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ECONOMIC RESILIENCE, DEMOGRAPHY AND LOCAL SYSTEMS: A COMMENTARY ON THEORY AND ASSESSMENT

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Biographical Note

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Abstract
Despite the growing relevance of the 'resilience' dimension, this concept has not been yet carefully defined or satisfactory measured within the more general issue of socio-ecological resilience. Resilience is the capacity of a local system to tolerate disturbance without collapsing into a state controlled by different conditions and processes. Investigating socioeconomic resilience in systems changing rapidly over time is important for sustainable land management under intense and increasing human pressure. This article presents an overview of definitions and approaches for objective quantification of the socioeconomic resilience and an empirical exercise applied to multivariate time series data to assess the specific contribution of demography in socioeconomic resilience. The study is intended to contribute to the resilience issue in the light of the (increasingly complex) relationship between environment, economic systems and the social sphere.
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1. Introduction

Socioeconomic resilience has not been yet carefully defined or satisfactory measured within the more general issue of socio-ecological resilience (Lepart and Debussche, 1992; Lavorel, 1999;

Thompson 2005). The 'resilience' notion, as originally illustrated by Elton (1958), refers to the amplitude of changes brought about by disturbance and by dynamics of post-disturbance recovery. Holling (1973) popularized this term within the broader framework of 'system stability'. He provided a definition of 'resilience' as the amount of disturbance that a natural or social system could withstand without changing self-organized processes and structures, defined as alternative stable states. The 'resilience' concept does not necessarily imply a return to the pre-existing state, but could be referred to as the capacity to respond to opportunities which arise as a result of change (Holling, 2001). Folke (2006) described 'resilience' as the set of opportunities that disturbance opens up in terms of recombination of evolved structures and processes, renewal of the system and emergence of new paths (Brand and Jax, 2007). 'Resilience' hence expresses the adaptive capacity that allows for continuous development like a dynamic interplay between sustaining and developing with change (Carpenter et al. 2001).

This article proposes an overview of definitions and measures of socioeconomic resilience focusing specifically on the demographic issue. We debated the implicit definitions proposed in recent literature dealing with socioeconomic resilience, commenting also on relevant assessment techniques. In the first section we present a general definition of the resilience concept from the social sciences perspective. A brief comment on common measurement techniques of socioeconomic resilience in local systems was subsequently proposed. A specific focus on the demographic component of socioeconomic resilience, intended as a underexplored dimension in the general literature of local systems' resilience, was proposed. An empirical exercise developed on a vast set of multivariate time series data were proposed with the aim to assess the specific contribution of demography (population structure and dynamics) in socioeconomic resilience of a developed European country. The relationship between ecosystem management and socio-economic resilience was further discussed in the light of complex relationships between the environment, the economic systems, and the social sphere. In the final section we outlined a demographically-oriented vision of the 'resilience' concept as an original contribution to issues of resilience and sustainability of socioeconomic complex systems.

2. Definitions

A traditional meaning of socioeconomic resilience is the ability of a regional economic system to maintain a pre-existing state (typically assumed to be an equilibrium state) in the presence of exogenous shocks. While few studies explicitly use the "resilience" term, most of the socioeconomic literature that deals with the idea of resilience is concerned with the extent to which a regional or national system that has experienced an external shock is able to return to its previous

level and/or growth rate of output, employment, or population (Blanchard and Katz, 1992; Rose and Liao, 2005; Briguglio et al., 2006; Feyrer, Sacerdote, and Stern, 2007). More articulated interpretations of the concept involve path-dependent, historical "lock-in" processes; this notion assumes that a local system has multiple equilibria, not all of which are efficient in a static or dynamic sense. This indicates regional resilience as the ability of a system to avoid becoming trapped into a low-level equilibrium. Systems that experience negative shocks may exhibit three different kinds of responses. Some of these may have returned to or exceeded their previous growth within a relatively short period of time. These systems are candidate to be 'economically' resilient. Some may not have been thrown off their growth path at all; these systems can be defined as shock-resistant. Finally, some systems may have been unable to rebound and return to or exceed their previous path; these can be considered non-resilient.

