Bouncing back from extreme weather events: Some preliminary findings on resilience barriers facing small and medium-sized enterprises

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Some preliminary findings on resilience barriers facing small and medium-sized enterprises

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Abstract
Extreme Weather Events (EWEs) pose unprecedented threats to modern societies and represent a much-debated issue strongly interlinked with current development policies. Small and medium-sized enterprises (SMEs) that constitute a driving force of economic growth, employment and total value-added remain highly vulnerable to and ill-prepared for such environmental perturbations. This study assesses barriers to SMEs' resilience to EWEs in an attempt to shed light on enabling factors which can define effective SMEs responses to nonlinear environmental stimuli. Relying on an exploratory quantitative survey, the assessment offers essential research findings for practitioners on SME management and sets forth linkages with current mechanisms for policy interventions towards an appropriate resilience agenda for SMEs.

1. Introduction

Scientific evidence suggests that climate change (CC) is expected to further affect the carrying capacity of ecosystems, generate large-scale environmental changes and increase the occurrence of extreme weather events (IPCC, 2013; Munich Re, 2013; Stern, 2007). Owing to a massive scale as well as scope, irreversibility, destructiveness and high uncertainty, such impacts can be highly discontinuous. In Europe, recent years have witnessed severe heat waves, major floods, heavy precipitation and extreme storms (e.g. Dlugolecki, 2009; Poumadère *et al.*, 2005) while the frequency and intensity of such impacts are projected to escalate (Beniston *et al.*, 2007; Forzieri *et al.*, 2016).

Unexpected changes and disruptive events have always been a major challenge for business planning (Weick and Sutcliffe, 2001). However, very few environmental problems exhibit as much uncertainty as that associated with CC and related extreme weather events (EWEs) (Barnett, 2001). Such environmental perturbations incur abrupt changes to business organizations in terms of asset damages, operational interruptions, increased costs as well as declining revenue and growth (Winn *et al.*, 2011; Linnenluecke *et al.*, 2011). It is therefore critical for businesses to identify such risks, to reduce their vulnerability to EWE threats and, ultimately, to effectively build their *resilience* to climate-induced physical challenges. Resilience indicates the ability to withstand, to adapt, and to quickly recover from stresses and shocks (European Commission, 2012) while organizational resilience signifies a blend of cognitive, behavioural, and contextual properties that allow a business entity to effectively absorb, develop situation-specific responses to, and ultimately engage in transformative activities to capitalize on disruptive surprises that potentially threaten its very survival (Lengnick-Hall *et al.*, 2011). Fostering the resilience capacity of α firm enables it to overcome survival threats and actually secure its longevity and prosperity under a complicated, uncertain, and volatile environment (Sutcliffe and Vogus, 2003; Seville *et al.*, 2008).

In its attempt to move towards higher levels of resilience to EWEs a firm may face an array of barriers. As such barriers are addressed the firm will achieve interventions and improvements endorsing business continuity planning. Likewise, when business entities experience extensive barriers to building resilience any intentions to foster disaster risk management will rarely be translated into actions. Such obstacles to managing environmental challenges can be either internal or external (Hillary, 2004; Chan, 2008; Shi *et al.*, 2008). Barriers not pertaining within the firm (i.e. external barriers) refer to parameters which are out of the direct control or influence of the organization. Internal barriers are on the other hand dependent upon parameters that may be directly controlled by the business entity, indicating intrinsic characteristics-attributes, resources and/or capabilities.

In this context, this study presents preliminary findings of a quantitative assessment on barriers to SMEs resilience to EWEs and contributes to an emerging body of literature aiming to respond to questions such as: i) how can businesses become robustly prepared and resilient towards the challenging conditions that CC introduces?, and, ii) what are the enabling conditions which facilitate the resilience of a business entity against EWEs? Responding to such pressing issues offers a discerning approach for addressing key aspects of sustainable development since equipping these companies to confront the climatic turbulence and extreme weather improves the development options of future generations (Sheffi, 2007; Moore and Manring, 2009).

