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THE FISCAL IMPACT OF THE DIRECT LOSSES CAUSED BY A FUTURE EARTHQUAKE TO THE PUBLIC BUILDINGS IN ROMANIA

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Abstract: *Public buildings and infrastructure from Romania are exposed to risk of earthquake damage. The Disaster Deficit Index (DDI) is a measure of the Government capacity to cover such losses. Modelling undertaken shows that the DDI value for damages caused by an earthquake from Vrancea area to public buildings belonging to the state is high at 2.51. At the present, the Government does not have enough resources available to meet the rehabilitation and reconstruction costs. The best way to remedy this situation within a short time-frame is to include public buildings in the existing system of compulsory insurance.*
Key words: *earthquake, public buildings, damages, disaster deficit index, Romania*

1. INTRODUCTION

Romania is seismically active, earthquakes with low intensity are happening almost daily. Most of these earthquakes are neither felt by the population nor produce material damages. However, the seismic intensity zonal map of Romania includes values between 6 and 9 on the Medvedev-Sponheuer-Karnic (MSK) Scale of 1964 whose value range is 1 to 12. This indicates that the Romanian seismic hazard is medium to high. In Romania, the highest seismic hazard is created by destructive earthquakes of intermediate depth in the Vrancea area. This area was responsible for the strongest earthquakes occurring during the last century: 10 November 1940, magnitude Mw 7.7, 4 March 1977, magnitude Mw 7.4, 30 August 1986, magnitude Mw 7.1 and 30 May 1990, - magnitude Mw 6.9 (www.infp.ro).

The social and economic impact of earthquakes from Vrancea area can be extremely severe. For instance, in the earthquakes from 1940 and 1977 2,621 people were killed while material losses were about USD 2.0 billion (http://www.emdat.be).

Most damage from earthquakes are to public buildings and public infrastructure such as roads, bridges and railways. Rehabilitation and reconstruction cost significant amounts. Since they are not covered by insurance, the fiscal impact on the state budget, which is the main source of funding of these losses, is very high and may create a financing gap, with macroeconomic imbalances in the medium and long term.

The potential fiscal impact of earthquakes on public finances can be measured using the Disaster Deficit Index (DDI). This research applies the DDI measure to Romania and seeks ways of increasing economic resilience. In order to establish the DDI value, we developed a case study which had as its main objective the estimation of PML for public buildings belonging to the state in case of earthquake in Vrancea area.

2. DETERMINING THE DISASTER DEFICIT INDEX IN CASE OF AN EARTHQUAKE

The DDI is a tool to evaluate the capacity of a Government to cover the losses caused by earthquake, at a certain moment. It is based on the relation between the demand for resources to cover the maximum probable losses – PML, and the economic resilience, ER, of the public sector, expressed in financial terms (Cardona et al., 2008), according to the formula No.1:

$$DDI = \frac{PML}{ER} \tag{1}$$

Economic resilience (ER) expresses the availability of internal and external resources that can cover the losses caused by an earthquake with a particular PML to public buildings and can be calculated according to the formula No.2:

$$ER = \sum_{i=1}^{7} Fi \tag{2}$$

where *Fi* represents the internal and external financial resources that the Government can gather for financing the post-disaster reconstruction process, and as an owner of the affected assets. A low value of ER shows a limited possibility of mobilizing of resources, and as a consequence, leads to an increase in DDI value; while a high value of ER leads to decrease in DDI value. A value of DDI higher than unity, expresses a negative fiscal impact upon the state budget or the inability of a Government to cover losses respectively a low economic resilience, while a value equal to unity, or less than that for DDI, indicates a high economic resilience.

In calculation of the DDI, two steps were required: the estimation of the PML and the determination of ER.

To estimate PML, IDRMS, the catastrophe risk model developed for Romania by RMSI Private Ltd, has been utilized. It was built to assist in the design and implementation of the mandatory insurance scheme for floods, landslides and earthquakes. The model incorporates the main determining elements of disaster risk: hazard, exposure and vulnerability (Birkmann, 2006), according to the formula No.3:

$$Risk = Hazard \times Exposure \times Vulnerability \tag{3}$$

Data processed in estimating the PML included for each building: the material of construction, the year of first use, the number of floors, the type of construction and the developed area, as well as the replacement cost/square meter. This data covered 2.777 public buildings from 16 counties and Bucharest, all of them situated within seismic influence of the Vrancea area. Using this model, the estimated PMLs for different recurrence periods of earthquakes was estimated, and is presented in the Table No.1.

