Socio-Economic Resilience of the L'Aquila Community in the Aftermath of the 2009 Earthquake

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SUMMARY:

Natural disasters like earthquakes often occur in vulnerable and populated areas with effects on the local communities and the entire surrounding countries. The concept of seismic resilience, usually meant as the ability of a community to recover its full functionality after an earthquake, is introduced in this work from an economic and social perspective. As a case study L'Aquila community, hit by a significant earthquake in 2009, is analyzed highlighting different aspects of the socio-economic resilience.

Keywords: socio-economic resilience, L'Aquila earthquake, gross domestic product.

1. THE CONCEPT OF VULNERABILITY, SUSTAINABILITY AND RESILIENCE

The raising number of natural catastrophes emphasized the need of putting an accent on some aspects of the society or, a community for a smaller scale reference, to trace its ability of facing and reviving after a natural disaster. Every community exposed to a natural hazard in fact, has a certain grade of vulnerability. The word *vulnerability* is used to mean the degree at which a system, sub-system or a component is able to face a damage caused after the exposure to a hazard. In a few words, it is the tendency of a community (or a structure) to suffer a certain level of damage after the exposure to a natural disaster of a given intensity. The concept of vulnerability can be directly referred to a structure, a building, a bridge or a general infrastructure that could experience a collapse. In this case, we define it as *direct vulnerability*. The concept can also be used to explain the degree to which an entire organization is exposed or how much the hazard can affect an entire network (e.g. the road network); in this case we talk about *indirect vulnerability* or used to express the effects that take place after the catastrophic event and how they can modify the behaviour of the affected population (*delayed vulnerability)*. Vulnerability is intimately related to social processes in disaster prone areas and it is usually related to the fragility, susceptibility and lack of resilience of the population when faced with different hazards.
Strictly connected to the notion of vulnerability, is the one of *sustainability*. The aim of the studies about sustainability is to ensure a safe development of a community without compromising the future generations from an environmental and social point of view.
Tied to both notions, is the concept of *resilience*. The etymology of the word "resilience" is the Latin verb "*resilio*" that literally means "to come back quickly". Ecologists were the first to use the concept of resilience more than 30 years ago (Holling, *Resilience and stability of ecological systems,*1973) and since then, it has been adapted for the case of short-term disasters (Tierney, 1997; Bruneau et al., 2003; Rose, 2004; Rose, 2007) and long-term phenomena, such as climate change (see Dovers and Handmer, 1992).
From a scientific point of view, the word resilience is the property of a material to come back to its initial state after being exposed to an external pressure. From a structural point of view, resilience can be meant as the ability of a structure to recover its initial level of functionality after an external shock (i.e. an earthquake, a tsunami, a volcanic eruption or a terrorist attack).These concepts have been

extended to different contexts like seismic engineering, sociology and psychology. The term *resilience* has lately been adopted to describe the ability of a person, or to a large extent of a community, to recover the "healthy state" after a shock and to observe the reaction of population after a natural disaster. To study a community that faced a natural disaster and its ability to stand it, it is necessary to conduct an "universal" analysis and to take an overview of the peculiarities of the society from a political, sociological and economic point of view.
In the seismology context, the *recovery time,* i.e. the time necessary to restore the functionality of a community or a critical infrastructure system (water supply, electric power, hospital etc.) to a desired level below, same, or better than the original one allowing proper operation of the system, is a random variable with high uncertainties. It typically depends on the disaster intensities, the type of area considered, the socio-economic environment and the availability of resources such as capital, materials and labor following the major event. For these reasons this is the most difficult quantity to predict in the resilience function. Porter et al. (*Assembly-based vulnerability of buildings and its use in performance evaluation*, 2001) attempted to make distinction between downtime and repair time and they tried to quantify the latter. Resilience is defined graphically as the normalized shaded area underneath the function shown in Figure 1.1, where in the x-axis the time range considered to calculate resilience is indicated, while in the Y-axis the functionality Q(t) of the system measured as a non-dimensional quantity. Analytically Q(t) is a non stationary stochastic process and each ensemble is a piecewise continuous function as the one shown in Figure 1.1.