2. Background and motivation for the study

SMEs are more vulnerable and ill-prepared to face extreme weather conditions compared to their larger counterparts, so they are disproportionately affected by EWEs (Crichton, 2009). This is due to limited resources, and a tendency towards short-term planning, reacting to circumstances as they arise and focussing on survival (Smith and

Smith, 2007). Likewise, they share less formalised structures and codified policies while they are most usually owner-managed resulting in a command-and-control management culture (Ates *et al.*, 2013). These characteristics result in SMEs having limited opportunities to recover from adverse weather extremes or quickly turnaround their operation from a loss making to a profit making one (Ingirige and Wedawatta, 2011).

EWEs can disrupt the efficiency of supply chain networks where many SMEs are embedded and incur infrastructure and facility damages as well as inventory cost and downtime losses (Snyder and Shen, 2006). Considering that they play a major role in business-to-business markets and a large number of SMEs is embedded in large-scale production chains, increasing their resilience capacity to EWEs represents a matter that warrants considerable attention. This is also because these enterprises are strongly embedded in their local community (Spence, 2007) and, therefore, they can play a pivotal role in mobilizing society to adopt anticipatory adjustments to the physical impacts of CC (Linnenluecke et al., 2013) and act as a useful stakeholder in relief and disaster recovery (Johnson et al., 2011). Hence, SMEs can contribute to the swift and successful recovery of local communities in which they are established (McManus et al., 2008), while the collective loss of a considerable number of SMEs due to weather extremes may devastate a local economy (Yoshida and Deyle, 2005).

For instance, in Europe, SMEs account for 99% of all enterprises, they contribute to more than 50% of the total value-added created by the EU business sector and drive employment by providing more than 60% of the private-sector jobs (European Commission, 2015). Moreover, taking into account that EWEs-related economic damages have reached record-levels over the past decade (Munich Re, 2013), addressing the barriers SMEs face in building their resilience capacity becomes a sheer necessity.

Nevertheless, current literature on business responses to climate change stimuli (e.g. Linneluecke and Griffiths, 2010) is mostly fuelled by normative arguments on how

organizational resilience can be developed while empirical findings on measurement and appraisal of organizational resilience to climate change are thin on the ground. Indeed, despite the fact that small and medium business entities potentially face greater losses from the effects of CC and EWEs (Runyan, 2006) and their role within supply chains and local sustainability is vital (Hong and Jeong, 2006), the organizational literature seldom concentrates on SMEs' resilience potential to such risks, with the exception of very few studies (Kuruppu *et al.*, 2013; Wedawatta and Ingirige, 2012).

3. Material and methods

Our assessment seeks to identify associations between the various observed items forming the individual internal/external latent constructs, as well as the associations between these individual latent constructs with the more general concepts of internal-external barriers in a holistic manner. To achieve this, we utilize recently collected data (from an ongoing research project) gathered through structured questionnaires administered to owners-managers of SMEs located in the Attica prefecture of Greece (n=109). The data collection instrument relies on 25 items measuring the level of agreement over a series of internal and external barriers (observed items) to resilience to EWEs, measured on a 1-5 Likert scale. A full description of the observed variables used as an initial input for constructing the latent factors described above can be found in Table 1.

To test the proposed methodological framework (Figure 1) we have followed a statistical modeling view. Specifically, we have fitted a structural equation model (SEM) (Bollen, 1989) in order to test the conceptual model that we have hypothesized. The hypothesized modeling scheme is a 2-level conceptual model. Indeed, we first explore the direct connections between the observed items forming the individual internal/external barriers and the corresponding constructs, whereas at the second layer of our model we added a testing of the two-layer SEM model, by allowing for the individual latent factors

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of internal and external barriers to directly affect the two general latter structures of internal/external barriers. The results of the analysis showed that the specific model conceptualization provided a moderate to good fit to the data. The SEM model was estimated through the AMOS software (Arbuckle, 2006).

