulating the functioning of the allocation system and sustainable production and consumption patterns (PLATJE, 2008). Institutional capital is particularly essential to ensuring the timely advancement of recovery efforts and facilitating resource mobility. Effective and responsible use of institutional capital can foster a resilient recovery by actively involving vulnerable populations in pre- and post-disaster planning and by ensuring that traditionally underrepresented groups have a voice in recovery processes. Social capital also facilitates access to other forms of capital essential to recovery, such as human capital and financial capital

Hypothesis 2: A community economy is likely to be resilient if it retains a diverse economic structure.

The diversity of economic structure can be seen as another important determinant of CER. This is suggested by the current literature on economic diversity and economic stability (e.g., IZRAELI and MURPHY, 2003; DAVIES, 2011; REGGIANI *et al.*, 2011) and views on diversity as an attribute of a resilient world (WALKER and SALT, 2006; HUDSON, 2010). A more diversified economic structure allows a community economy to be more flexible when shifting its focus from one industry to another, and therefore to be quicker to adapt to changing economic conditions due to disturbances (CHRISTOPHERSON *et al.*, 2010; MARTIN, 2012). For instance, the existence of a flexible, multi-skilled labour force in the community economy can serve as a 'disturbance absorption' instrument, as unemployment caused by an external negative disturbance on the demand in one economic sector can be quickly absorbed by shifting resources including labour in this sector to other growing sectors (BRIGUGLIO *et al.*, 2009), thereby reducing regional unemployment (IZRAELI and MURPHY, 2003). A diversified economic structure can also serve as a type of averaging process – industries can replace or compensate for each other during economic disturbances, thus mitigating severe overall economic decline {Dissart, 2003 #171} {Kort, 1981 #173}{Dissart, 2003 #171}. By contrast, a community economy heavily dependent on a primary industry or a narrow range of natural resources is likely to be more prone to productivity or income shocks (WOLFE, 2010; MYERS-SMITH *et al.*, 2012; BAILEY and BERKELEY, 2014) or to be severely constrained in its ability to adapt (FREUDENBURG, 1992; BAILEY and BERKELEY, 2014). Therefore, a diverse economic structure is

needed as diversifying today will be a critical determinant of the economic well-being of the community over the long-term (MAYER and GREENBERG, 2001).

Hypothesis 3: A community economy is likely to be resilient if it is highly accessible.

Building on the spatial economic theories (CHRISTALLER, 1966; FUJITA and THISSE, 1996; MARTELLATO and NIJKAMP, 1998; PAEZ, 2004), this article argues that another key attribute of CER is the level of accessibility of a community economy to a wide range of goods, services, and employment and business opportunities from its service centre. Connectivity to a large number of economic opportunities is likely to increase the accessibility of a location (PAEZ, 2004). Stronger linkages with the regional economy also give the community economy more flexibility when facing changing economic conditions. These cross-scaled linkages are referred to in exploring the concept of resilience in ecology (HOLLING, 2001; GUNDERSON and HOLLING, 2002; FOLKE, 2006; GALLOPÍN, 2006), but the concept of cross-scaled linkages has been applied extensively in economics (BARKLEY *et al.*, 1996; GANNING, 2010; FINGLETON *et al.*, 2012). The community economy can substitute its input shortages by buying from external sources, thereby maintaining its production activities. Whilst the community economy may become more vulnerable to changes in the regional economy due to the interconnections between these economies, the community economy can benefit from economic opportunities that the regional economy provides.