3. Assessment

Resilient and non-resilient systems can in principle be identified by examining their economic, social and demographic performance over an enough long-time interval. Criteria for a negative economic shock can be defined and pre- and post-shock growth rates and levels of economic performance can be measured. A region where post-shock growth rate is at least as high as its pre-shock growth rate and that achieves its pre-shock level of performance within a specified time period can be considered resilient, while a region that experiences a negative shock and does not meet these criteria can be considered non-resilient. Conditions for socioeconomic resilience are strictly determined by demographic conditions, including population dynamics and structure. Resilient and non-resilient systems can be identified using several indicators and criteria, based on e.g. diachronic data on aggregate performance. Shock-resistant systems can be assessed using data on industrial performance or other information on non-industry shocks. Human skill may also be regarded as an important factor here but is rather difficult to calculate in a way comparable with the other factors. A general measure of socioeconomic resilience should consider the following issues:

(i) what measure(s) of socioeconomic performance should be used, e.g. gross domestic product, employment, earnings, income?

(ii) should the growth rate for a region be measured in absolute terms, relative to the national average, or relative to the average in the relevant economic zoning, census region, or administrative division?

(iii) how far back in time should growth paths be traced (in economic and demographic terms?

(iv) for how many years should growth paths and shock periods be measured? Should the same number of years be used to define pre-shock, shock, and post-shock periods, or should the lengths of these periods be allowed to differ?

(v) how large does a negative deviation have to be (relative to the region's previous performance and/or national average performance) to count as a negative shock?

(vi) How should a region's pre-shock level of performance be defined (e.g., peak or average performance during the pre-shock period)?

4. Indicators of socioeconomic resilience

The first challenge faced in measuring socioeconomic resilience is to define spatial areas that reflect patterns of human activity. Any spatial definition of socioeconomic systems is to some degree subjective; these are open systems in which people, money, goods, and services continually cross any boundary adopted. Further, if socioeconomic systems are defined in a spatial hierarchy (international, national, regional, and local), interactions will occur among all levels. The theoretical basis for socioeconomic resiliency rests on the concept of social well-being, which is defined as a composition of three factors: economic resilience, population structure and dynamics, socio-cultural diversity (e.g. population size, human skill mix) and civic infrastructure (McCool et al., 1997).

Partial indexes of economic resilience have been developed directly from measures of diversity in sectoral employment or income. Social and cultural diversity was measured by using data on lifestyle diversity. Population density may be used as a proxy of civic infrastructure, because of the lack of direct ways to measure this dimension (Barkley et al., 1996). In this context, measures for both economic resilience and lifestyle diversity are calculated using the Shannon-Weaver (1949) diversity index. The composite rating of socioeconomic resilience is determined by combining the results of economic resiliency, population density, and lifestyle diversity. The socioeconomic resiliency rating based is assigned on the sum of the ratings for the three factors; that is, the three factors are equally weighted (Horne and Haynes, 1999).

Briguglio (2007) demonstrated that economic resilience is associated with actions undertaken by policy-makers and private agents which enable a region to withstand or recover from the negative effects of shocks. Actions which enable a region to better benefit from positive shocks are also considered. The ability of a regional economic system to recover from the effects of adverse shocks is associated with the flexibility of an economy, enabling it to bounce back after being adversely affected by a shock. This ability is enhanced when a system displays discretionary policy tools counteracting the effect of negative shocks. The ability to withstand shocks relates to the capability to absorb shocks in a way that the end effect of a shock is neutered or significantly

contained. This type of resilience can be observed when a given system displays mechanisms to reduce the effects of shocks. In this sense, the existence of a flexible, multi-skilled labour force could act as an opportunity to absorb shocks, as negative external demand shocks affecting a particular sector of economic activity can be relatively easily met by shifting resources to another sector enjoying stronger demand.

Compiling a composite index of socioeconomic resilience encountered a number of problems with regard to data collection, the most important being associated with data availability and heterogeneous definitions across countries. A resilience index may assess the effect of shock-absorption or shock-counteracting policies across countries. Dimensions capturing these effects include (Briguglio, 2006): (i) macroeconomic stability; (ii) microeconomic market efficiency; (iii) good governance; (iv) social development. The composite index aggregates standardized variables (using a linear transformation) by arithmetic mean with homogeneous weighting (Briguglio, 2007). In such exercises, demography is a less investigated issue, sometimes relegated in the 'social development' dimension or not assessed at all. According to Horne and Haynes (1999), developing a composite measure integrating demographic issues in socioeconomic resilience is particularly useful for understanding the extent to which changes in policies may affect human systems (Quigley et al., 1996). The interest of this analysis stems from a long-lasting concern about the relation between socio-demographic trends and economic well-being.