In order to test the influence of the 25 items on the latent constructs that contribute to the SMEs' barriers, we performed our analysis, deriving results for the collected data sample which included the total sample of 109 SMEs. The sample size meets the absolute minimum requirement of 50 respondents for the SEM modeling to provide valid inferences (Hair *et al.*, 2006), although the recommended size is 100 or above.

3.1 Items utilized for the SEM modeling

An analytical description of the observed items from the questionnaire that were utilized for the construction of the individual latent factors of internal/external barriers is provided in Table 1. In particular, a total number of 25 observed variables were selected – measured in an ordinal Likert scale - which was included into four factors to form the more general factors of internal and the external barriers, respectively. Analytically, the 8 individual factors utilized for the current analysis are described below, along with the Cronbach's α values (Bollen, 1989) and the percentage of variance of the selected items explained by each of the latent factors:

Internal barriers

1. 3-item scale factor (Cronbach's α: 0.809; % of explained variance: 72.4) measuring Resources barriers.

2. 3-item scale factor (Cronbach's α: 0.458; % of explained variance: 49.63) measuring Understanding and Perception barriers.

3. 3-item scale factor (Cronbach's α: 0.66; % of explained variance: 72.18) measuring Implementation barriers.

4. 3-item scale factor (Cronbach's α: 0.097; % of explained variance: 36.01) measuring Attitudes and company culture barriers.

External barriers

1. 3-item scale factor (Cronbach's α: 0.351; % of explained variance: 43.6) measuring Operational/adaptation consultants barriers.

2. 3-item scale factor (Cronbach's α: 0.157; % of explained variance: 39.22) measuring Economics barriers.

3. 3-item scale factor (Cronbach's α: 0.553; % of explained variance: 53.17) measuring Institutional weaknesses barriers.

4. 4-item scale factor (Cronbach's α: 0.385; % of explained variance: 64.64) measuring Support and guidance barriers.
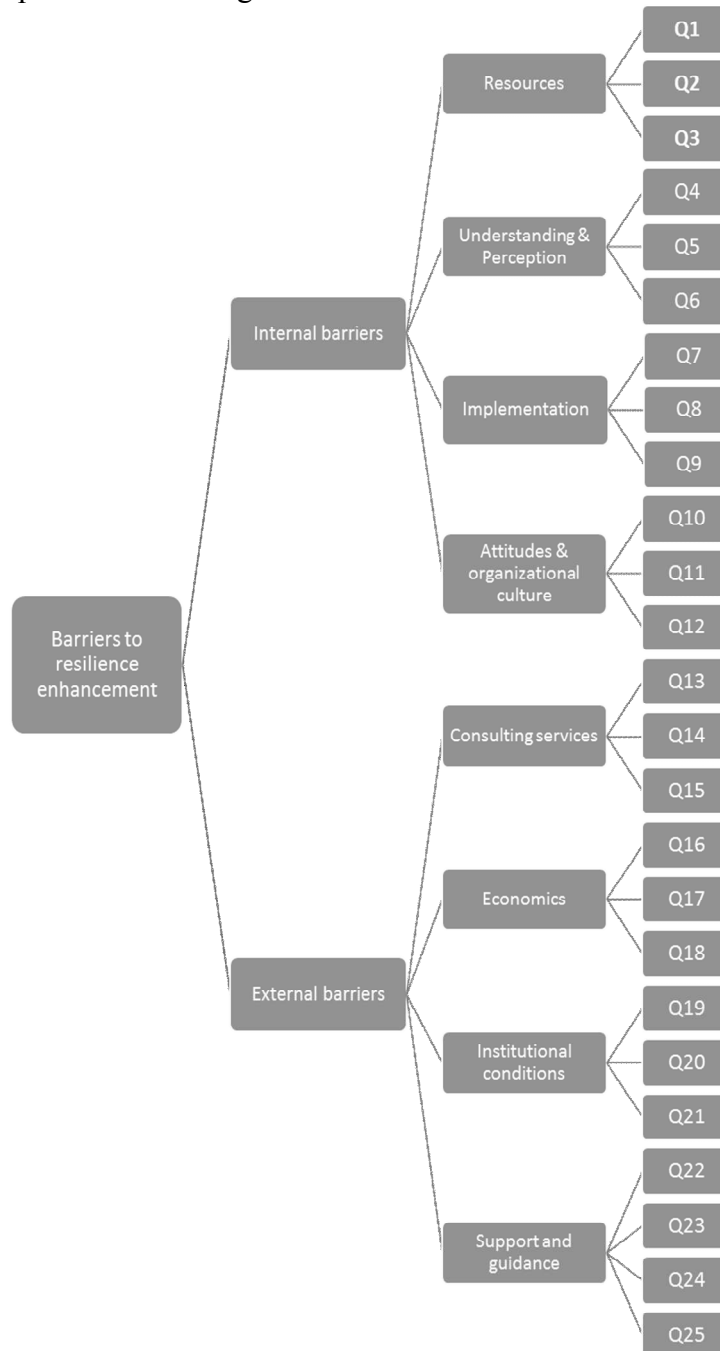
4. Results