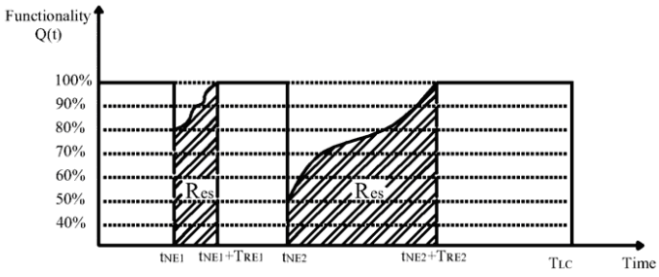

Figure 1.1. Uncoupled resilience

2. INDICATORS FOR ECONOMIC AND SOCIAL RESILIENCE

To be defined "sustainable" and "resilient", communities should be able to resist to an extreme geophysical event and to recover rapidly from disasters when they occur, both from structural and a socio-economic point of view. Sustainability and resilience then are complementary concepts based on careful planning and organization of society, to ameliorate the impact of disasters and to facilitate its recovery. These strategies have to include mitigation programs to reduce risk and exposure, post-disaster plans to facilitate the recovery, and careful consideration of structural and cognitive factors that will influence program efficacy.
Thus, even if these concepts were originally introduced in a different field, they are in this context used to measure the recovery time from different points of view. Schematizing, the resilience after a natural disaster is measured for the infrastructures, the economy, the society and the environment.
To study a community that faced a natural disaster and its ability to stand it, it is necessary to conduct an "universal" analysis and to take an overview of the peculiarities of the society from a political, sociological and economic point of view before and after the natural disaster i.e. an earthquake.
The disasters' reduction must be part of decision making processes, i.e. institutional development must be strengthened and investments in vulnerability reduction stimulated, in order to contribute to the sustainable development and resilience processes in the affected countries.
In order to do that, existing risk must be identified and recognized, as well as the possibilities of new risks of disaster. This implies the need to dimension, measure and monitor risk with the aim of determining the effectiveness and efficiency of intervention measures and whether these can be corrective. Risk, however, must be made manifest, it must be socialized and its causes identified.

In order to evaluate the degree of resilience and sustainability from an "universal" point of view, it is necessary to introduce some indicators pertaining to different dimensions. In this work we utilize some economic indicators such as the regional Gross Domestic Product at current prices (GDP), the employment rate, and some social ones, i.e. the immigration rate and the number of university applicants (used as a proxy for a social and psychological indicator).
The aim of this work is to analyze the multiple aspects of a community from an economic and a social point of view. In order to do that, it would be appropriated a brief description of the community that is going to be analyzed.
The case-study analyzes all the characteristics of the Abruzzo's socio-economic context; we analyze this dimension keeping into account the population characteristics like age, education, the economy of the region and its main features.

3. THE ABRUZZO CASE – STUDY

This research aims to conduct a study on the Abruzzo's community after the 2009 earthquake. In particular, the area that has been taken into account is the so-called *crater-area*. This area is composed by several municipalities struck by the earthquake and for which the damages have been relevant. The study is conducted by making a comparison of the socio-economic characteristics of the area before and after the event.

3.1 The 6th of April 2009

In December 2008, a series of seismic events (foreshocks and aftershocks) started in the Abruzzo region and led to the main shock of the 6th of April 2009 at 3.32 p.m. It was rated as 5.8 on the Richter scale and 6.3 on the moment magnitude scale (Mw) with the epicentre in the spot between Roio Colle, Genzano and Collefracido. The earthquake was felt throughout central Italy; 308 people are known to have died, making this the deadliest earthquake to hit Italy since the 1980 Irpinia earthquake.

3.2 A pre-earthquake social-economic analysis of the "Crater".

Before analyzing the socio-economic situation of the Abruzzo region after the earthquake, it is necessary to define what the "*crater area*" is and its demographic characteristics before the natural disaster. According to the definition given by the *Commission for the Reconstruction*, the number of municipalities included in the crater is 57, 42 belonging to l'Aquila's province, 8 to Teramo's province and 7 to the Pescara's one.