5. Demography and socioeconomic resilience

A social structure is not static; while persisting for a long time, it evolves in ways that ultimately threaten firms' profitability, long-term macroeconomic growth, population structure and dynamics. A diachronic perspective would emphasize the intimate relationship between factors of growth and change persisting over a long period of time and the underlying economic, political, and social conditions (Reich, 1997). Economic systems would be resilient when the related social structures are stable or allow rapid transitions from one structure to another. In this sense, socioeconomic resilience is defined as the ability of a nation or a region to recover successfully from shocks to its economy that either throw it off its growth path or have the potential to throw it off its growth path but do not actually do so. From the demographic point of view, a balanced population structure by age is an important prerequisite for system stability and capacity to respond to exogenous shocks.

One important aspect of recent demographic trends, with impact on socioeconomic resilience of local systems, is Demographic Transition (DT). The DT process refers to the transition from high to low birth and death rates as a country develops from a pre-industrial to an industrialized system with consequent societal and environmental changes (Chesnais, 1993). The

DT theory is based on the interpretation of demographic history dealing with transitions in birth and death rates over a long-time period (Dudley, 1996). Demographic transition involves four stages: in stage one, pre-industrial society, death rates and birth rates were high and roughly balanced. All human populations are believed to have had this balance until the late 18th century, when this balance ended e.g. in Western Europe. In stage two, death rates dropped following improvements in food supply and sanitation, which have increased life spans reducing common diseases. In stage three, birth rates fell due to important social changes including access to contraception, increases in wages, urbanization, increased status of women, and visible improvements in the education of children. During stage four low birth rates and low death rates were observed (Baudelle and Olivier, 2006). Birth rate decline in developed countries started in the late 19th century in northern Europe. By the late 20th century, birth rates and death rates in developed countries leveled off at lower rates (Myrskyla et al., 2009).

6. An empirical exercise to assess demography contribution in socioeconomic resilience

A collection of demographic indicators was used to investigate exogenous shocks in Italy over a relatively long-time period. The investigated area coincides with Italian country and extends 301,330 km^2 of land (23% lowland, 42% upland and 35% mountainous land). Recent demographic trends in the country were discussed in Billari et al. (2007), Caltabiano et al. (2009), Caltabiano (2016). A total of 14 indicators (Table 1) were calculated from a large set of homogeneous time-series data (1862-2009) made available at the country scale by the Italian National Institute of Statistics (ISTAT). Indicators assess (i) population dynamics (POP: resident population, logarithm; GRO: annual population growth rate (%); BIR: crude birth rate (percentage of total population); DEA: crude death rate (percentage of total population); MIG: migration rate (percentage of total population); NAT: natural children rate (percentage of total births); STI: still birth rate (percentage of total births); MAR: marriage rate (percentage of total population)) and (ii) demographic structure (SEX: sex ratio; SPO: average age of the groom at marriage (years); AGE: median age at death (males, years); DEY: death rate at age 0-4 years (percentage of total population); MED: absolute difference (years) in female to male median age). Indicators were derived from various official data sources including national censuses of population and households, demographic register, forest and environmental statistics. The selected indicators are homogeneous over time and provide a comprehensive picture of socio-demographic changes observed on a time interval of 150 years in Italy. Indicators were calculated for each year between 1862 and 2009 and subjected to a Principal Component Analysis (PCA). The PCA was run to identify latent correlations among the studied

indicators and their evolution over time. Components with eigenvalues > 1 were extracted and two separate plots for component loadings (statistical indicators) and scores (years) were produced.

Table 1. Indicators' list, abbreviations and analysis' dimensions.