The path diagram obtained by the fit of the SEM model is shown in the following Figure (Figure 2), summarizing the most important findings. The single-headed arrows in the path diagram are used to imply a direction of assumed causal influence while the numerical values next to each arrow denote the (standardised) regression weights (β's) of the corresponding item on the latent variables as well as the weights from the four internal/external barriers to the general factors of external and internal barriers. The statistical significance of each association is also indicated in the graph with the use of asterisks. The loadings of non-statistically significant paths are not reported for space saving. Instead, we have marked the corresponding arrow of causality with a dashed line in the case of the non-significant associations.

Table 1: The data collection instrument

n/n	A critical inhibitory factor in building the resilience of my enterprise towards extreme weather events is:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Q1	Lack of time to design, implement and monitor such resilience measures	o	o	o	o	o
Q2	Lack of relevant training and expertise by members of the staff	o	o	o	o	o
Q3	Financial constraints	o	o	o	o	o
Q4	Absence of clear benefits for the firm	o	o	o	o	o
Q5	The relevant management cost is high	o	o	o	o	o
Q6	It incurs additional, bureaucratic, internal procedures	o	o	o	o	o
Q7	It may interrupt other (important) operational processes within the firm	o	o	o	o	o
Q8	Doubts about the effectiveness of such actions and their objectives	o	o	o	o	o
Q9	Difficulties in evaluating comprehensively related environmental risks	o	o	o	o	o
Q10	Previous experience with nonfinancial management systems proved they are inefficient within my enterprise	o	o	o	o	o
Q11	They may bring forward drastic and unwanted changes to my enterprise	o	o	o	o	o
Q12	I have more critical-important issues to engage with	o	o	o	o	o
Q13	The costs of consulting on business continuity planning is high	o	o	o	o	o
Q14	Business continuity consultants serve their intrinsic interests which exceed their role in improving business operation and performance	o	o	o	o	o
Q15	Business continuity consultants will offer low quality as well as largely prescriptive and/or bureaucratic services to the firm	o	o	o	o	o
Q16	The volatile economic environment influences the importance attached to resilience measures against EWEs	o	o	o	o	o
Q17	There are no economic incentives to motivate engagement in resilience measures	o	o	o	o	o
Q18	The implementation of resilience measures to EWEs has no value in the market place my enterprise operates in	o	o	o	o	o
Q19	Lack of related promotion activities by apposite governmental bodies	o	o	o	o	o
Q20	Inadequate information provision by the authorities on the design and implementation of resilience measures to EWEs	o	o	o	o	o
Q21	The regulatory framework is complex and strict and undermines any attempts to endorse resilience-related modifications within the enterprise	o	o	o	o	o
Q22	Mechanisms of external support are of low quality and inconsistent	o	o	o	o	o
Q23	Mechanisms of external support lack knowledge of the intrinsic characteristics of the sector my enterprise operates in	o	o	o	o	o
Q24	The trade associations/business chambers my enterprise pertains to offer inadequate support to resilience enhancement	o	o	o	o	o
Q25	Absence of clear guidance, information provision to increase awareness as well as assistance by other primary stakeholders of the firm on how to enhance resilience to EWEs	o	o	o	o	o