Table 2 Definitions of CER constructs

CER Construct	Definition
Human capital	Human capital refers to the productive capacities of an individual, both inherited and acquired through education, training and experience (GOODWIN, 2003). Components of human capital include education, skills and health (BECKER, 1962; GROSSMAN, 1972; GRILICHES, 1997; CALLAGHAN and COLTON, 2008)
Financial capital	Financial capital refers to the money that is invested in any productive activities, so is not productive but facilitates the production process. Of all the capitals, financial capital is the most easily converted to other forms of capital (GOODWIN, 2003).
Natural capital	Natural capital includes natural resources (e.g., air, water, land, flora and fauna) and ecological systems from the natural world (GREEN and HAINES, 2002; GOODWIN, 2003).
Physical or built capital	Physical or built capital refers to 'physical assets generated by applying human productive activities to natural capital and capable of providing a flow of goods and services' (GOODWIN, 2003).
Social capital	Social capital is defined as 'networks, together with shared norms, values and understanding that facilitate co-operation within or between groups' (ABS, 2004, p.109). Social capital can be classified into three types: bonding, bridging and linking (MAGIS, 2010). Bonding capital includes the close ties among people in homogenous groups in terms of demographic characteristics, such as families and close friends, providing cohesion between members within groups (MAGIS, 2010). Bridging capital represents looser ties between people similar in some demographic characteristics, such as loose friendships, or relationships among colleagues (GRANOVETTER, 1973), exposing them to diversity, enabling them to work together (WOOLCORK, 2001), and providing them more available resources (MAGIS, 2010). Linking capital focuses on connections with people in power or with formal institutions (WOOLCORK, 2001; MAGIS, 2010). Linking capital includes governance, institutions and leadership.
Diversity of economic structure	A 'diversified' regional economy has been defined variously as one in which: (i) all industries are of equal size; (ii) the industry mix minimizes portfolio variance, or (iii) the region's industry mix is the same as the nation's (SHERWOOD-CALL, 1990).
Accessibility	Accessibility is broadly defined as the potential for interactions between locations in space (MARTELLATO and NIJKAMP, 1998). Alternatively, accessibility is referred to a 'multiplicative function of weight (a measure of the number of opportunities available at a given location) and impedance (the cost of overcoming the distance that separates a second location from those opportunities)' (PAEZ, 2004, p. 2213).

4 Measures of CER

Now that this paper has provided meaningful and testable constructs of CER, this section further develops the framework by offering approaches to measurement. It proposes two complementary approaches to measuring CER. The constructive, ex-ante approach measures *potential* CER before the disturbance occurs, based on community resilience constructs hypothesized in section 3.2. The performance, ex-post approach quantifies *emerging CER* after the realization of the disturbance from three dimensions (outcomes, time and cost) using the four guiding questions in section 3.1.

4.1 The constructive approach

A common approach to measuring latent variables that are not directly observed is to measure them through their constructive attributes. This constructive approach has been deployed in quantifying latent variables such as psychological resilience (AHERN et al., 2006), community resilience (KIRMAYER *et al.*, 2009; AWM, 2010; SHERRIEB *et al.*, 2010), and vulnerability (JOHNSTON and WILLIAMSON, 2007; PARKINS and MACKENDRICK, 2007; ABARE-BRS, 2010). Following this approach, CER at time t, R_t, can be expressed as a function of its attributes:

$$R_t = f(K_{H,t}, K_{F,t}, K_{N,t}, K_{P,t}, K_{S,t}, D_t, A_t)$$

As presented in section 3.2, the CER attributes include human capital $(K_{H,t})$, financial capital $(K_{F,t})$, natural capital $(K_{N,t})$, physical or built capital $(K_{P,t})$, social capital $(K_{S,t})$, diversity of economic structure (D_t) and accessibility (A_t). Each attribute is in turn a function of relevant indicators.