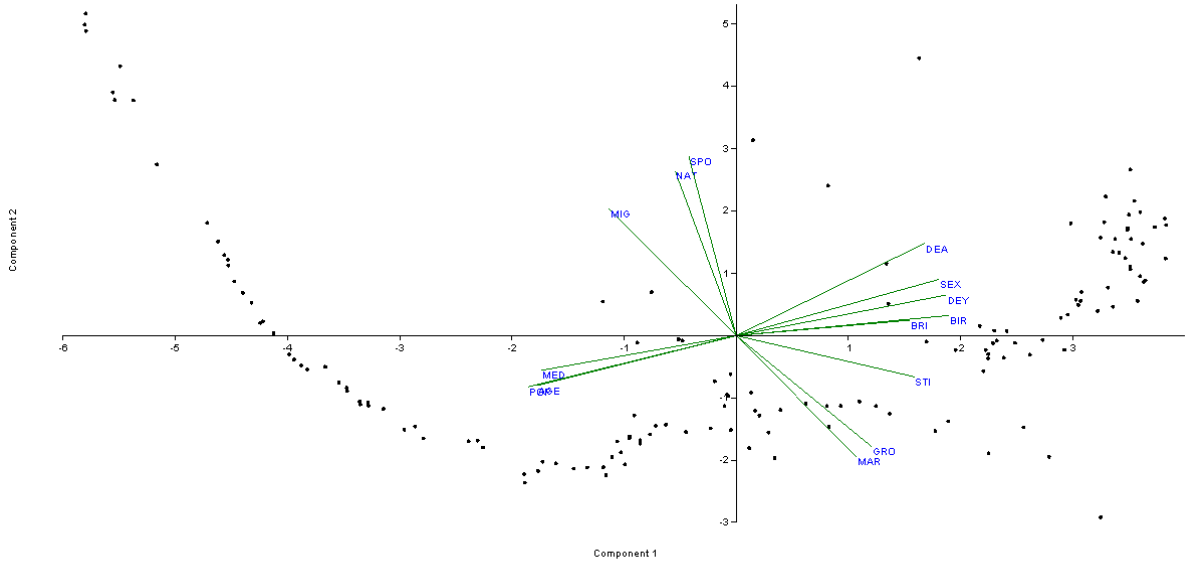
Variable	Acronym	Dimension
Population growth (per year, % rate)	GRO	Pop. dynamics
Resident population (logarithm)	POP	Pop. structure
Sex ratio (male vs female)	SEX	Pop. structure
Birth rate (% in total population)	BIR	Pop. dynamics
Death rate (% in total population)	DEA	Pop. dynamics
Migration rate (% in total population)	MIG	Pop. dynamics
Natural children rate (% in total births)	NAT	Pop. dynamics
Still birth rate (% in total births)	STI	Pop. dynamics
Age difference between groom and bride (yrs)	BRI	Pop. structure
Marriage rate (% in total population)	MAR	Pop. dynamics
Average age of the groom at marriage (years)	SPO	Pop. structure
Median age at death for males (years)	AGE	Pop. structure
Difference female vs male median age (years)	MED	Pop. structure
Death at age 0-4 years (% in total population)	DEY	Pop. dynamics

Trends over time in the considered indicators in Italy highlight for birth and death rates a decreasing pattern with a time lag by 30 years (i.e. death rate declined with the same intensity of birth rate thirty years later, converging during early 1980s). Population growth rate showed an inverse U-shaped trend with a peak before World War II. Conversely, migration rate showed a U-shaped pattern with a peak in the same period. Population growth and sex ratio display continuously increasing (or decreasing) trends over the entire study period. The Principal Component Analysis extracted two components with cumulated variance above 80% (Figure 1). Component 1 (61.0% of the total variance) identified a gradient associated negatively with changes in demographic dynamics (BIR, DEA, SEX) and positively with size of resident population (POP). Population growth rate (GRO) was counter-correlated with migration rate (MIG) along both component 1 and 2 (20.7% of the total variance). The component score plot ordered years between 1862 and 2009 along component 1 with an inverse U shape discriminating two turning points, possibly indicating exogenous shocks in population structure and dynamics approximately around the late 1910s and the early 1940s. These periods corresponded to the World Wars impacting negatively stability and resilience of the Italian demographic system.