3.2.1 Population

In 2008, year before the earthquake, the crater counted 133,831 people, the 12.2% of which had an age between 0 and 15 years and the 22.1% greater than 65. University students who resided there and occasional visitors who were there for work-related reasons (accounting from 13,000 to 14,000 unities) were not included in the computation. The 1st of January 2009, the census established that the population affected by the earthquake amounted to 144,415 people, the 11% of the regional population and the 0.2% of the national one. More than the 50% of the affected population was living in l'Aquila (72,696 citizens). The smaller municipalities were characterized by high ageing phenomena where more than one third of the population was more than 65 years old. From a demographic point of view, almost the complete territory was subject to a high depopulation and ageing with a negative birth rate. Except L'Aquila, between 1991 and 2009 all the crater towns lost the 5% of their population.

3.2.2 Economic characteristics of the crater before the earthquake

Before the disaster, the average per capita GDP of the towns belonging to the Crater area was the 81% of the regional average. Till 2008, the employment rate was relatively high in the L'Aquila province, and the *Labor Local System* of Pineto and Teramo were above the national average. Between 2008 and

2009 the employment rate slightly decreased (about 1%) in the crater area, but the entrepreneurship rate was still above the regional average.
The productive system of the seismic areas was based on the construction and service sectors, together with a relevant farming activity. About the agriculture, in the years before 2009, it had a rapid growth due to specific activities implemented in some areas (typical products and farming) and thanks to some typical agricultural activities like rural tourism , farms-restaurants and hotels.
The building trade and tourism before 2009, showed higher rate of development in the rest of the crater than the main city (L'Aquila).

3.3 L'Aquila earthquake's main consequences

The 6.3-magnitude earthquake caused damages to between 3,000 and 11,000 buildings in the historical part of the city of L'Aquila. 308 people lost their lives and about 1,500 people were injured. Twenty of the victims were children and about 65,000 people lost their houses.
Schools remained closed in the Abruzzo region for many weeks after the event and most of the inhabitants of L'Aquila abandoned their homes and the city itself. The hospital of L'Aquila, where many of the victims were brought, suffered damage in the aftershocks which followed the main earthquake an hour later.
Many of L'Aquila's medieval buildings were damaged: the apse of the Basilica of Saint Bernardino of Siena, L'Aquila's largest renaissance church, was seriously damaged, and its bell tower collapsed; almost the whole dome of the 18th-century in Piazza Duomo fell down, just like the 13th-century Basilica di Santa Maria di Collemaggio; the third floor of the 16th-century castle housing the National Museum of Abruzzo collapsed, as it did the cupola of the 18th-century Baroque church of St Augustine, damaging L'Aquila's state archives.
One of the worst consequences of the earthquake was the collapse of the dormitory of the university of L'Aquila, with the consequent death of 8 students. The 9th of August 2009, it was estimated that the homeless people were 48,818, 19,973 of which found accommodation in 137 tented camps while about 19,149 were guest in hotels and 9,696 found place in private houses.
The 22nd of January 2010 the number of evacuees was estimated around 10,128, while 12,056 people had a temporary accommodation in the C.A.S.E. (Complessi Antisismici Sostenibili ed Ecocompatibili – Eco-compatible and eco-sustainable anti-seismic complex) and 2,362 in M.A.P.s (Moduli Abitativi Provvisori - temporary living modules).
The government declared immediately the emergency state. The highway A24 was closed immediately and the civil protection suggested to not travel toward the Abruzzo, Molise, Umbria and Marche regions to facilitate the movements of the firemen and civil protection trucks.
In the so-called Abruzzo's decree, approved after the Easter of 2009, some important measures to face the crisis and to promote resilience were listed:

- Suspension for 3 months of the payment of welfare and insurance contributions that would have been paid by the government.
- 400 Euro of government grant for the homeless families, or 500 if one of the family members was more than 65 or handicapped.
- Suspension for 2 months of the utilities payments (gas, telephone, electricity).
- Suspension for 4 months on the mortgages monthly payment.
- Institutions of bank current accounts for the civil protection to receive donations.
- 70 Millions of Euros for the immediate reconstruction.
- 700 soldiers to avoid the profiteering