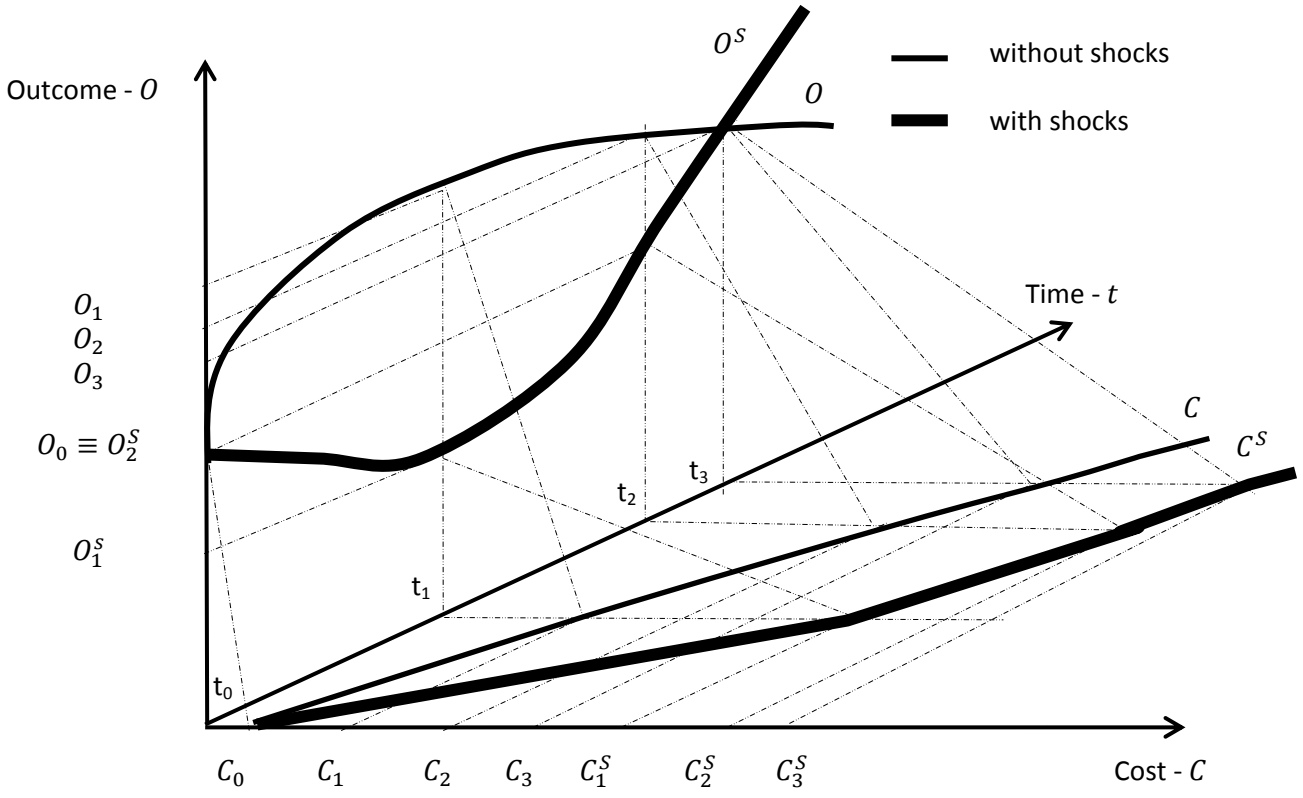
To measure the summary index of CER, one would first require explicit collection of data for relevant indicators of each attribute. Then appropriate statistical methods such as factor analysis or principal component analysis would need to be adopted to produce indexes of individual attributes and finally the overall summary index of CER. Similar approaches have been deployed for measuring vulnerability (PARKINS and MACKENDRICK, 2007; ABARE-BRS, 2010) and resilience (AWM, 2010; SHERRIEB *et al.*, 2010).

4.2 The performance approach

The performance or ex-post approach measures emerging resilience after the disturbance has occurred. Resilience thus can be quantified by its proxy outcomes, such as mental health measures in psychology (ALIM *et al*., 2008; NETUVELI *et al.*, 2008), the distance between stable point and unstable threshold in units of slowly changing variables in ecology (CARPENTER *et al.*, 2001), and outputs or employment in economics (ROSE and LIAO, 2005; HILL *et al.*, 2008; NAVARRO-ESPIGARES *et al.*, 2011; MARTIN, 2012). Resilience is also measured by the time required for the system to recover (FOSTER, 2007; HILL *et al.*, 2011; BRISTOW and HEALY, 2013) or the costs associated with maintaining resilience (CARPENTER *et al.*, 2001; WALKER and SALT, 2006; FOSTER, 2007; VUGRIN *et al.*, 2011). In economics, ex-post resilience measurement focuses on output-based measures. In order to assess post-shock CER thoroughly, measurement should be conducted through three dimensions: outcome, costs and time, as shown in Figure 1.