Please indicate your level of agreement with the following statements:

Figure 1: The proposed methodological framework

Fit statistics for the SEM model show that the path analysis structure tested provided a moderate to good fit, since that most of the values are at the borderlines of acceptable limits. As regards the results, as we see, most of the observed items of internal barriers to SMEs' resilience to EWEs (questionnaire items Q1 to Q12) have a significant effect on the assigned corresponding factor, with the exception of the attitudes and company culture

internal barriers to SMEs' resilience. The most dominant factors were found to be those of resources (regression weight β: 0.999; p-value<0.001) and understanding & perception barriers (β: 0.72; p-value<0.001). A marginal significance is also observed for the implementation barriers factor (β: 0.355; p-value<0.001).

For the external barriers of SMEs, we observe that the most important barrier factors are those of institutional weaknesses external barriers to SMEs' resilience to EWEs (β: 0.791; p-value<0.001) and support & guidance barriers (β: 0.999; p-value<0.001). The economic barriers are also contributing – marginally though – to the external barriers (β: 0.556; p-value<0.1). Finally, on behalf of the external barrier factors only the effects of the operational adaptation consultants factor was found to be non-important for the external barriers.

It would be also of interest to examine the importance of the various observed variables that contribute to the individual latent constructs of external and internal barriers, respectively. As regards the resources barrier construct, we observe that all three observed variables of [Q1], [Q2] and [Q3] barriers are important for its construction. The same is also true for the latent construct of the understanding & perception barrier, since that all three tested items load strongly on the specific factor. On the other hand, the implementation barrier construct is mainly affected by the [Q7] observed variable (β: 0.493; p-value<0.001), whereas it is also marginally affected by the variable of [Q8] (β: 0.181; p-value<0.1).

As regards the items that comprise the important latent constructs of external barriers referring to institutional weaknesses and support and guidance, it was observed that all individual observed items load strongly on the latter constructs. The economic-related barrier, that contributes only marginally to the overall latent construct of external barrier, is mainly affected by the [Q16] observed variable (β: 0.196; p-value<0.1).