4. THE ABRUZZO'S ECONOMY RESILIENCE PATH AND A COMPARISON WITH OTHER ITALIAN EARTHQUAKES

The 28th of April decree n. 39, published in the "official Gazette" n. 97 called "*Urgent interventions for the populations affected by the earthquake in the Abruzzo region*", contains a series of aids and measures for financing interventions in the first immediate post-earthquake phase, and for the following measures. The Italian government, by March 2012, allocated 10.576 billion euros for the

reconstruction that should be completed in 10 years, as reported in the document "*Reconstruction of the L'Aquila Crater's Municipalities*" issued by the ministry of territorial cohesion (Table 4.1).
It is quite obvious that the April 2009 earthquake affected the economy of the entire region destroying not only houses, but also lots of economic activities on which the region founded its source of wealth. It has already been illustrated in the previous chapter the number of houses destroyed, and with them, lot of industrial buildings. The government national aids issued for the reconstruction, are reprieved for 10 years believing that the region can recover the 100% of its "functionality level". This research aims to understand if the Abruzzo communities is resilient enough and if it is moving in the right direction for the recovery.

Table 4.1. Reconstruction funds for L'Aquila earthquake (Million euros)

	Allocated funds	Available funds	Used funds
Private Building reconstruction.	2,000	954	1,046
Roads and railways	300	300	0
Other reconstructions	3,955	3,218.3	737
Public buildings reconstruction divided in three operational lines: Public work, University of L'Aquila, Second program for public works	200.8	113.1	88
	40	31.7	8
	167.7	167.7	0
Safety measures for schools	226.4	144.8	82
Funds to small and medium local companies	88.4	88.4	0
Help the balance sheet of the crater's public institutions.	30	0	30
Contribution to local municipalities	2	0	2
	10	0	10
	3.5	3.5	0
Jobs and work contracts	6	6	0
Investments in real estates	600	600	0
Total recostruction funds	7,630	5,627.5	2,002
Total emergency funds	2,859.3	33.5	2,826
TOTAL GOVERNMENTAL AID	10,489	5,661	4,828
PRIVATE DONATIONS	67.3	0	67.30
OTHER GOVERNMENT DONATIONS	19.7	0	19.70
TOTAL AIDS RECEIVED	10,576	5,661	4,915

The reconstruction path in the Abruzzo region is proceeding at a good pace. In Figure 4.1, the reconstruction path for two major Italian earthquakes is represented: the L'Aquila earthquake (2009) and the Friuli one (1976). The damage for the last earthquake (6.4 Mw), was estimated to be 8.12 billion Euros. On the X-axis, the estimated damages and the funds supplied by the governments are reported. On the y-axis we indicated the elapsed time after the earthquakes. In the Abruzzo region, the 47% of the lavished funds have been used after 3 years, while in the Friuli case (1976), just the 39% of the funds was used in 1979. The "speed" of resilience, shown by the slope of the hypotenuse of the "resilience triangle", is flatter in the Friuli case, indicating a slower recovery time.
While in these two regions of central Italy, the resilience seems to be proceeding in a consistent way, in the Italian history, there is an example for which this is not happening. The Belice 1968 earthquake (Mw 6.1), pointed out the backwardness level of the towns in West Sicily, starting from the high vulnerable and law sustainable tuff-buildings. The hit population was composed mostly by old people, women and children since a great percentage of the man emigrated in the northern Italy looking for a job. This sociological environment was known and ignored by the institutions, that did not take care of these people even after the earthquake. The lack of logistic preparedness, the inactivity of the institutions, the delays in the reconstruction process, forced the citizens to emigrate and the dreariness of the shacks for the survivors underlined the lack of preparedness and resilience of the local institutions. The expense for the reconstruction was estimated to be about 6.1 billion euros and after 44 years, an incredible waste of time by the institutions, the Sicily region asked the Italian government for

additional 433 million euros: more than 130 million euros for public buildings and 300 for the private ones.