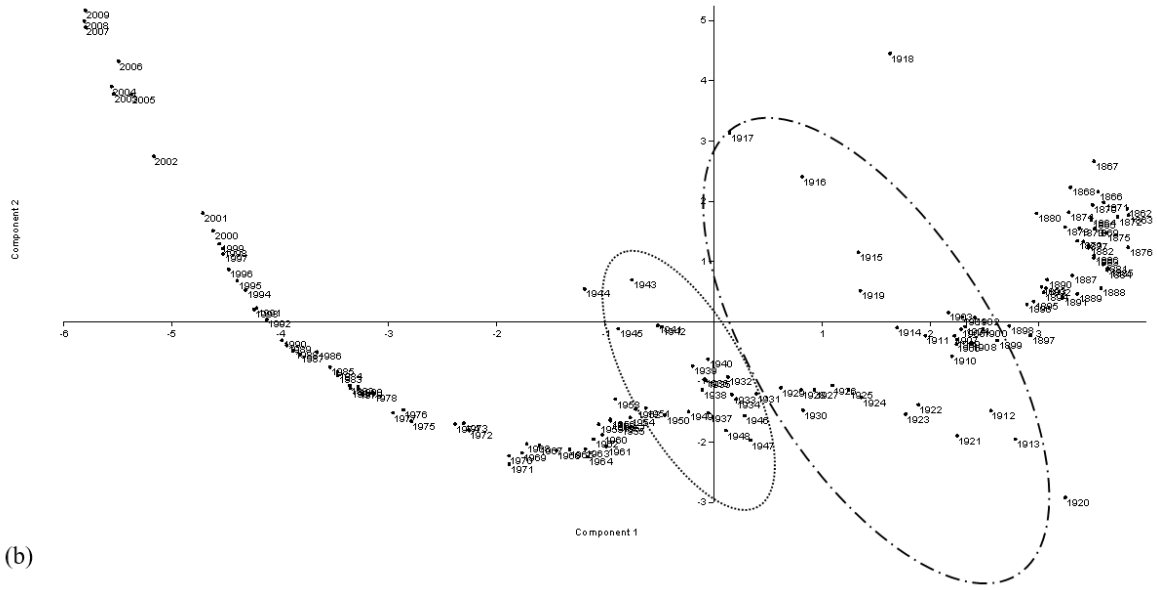
In this way, the PCA identified four distinct time periods with homogeneous demographic characteristics. These time intervals represent conditions of dynamic equilibrium highlighting latent transitions in population variables. Long-term demographic dynamics have indirectly influenced the potential for resilience by polarizing population density and relegating large areas of the country to

marginal economic conditions and unbalanced demographic structures with stagnant population dynamics. The approach proposed here allows identifying the demographic indicators most associated to exogenous shocks over long time periods (Harte, 2007). The analysis also identified the late 1920s as a time interval with the most evident turning point in the demographic structure of Italy, indicating distinctive groups of variables of pre-transitional, transitional and post-transitional phases (Myrskyla et al., 2009). Our findings highlight the importance of integrated assessment frameworks evaluating the resilience potential of socio-demographic and economic issues jointly.

Figure 1. Principal component analysis biplot (a) and factor score plot indicating time periods with exogenous shocks (b).



(a)



(b)

7. Conclusions

Quantitative approaches assessing the contribution of demographic structure and dynamics to socioeconomic stability are potentially interesting although difficult to apply to a comparative analysis across systems. Specific components of the 'resilience' dimension require assessment improvements. For example, social development is an essential component of economic resilience. Social development can be measured in many ways. Variables relating to income dispersion and the share of population living in poverty, the long-term unemployment rate — indicating the proportion of the population with low skills and inadequate employment prospects — and the proportion of population with low level of education could be relevant indicators of social resilience, in addition to indicators of demographic resilience.

In this analysis it is assumed that the relation between diversity and resilience in social systems is in some ways like that found in the ecological literature (Moffat, 1996); that is, a system with higher diversity is less affected by change than a system with lower diversity and the former therefore has higher resilience. Socioeconomic systems with high resiliency are defined as those that adapt quickly as indicated by rebounding measures of socioeconomic well-being. People living in areas characterized by high resilience have a wide range of skills and access to diverse employment opportunities. Systems with low resilience have more lingering negative impacts, such as unemployment or out-migration rates that remain high for several years. The terms "high" and "low" should not be thought of as "good" or "bad," but simply as a reflection of the ability of a socioeconomic system to respond to changes in its constituting elements. Greater diversity (and higher resilience) does not eliminate the possibility of wide fluctuations for single economic systems. Taken together, empirical evidences suggest that a thorough analysis involving multiple research dimensions and incorporating multi-scale assessment frameworks (from local to sovra-national) assures comprehensive definition and operational description of socioeconomic resilience.

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