Figure 1 presents different outcomes and their associated costs over time in different scenarios which will be used to illustrate alternative performance-based measures of CER. At the initial time t_0 when no shock occurs, the outcome is O_0 and its associated cost is C_0. In a non-disturbance scenario, the outcome and its associated cost follow their business-as-usual growth paths O and C, respectively. The corresponding outcome and its associated cost combinations are (O_1, C_1) at time t_1, (O_2, C_2) at time t_2 and (O_3, C_3) at time t_3. In a disturbance scenario, their growth paths redirect to O^S and C^S. The corresponding outcome and its associated cost combinations are (O_1^S, C_1^S) at time t_1, (O_2^S, C_2^S) at time t_2 and (O_3^S, C_3^S) at time t_3.

Figure 1 Pre- and post-disturbance growth paths



4.2.1 Outcome-based measure

The outcome-based measure of CER is defined as the extent to which the selected economic performance indicator (e.g., output, living standard or employment) deviates from its target outcome given an external disturbance.

$$R_O = \frac{(O_T - O_a^S)}{O_T} \times 100\%$$

R_O: Outcome-based resilience index

O_a^S: Actual value of the outcome given a disturbance

O_T: Target outcome

By construction, the less difference there is between the actual outcome and its target level, the more resilient the community economy. However, the way that the target outcome is defined depends on assumptions and availability of data. The simplest method is to use the pre-disturbance outcome, O_0 , as the target outcome. In this case, the resilience index simply measures the percentage change in the selected outcome before and after disturbances. This is similar to the approach adopted by most of the regional economic literature that considers regional economic resilience as the ability of a regional economy to return its previous level of economic performance or to avoid experiencing large swings in output (BLANCHARD *et al.*, 1992; HAUSMANN *et al.*, 2005; ROSE and LIAO, 2005; DUVAL *et al.*, 2007; HILL *et al.*, 2008; BRIGUGLIO *et al.*, 2009). Although this method is simple, it makes a strong assumption that there is only one steady state in the economic system. In addition, it does not take into account the counterfactual effects which capture possible changes in outcomes over time under the business-as-usual scenario.

Another method is to use the projected outcome under the business-as-usual scenario, O_1 , as the target outcome. In this case, the index measures the deviation of the selected outcome under shocks from its business-as-usual value. This explicitly controls for the counterfactual effects, allowing for multiple equilibriums in the community economy.

4.2.2 Cost-based measure

Another performance- measure of CER is based on costs. A cost-based measure of CER is calculated as the deviation of the associated cost for the target outcome from that for the actual outcome given a disturbance.

$$R_C = \frac{\left(C_T^S - C_a^S\right)}{C_T^S} \times 100\%$$

R_O: Cost-based resilience index

C_T^S: The associated cost for a target outcome given a disturbance

C_a^S: The associated cost for the actual outcome given a disturbance

As for the outcome-based resilience measures, a cost-based measure also depends on the selected target outcome. For target outcomes defined at before-the-disturbance and business-as-usual scenarios, the associated costs are C_2^S and C_3^S, respectively.

4.2.3 Time-based measure

In terms of time, CER can be measured as the inverse of the time needed for the local economy to reach a certain target level of outcome after being shocked by a disturbance. So the shorter the time taken, the more resilient the community economy. It should be noted that the time measured depends on the outcome level chosen as the target outcome. As shown in Figure 1, t_2 is the required time for the community economy to return to its before-shock performance level, $O_2^S \equiv O_0$, while t_3 is the time needed to reach the outcome level under the business-as-usual scenario.

5 Framework for Measuring CER

This paper provides a meaningful, measurable and testable framework for specifying and quantifying CER, as summarized in Table 3. In an attempt to avoid the ambiguity of the concept of resilience criticized in the literature (HASSINK, 2010; PIKE *et al.*, 2010; SIMMIE and MARTIN, 2010; HOLM and ØSTERGAARD, 2013), this paper proposes four guiding questions to specify the concept of CER in terms of systems (*'Resilience of what?'*), disturbances (*'Resilience to what?'*), beneficiaries (*'Resilience for whom?'*) and goals (*'Resilience for what?'*). It then adds a fifth question to determine measurement constructs of CER (*'Resilience due to what?'*), of which the answer is found through three hypotheses:

> Hypothesis 1: A community economy is likely to be economically resilient if it has a strong base of community capitals in use and has a high level of factor mobility.
>
> Hypothesis 2: A community economy is likely to be economically resilient if it retains a diverse economic structure.
>
> Hypothesis 3: A community economy is likely to be economically resilient if it is highly accessible.