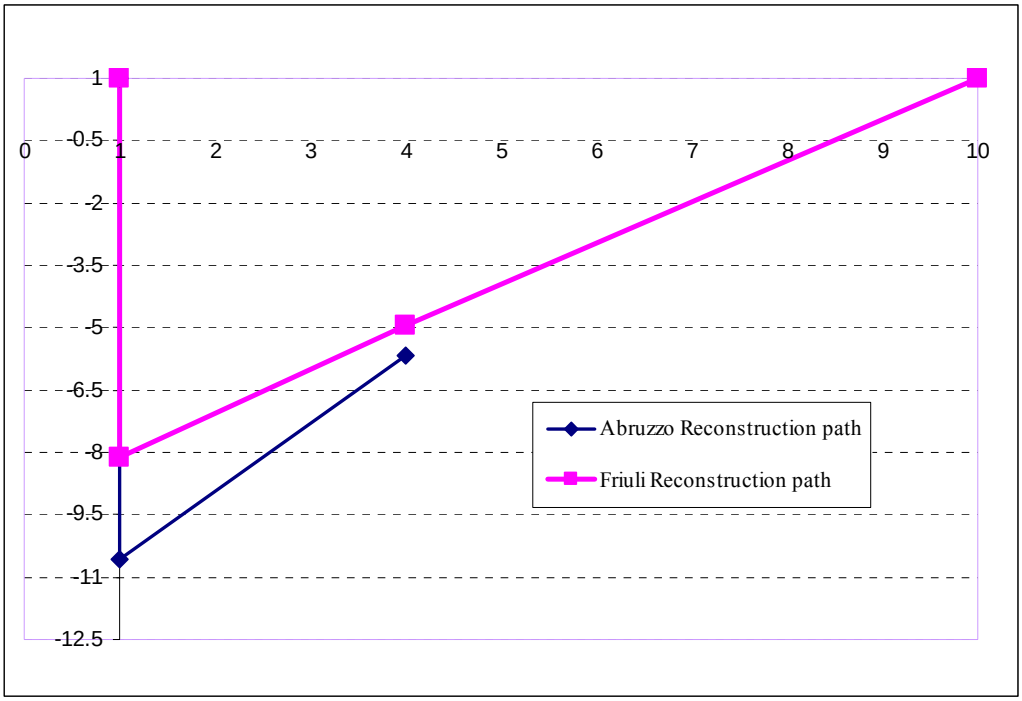

Figure 4.1 Abruzzo and Friuli reconstruction path

4.1 Macroeconomic aspects

In line with the world economic cycle, also the Italian economy started to grow up recently but to a slower pace. In 2009 the Italian and the Abruzzo's economy experienced a downturn and the GDPs moved in the same direction losing about 6 percentage points (Figure 4.2). We are used to think that a natural disaster, for its intrinsic destructive power, has a damaging effect on the regional economy, but as it is pointed out from our empirical analysis, the regional GDPs actually gained some benefits from these catastrophes. The explanation to this phenomenon, is given by the composition of the Gross Domestic Product. The GDP of a nation is given by the sum of consumption (C), investments (I), public spending (G), and net Exports (X). If the consumption can be the only element to be underprivileged by a natural disaster, because consumers lost their goods and so the marginal propensity to consume is lower, the public spending and investments have, for the years immediately after the earthquake, a big increment due to the reconstruction needs.
This phenomenon can be adapted to the concept of *creative destruction,* an expression coined for the first time by the economist Joseph Schumpeter and borrowed by catastrophists to explain the GDP expansion after a natural disaster. The needs for reconstruction in fact, seem to "feed" the economy through the post-disaster demand of goods and services, making the economy grow faster to adapt to current reconstruction necessities. Recent studies regarding it, show a positive correlation between the frequency of natural disasters and the long-run economic growth. This idea can be interpreted as the proof that natural disasters can give the chance to make new investments in capital stocks and adopt new technologies to improve what existed before the natural catastrophe, giving a new impulse to local economies.
The Abruzzo region in 2009 lost more percentage point respect to the national average because of the economic consequences after the earthquake, but the unexpected effect is that the very next year (from 2009 to 2010), the regional GDP experienced a bigger growth than the national one (4.54% compared to the national one of 2.17%) .The results are shown in Figure 4.3.

