

Abstract

Measuring economic resilience in natural disasters: an analysis of major earthquakes in Japanese prefectures

In recent years, the study of resilience of regional and local systems has become a popular topic in relation to the increasing of economic, social and environmental shocks. Despite the theoretical framework has been enriched through definitions and empirical investigations, accordance in measurement is still missing.

A part of scholars in Regional Science started to study resilience of systems in relation to the recessionary periods that affected economies in the last few years. They tried to explain why some regions can better cope with shocks, showing a positive response to crisis with a specific attention to the interacting and multiple causes of this response (Fingleton *et al.*, 2012; Martin *et al.*, 2015). Investigations have concerned long-term analysis on a single area (Simmie and Martin, 2010; Simmie, 2014; Cellini and Torrisi, 2014; Bell and Eiser, 2016) or comparisons between different regions (Cuadrado-Roura *et al.*, 2016; Sensier *et al.*, 2016). The objects of the measurements have often been comparable macroeconomic variables such as GDP, output and employment.

Despite the measurement is an issue still widely debated, a first methodology proposed and, subsequently, largely applied to study economic resilience of regions has been the recovery and the resistance indices theorized by Martin (2012). The author, in defining regional economic resilience, identifies four interrelated dimensions that contribute to understand how regional economies respond to shocks: resistance, recovery, reorientation and renewal. To evaluate dimensions of resistance and recovery, he proposed to two different indices. The resistance index is calculated as the change in employment in the region compared to the change at national level in the shock period and gives an idea of the ability of a region to cope with a shock. The recovery index can help to demonstrate the capacity of the system to restore a trajectory of growth. It is evaluated through the measure of the growth in employment in the period following the shock.

The measurement of resistance and recovery have been applied and revised by several authors (Lagravise, 2015; Faggian *et al.*, forthcoming) in order to evaluate and describe the ability of economic systems to resist to crisis.

A first analysis of definitions and measurements of resilience in regional science – including empirical applications relative to indices of resistance and recovery of Martin (2012) - shows that while studying economic shocks is common, there is less interest in studying relationships between resilience, natural disasters and economic change. This is an important lack in order to build a strong

theory of resilience. A conclusive theory should analyse the economic system through a holistic vision.

This paper aims to enlarge the debate of regional economic resilience proposing a measurement of the resilience in response to natural disasters toward the construction of the indices of resistance and recovery. Particularly, the paper tries to apply the framework and the tools belonging to the study of regional economic resilience to test the ability of Japanese prefectures to cope with earthquakes. Building an index to measure the economic resilience of regions stricken by a natural disaster can help to identify, in relative terms, the system that has better reacted to the shock.

Japan is located in the Pacific Ocean on the Ring of Fire that makes it one of the areas most affected by seismic activity. According to data provided by the Centre for Research on the Epidemiology of Disasters (CRED), Japan suffered of a total amount of 59 significant earthquakes in the years between 1900 and 2015. The impressive numbers of earthquakes have made the country one of the most proactive not only in the aspects related to aseismic technology but also in the process of prevention, recovery and hazard mitigation. Based on this statement, Japanese prefectures appear as an interesting unit of analysis to investigate economic resilience in face of natural shocks.

Moreover, according to the Asian Disaster Reduction Centre (ADRC), the amount of natural disasters occurred between 1975 and 2000 has increased in accordance with changes in population, urbanization, deforestation and desertification (ADRC, 2002). A special focus on earthquakes shows a general increasing trend in the number of earthquakes occurred around the world and a concentration of such disasters in Asian countries. Such considerations make the study of the capacity of economies to overcome natural shocks, restoring a pre-disaster level of growth or promoting a higher level, as a relevant topic in studying the resilience of regions.

The analysis concerns the major earthquakes occurred in Japan, in the proximity of urban areas, between 2003 and 2008. Data of earthquakes have been selected from the “Global Significant Earthquake Database” of the National Oceanic and Atmospheric Administration (NOAA) distributed by the National Centre for Environmental Information (NCEI). Such data have been compared to the data of the International Disasters Database released by the Centre for Research on the Epidemiology of Disasters (CRED) of the Université Catholique de Louvain (UCL) in Brussel. Comparing the two databases, significant earthquakes have been selected as those which have a magnitude greater than or equal to 7 on Moment Magnitude Scale (Mw) and/or an amount deaths greater than or equal to 10 people and/or a damage greater than or equal to 1 million of dollar. The prefectures in which the earthquakes occurred have been detected looking at the data on the latitude and the longitude of the singular earthquake’s epicentre. In the end, the analysis conducts to the selection of 6 major earthquakes occurred between 2003 and 2008 with a direct impact on 10 Japanese prefectures.

The aim of this analysis is to describe the economic effect for such disasters and identify changes in employment to understand the ability of the different areas to cope with earthquakes.

Starting from the data on employment of the OECD for the Japanese prefectures in which major earthquakes occurred, indices of resistance and recovery are calculated to identify which regions can be defined the most resilient.

The first part of the paper is devoted to critically discuss the most relevant measurement methods proposed to analyse resilience in response to natural disasters. This analysis will concern the main contributions identified in literature looking at the authors, the definition of resilience, the type of shock and the methodology applied. The review will highlight the deep differences in the analysis of resilience to natural shocks which involves several typologies of shocks and different measurements.

In the second part, it will be clarified the methodology applied to analyse the resilience of Japanese prefectures in face of earthquakes and a detailed discussion will regard the construction of the indices. Moreover, in this part, an important reflection will concern the difficulties in identifying an appropriate measure of resilience.

In the final part, results and conclusions will be presented in order to offer some insights to the study of economic resilience and natural shocks. A specific focus on each single event will be proposed through an analysis of long-term employment trends in order to understand the impact of the disaster but also the interaction between the economic and environmental aspects and to identify vulnerable aspects of regional economies. Results will show that changes in employment not always are a clear consequence of natural shocks but often they intercept and overlap the cyclical periods of growth and decline of national and local economy.

Essential References

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