Figure 2: Estimated SEM Model for the internal-external barrier constructs
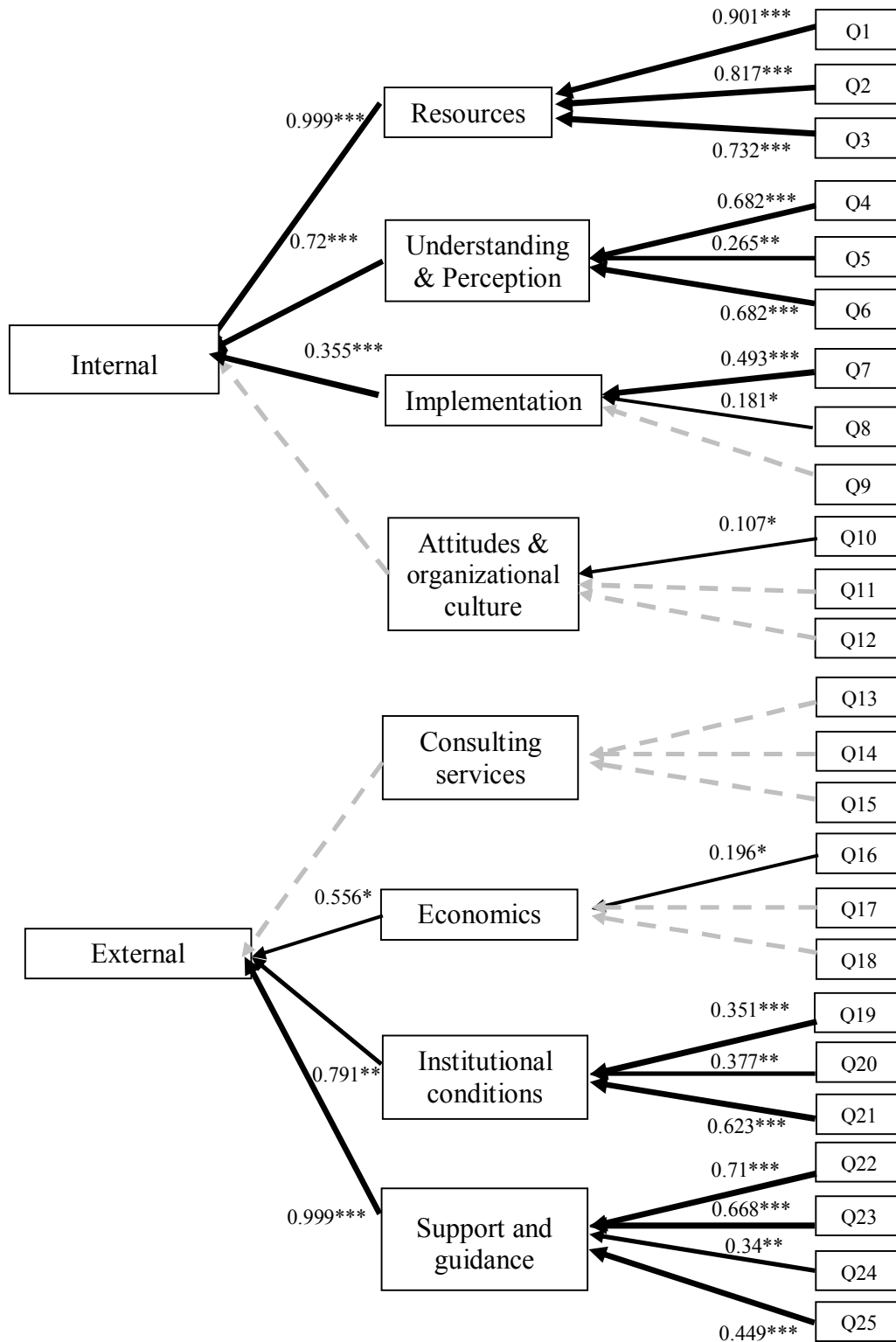
Significant direct positive effect

Insignificant direct effect

*: p< 0.1; **: p< 0.05; Chi-square: 310.958 (p-value: 0.05); GFI: 0.77; AGFI: 0.728.

Our SEM modeling tests failed to obtain a stable model convergence, by retaining the associations between the two general latent constructs of internal-external barriers with the 4th-layer factor of barriers to resilience, as hypothesized in Figure 1. While this is a task of ongoing research, this finding is indicative of the diversity between the internal and external barriers to building resilience as a general concept and their differences as regards their responses from the SMEs' owners-managers viewpoint.

5. Concluding remarks

A key issue in decision-making towards fostering business resilience to EWEs is to identify barriers that undermine the ability of firms to respond in a timely and effective manner to environmental stimuli and disruptive events, such as EWEs. Assessing barriers to resilience is a promising avenue of fruitful evidence for policy implementation towards CC adaptation that will stimulate SMEs to upgrade their ability to withstand EWE phenomena. Reliance on a single set of inhibitory factors may not allow the enhancement of organizational resilience if other clusters of barriers which can offset desirable outcomes are isolated. Therefore, all barrier groups should be identified and considered and by devising relevant schemes and incentives under the scope of a 'climate-proof' SME sector.

These preliminary findings suggest that certain elements of external and internal barriers have a significant positive effect on building SME resilience to EWEs while other hypothesized associations were not found to be important. Internal barriers pertaining to resources as well as managerial perceptions are most critical as suggested by the statistical analysis of gathered data. In relation to external barriers, those referring to institutional conditions and to mechanisms of external support and guidance are equally critical in shaping resilience. Nevertheless, the central outcome of the study is that the hypothesized model of SMEs' barriers can be a valid instrument for linking the various individual latent constructs of barriers with the general concepts of internal and external inhibitory factors.

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