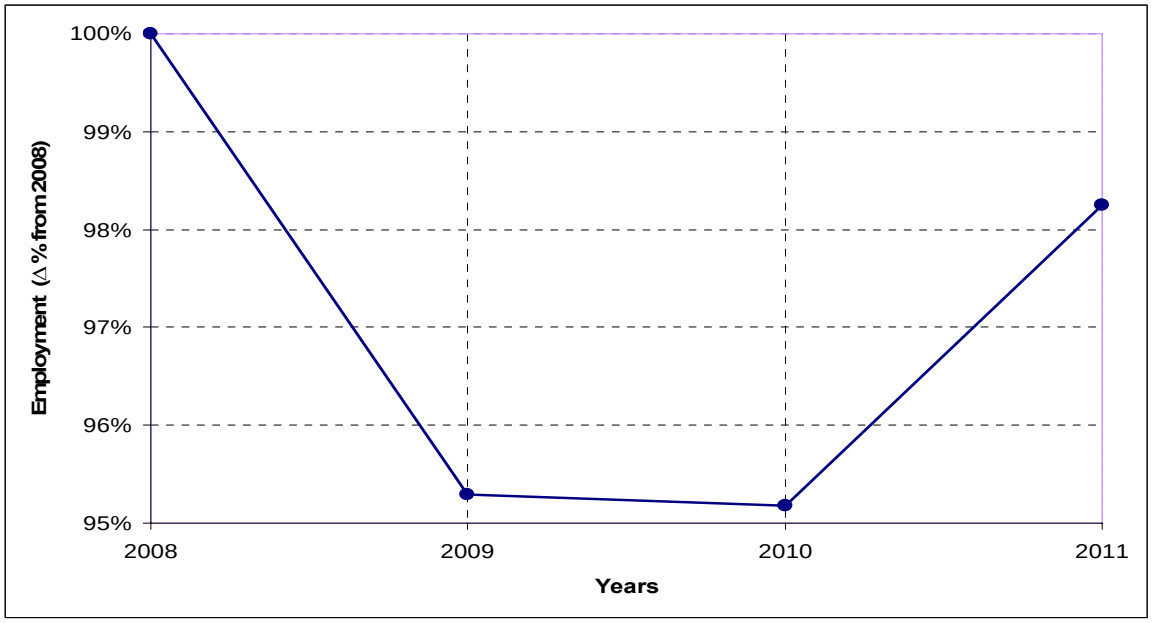

Figure 4.2 The time path and dynamics of the GDP resilience for the Abruzzo region

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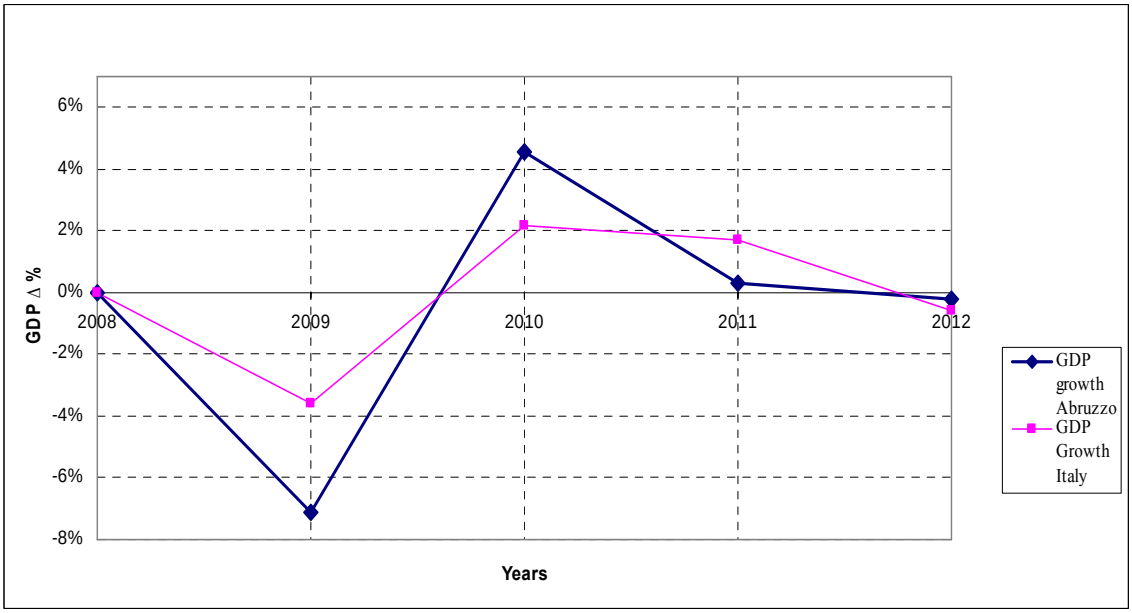

Figure 4.3 - GDP % Variation for Abruzzo and Italy (2008-2012)

The same phenomenon occurred after the Umbria-Marche 6.1 Mw - earthquake (1996), where the GDP of the two regions presented, in the year immediately after the earthquake, like in the Abruzzo case, a greater average growth than the national one (Umbria 5.37%, Marche 4.89%, Italy 4.38%). The results are shown in Figure 4.4.