These guiding questions and hypotheses in turn offer two comprehensive approaches to measuring CER before and after disturbances. The constructive (ex-ante) approach quantifies *potential* CER through its attributes including five capitals, economic diversity and accessibility. These factors are considered both as means to achieve wellbeing and as valuable goals themselves (KIRMAYER *et al.*, 2009). This approach enables community economies to predict their resilience before it is evidenced

or realized. The biggest advantage of this approach is its ability to capture theoretical components of CER. A comprehensive picture of potential CER is drawn, which can meet the different needs of various research disciplines, and be useful for policy-making processes.

[Table 3 here]

Table 3: Framework of constructivist and performance-based measures of CER

Measurement approach	**Constructive (ex-ante)**	**Performance (ex-post)**		
Questions		Outcome-based	Cost-based	Time-based
Resilience of what?	Community connectivity, accessibility and potential stocks of five capitals	Outcomes associated with community economy	Costs associated with outcomes	Time associated with outcomes
Resilience to what?	Any shock to the social-ecological system	A specified shock to a community economy		
Resilience for whom?	Community economy			
Resilience for what?	Maintain community economic standards of living	Idealized economic outcomes	Minimum costs associated with idealized economic output	Minimum costs associated with idealized economic output
Resilience due to what?	Specific indexes and measures of human, financial, natural, physical, social capitals, economic structure and accessibility	Difference in economic outcomes (e.g. income and jobs)	Cost of the economy to return to target	Time taken for economy to return to target 'performance'

The main drawback of measuring CER through its attributes is the heavy data requirements. Each attribute or domain requires a number of proxy variables which may not be available at the small scale of the community (i.e. small statistical areas). Data on natural capital are mostly in an aggregate form, so need to be re-estimated and disaggregated at a community level. In addition, the index is highly sensitive to the proxy indictors selected for each domain.

While the performance (ex-post) approach is based on the 'inputs' to produce CER, the performance CER measures rely on proxy outcomes of CER. As resilience is demonstrated after the shock has occurred (WILDAVSKY, 1988), this approach quantifies the *emerging* CER and thus complements the constructive approach. A key advantage of the performance approach is that it provides multi-

faceted measures of actual CER in terms of different outcomes, associated costs and time. One community economy may remain resilient in terms of keeping the economy growing (outcome-based resilience), but it may turn out to be too costly to achieve this (cost-based resilience). In this case, outcome-based measures of resilience become undesirable and unaffordable. These multi-aspect performance-based measures of CER offer useful implications for policy in their ability to inform the selection of appropriate strategies to improve economic resilience. Another advantage of the performance (ex-post) approach is that it requires less data collection and analysis than the constructive approach.

The framework presented in Table 3 summarizes the arguments presented in this article to enable future researchers and policy makers to pragmatically apply it to investigate CER through a set of questions and measures. However, as a framework (or heuristic) it is necessarily general, and has limitations. Obviously, this framework is based on multiple projects and learnings but still needs to be critically and instrumentally applied *de novo* to investigating CER. This application should ideally be undertaken both for policy and research insights. Second, the framework is focused on pragmatic 'measuring' of resilience; as such, some of the more intangible attributes such as motivation, leadership, shadow networks, and social learning are not included. This work would benefit from further addressing of both of these limitations.

The purpose of this paper was to provide a framework for specifying and measuring CER. A tacit approach based on literature and past experience has provided a meaningful, measurable and testable framework. This was achieved by postulating five questions on how to specify and measure resilience, testing these through three hypotheses, and then identifying two complementary approaches to measuring resilience, as summarized in Table 3. The two approaches will help policy makers and researchers evaluate CER both before and after shocks. This novel framework synthesizes the many different approaches used to investigate resilience and provides meaningful (rather than just conceptual) insights on predicting and tracking CER over time.

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