Another macroeconomic indicator that is taken into account in this analysis is the employment rate. The labor market for the Abruzzo region, does not look so "reactive", except the province of L'Aquila. In 2008, year before the earthquake, the number of employed people for the region was 517,960.

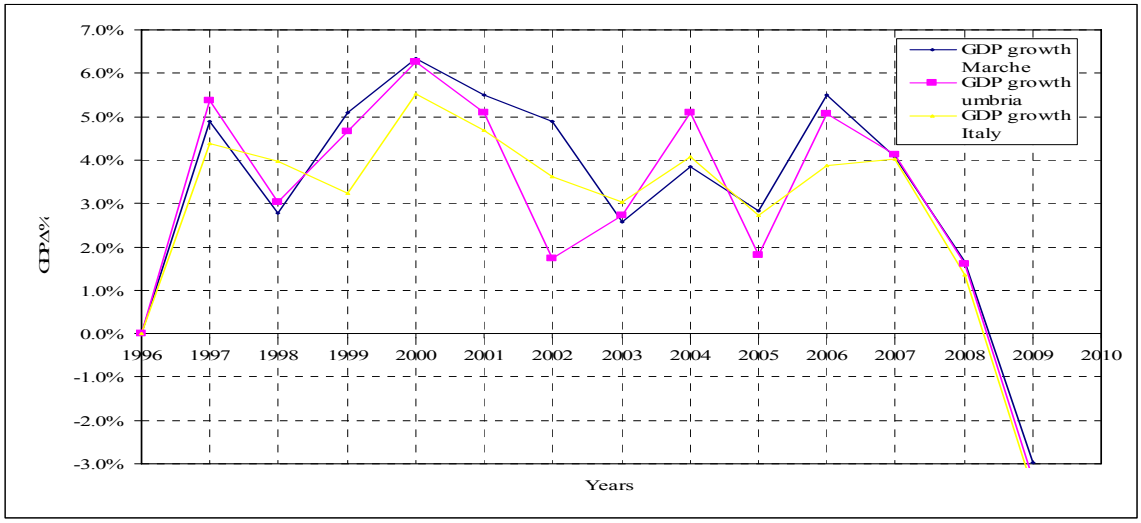

Figure 4.4 GDP % variation for Umbria, Marche and Italy (1996-2009)

At the end of 2009, the Abruzzo region experienced a loss of 23,810 jobs. This "haemorrhage" seems to be ended in 2010 when the fall from the previous here was just of the 1% (about 600 unities). The data about the employment rate in the Abruzzo region, are shown in the table 4.1.

Table 4.1 Abruzzo Employment Growth path from 2008 and its yearly variation

Years	Employment (in thousands)	Δ % Employ. from A_{-1}
2008	517,96	
2009	494,15	-0.0470589
2010	493,55	-0.00121494
2011	509,00	0.03082385

Also for this indicator, the resilience path for employment is constructed (Figure 4.5)**.** It shows that in 2011 the employment rate is coming back to the initial state-level (2008). After the big downturn of 2009, in fact, it is clear from the analysis that in 2011 the employment rate reached the 98.2% of the 2008 level (year before the earthquake).
For the Abruzzo region, more optimistic signs are given by the service sector. In 2009 in fact, this sector registered 7,000 jobs more than 2009. Looking at this cyclic dynamics there are some structural "knots" for which the actual polices had no effects. In fact, clear criticalities concerning the jobs for women and young people still persist.

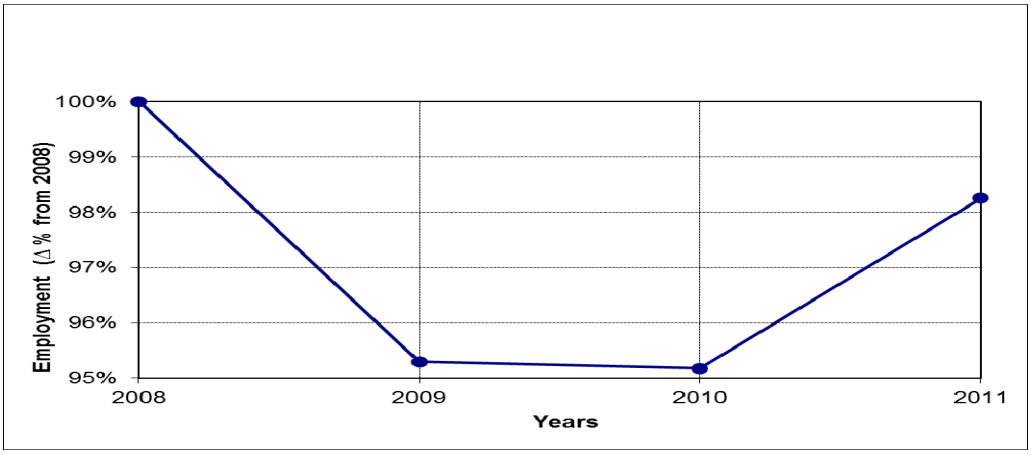

Figure 4.5 The Employment rate resilience path – Abruzzo region

4.2 Social aspects

The same study conducted for economic indicators, is run for social indicators. The first indicator that we would like to analyze is the demographic one. In contrast with what may been thought, between 2009 and 2010, the population in the main crater's municipalities grew, but at a slower pace than the 2002-1012 decade. Despite the migratory balance, i.e. the difference between the people present in the residents register and the ones deleted from there has always been positive even after the big earthquake, from august 2009 the "migratory-population" started decreasing. This contraction was due in part to the fact that the national and regional aids were delivered just to residents, so people who resided there for work-related reasons did not benefit from them, and most of all due to the displacement of lots of university students that have been the main engine for the positive residents growth rate in the previous years.
From the 27,168 applied students of 2008, L'Aquila university saw just 22,495 students in 2010, a reduction caused by the fear of the new freshmen who saw 8 students dead for the dorm collapse (Table 4.2).

Table 4.2 L'Aquila university applied students from 2008 and its yearly variation

Years	Enrolled students	Var % A_{-1}	Var % 2008
2008	27,168		
2009	21,463	-0.23	-0.23
2010	22,945	0.07	-0.17
2011	24,723	0.07	-0.09

This number, that we consider in this research as a proxy for a social and a psychological indicator, seems to be quite resilient despite the huge fall in university applications in 2010. From the available data in fact, the university of L'Aquila recovered the 91% of the applications for the academic year 2011-2012 . It was expectable that a lot of students would have moved to another city because of the collapse of the dormitory, but thanks to the incentives from the Abruzzo's region institutions, the "migration" was arrested.

5. CONCLUSIONS

Resilience against earthquakes is a broad concept that requires a multi-disciplinary response and it must be set in motion and maintained by a collective effort that involves all stakeholders and people who are at risk in high seismic areas. In the present context, the word resilience is referred to the propensity of human and socio-economic systems to suffer a harm as a result of major hazards.
From the empirical study conducted in this work, it is clear that the resilience for the economic indicators for L'Aquila region is taking place and that the slow pace at which the economy is reviving is mainly due to the national economic crisis. What it is worth underlining, is that comparing the L'Aquila earthquake to previous Italian earthquakes, in particular with the Friuli one (1976), the hypotenuses of the resilience triangle is steeper for the four years subsequent to the earthquake. Another important point is that we find "acceptable" the theory of *creative destruction*. An earthquake has, in many cases, been the engine of the economic expansion. The building sector had great expansion after the earthquake, helping the regional GDP that saw a higher growth compared to the national GDP growth. The role of the investments for the reconstruction, together with the public spending, played the bigger role in the regional GDP growth in the aftermath of the analyzed Italian earthquakes.
The other indicator that seems to be resilient, is the social one i.e. the number of enrolled university students. The data are available just for a short period of time but in just two years, the university of L'Aquila recovered the 91% from the year of the disaster.

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