Total Exposure	3,831,835,527 €	-
Recurrence period (years)	PML (€)	% of losses in Total Exposure
1,000	260,773,096	6.81
475	229,288,768	5.98
250	208,370,829	5.44
100	132,274,044	3.45
50	65,516,807	1.71

Tab. 1. PML for public buildings belonging to the state

The data for PML estimation were gathered at commune level, for each county, from the Ministry of Public Finance. In some cases, due to the lack of necessary data, it was needed to estimate them, thus limiting, in small measure, the accuracy of the estimated exposure value. The results of modelling showed that the direct losses may be to 6.81% of total exposure value for an earthquake with a return period of 1,000 years. This value depends directly by the seismic vulnerability of public buildings which depends, in turn, mainly on the material of construction, the year for first use of building, the number of floors and the shape of constructed area.

Two patterns in the seismic vulnerability of public buildings have been identified. The first pattern of higher vulnerability includes older buildings, built before 1964, and those using low quality materials – masonry, wood, and adobe (25.81% of the total buildings number). These were more affected by the earthquakes in 1977, 1986 and 1990 because of their lower resistance. On the other hand, the second pattern comprises buildings that were built after 1977, when the design and building codes were improved (55.42 % of the total number of buildings) and also has a larger share of buildings built with materials of a very good quality (43.16 % from the total number of buildings). The study highlighted that is that 56.58% of total losses are expected to occur in Bucharest, a city whose population represents only 9.06% of the total population in Romania, as at 01 July 2010 (http://www.insse.ro).

On the basis of this data, the DDI for Romania was determined, as is presented in Table 2, taking the PML of an earthquake with a return period of 100 years and the Government's current ability to cover potential losses.

Details	Code	Value (mil. €)	% in PML
Probable maximum loss	PML	132.27	-
Insurance and reinsurance	F_1	0.00	0.00
Reserve fund	F_2	1.67	1.26
Aids and donations	F_3	3.31	2.50
Increased taxations	F_4	0.00	0.00
Budgetary reallocations	F_5	47.62	36.00
External credit	F_6	0.00	0.00
Internal credit	F_7	0.00	0.00
Economic resilience	ER	52.60	39.76
Disaster Deficit Index	DDI	2.51	-

Tab. 2. DDI for public buildings belonging to the state

A value higher than unity for the DDI at 2.51 shows the vulnerability of Romania. An earthquake in the year ahead causing damages of €132.27 million would have a very high fiscal impact upon the state budget because Romania has a low ER. This is due to the fact the internal and external resources available to be mobilized in a short period of time by the Government can cover only up to 39.76% of the funding needed for rehabilitation of public buildings affected. Of these resources, 93.7% would come from the state budget (F_2+ F_5 in Table 2). The reserve fund and budgetary reallocations values were approved for 2011 through the annual budget law.

The basis for estimating F_3 was the ratio of the amounts received by Romania from the EU Solidarity Fund following the floods of 2008 and the total economic losses recorded: this ratio was 2.5%.

Because public buildings are not covered by insurance, there are no ex-ante arrangements for financing losses to them from disaster damage. Financing based on internal and external credits as well as the increased taxation (F_1, F_4, F_6, and F_7 in Table 2) affect economic growth, and do not contribute to increase in the ER.

In conclusion, with a DDI value of 2.51, Romania shows a high financing gap with a negative fiscal impact upon the state budget in case of an earthquake in Vrancea area.

3. SOLUTIONS FOR REDUCING THE FISCAL IMPACT IN CASE OF AN EARTHQUAKE

The financing gap of €79.67 million or 60.23% of the PML remains to be covered. To achieve fill the gap there are two options: reduce the PML by mitigating earthquake risk such as strengthening of buildings which is a costly and long-term solution, or improve of the ER using additional financing resources, which is a more practical solution.

The best option, in terms of cost, would be the inclusion of public buildings into the existing system of compulsory insurance, thus transferring the earthquake risk from Government to the Insurance Pool against Natural Disasters in Romania (PAID), whose main objective at present is the compulsory insurance management of dwellings. Other sources such as the use of internal or external credits or an increase the level of taxes are disadvantageous solutions because in the post-disaster stage the cost of capital is more expensive, and the country's debt service would be affected. On the other hand, raising taxes may discourage private investment (Cummins & Mahul, 2009) and have a negative impact on economic growth.

4. CONCLUSION

Although the vulnerability of public buildings overall has declined since 1977, in the event of a devastating earthquake public buildings will suffer important losses. Most of buildings from the impact zone built before 1964 would be destroyed or severely damaged. The best way to reduce the impact on the public finances of losses suffered due to damage to public buildings and to avoid macroeconomic imbalances is to include all public buildings in the existing compulsory insurance system. Because of lack of data and difficulties in on estimating the exposure value of public infrastructure and public buildings belonging to the local authorities, the case study has taken into account only the direct damages suffered by public buildings belonging to the state. Also, indirect losses such as the social costs of disruption of governmental services does not include in this research. Thus, the DDI for all public property is higher still and from a macroeconomic and financial perspective, the country risk of Romania in case of a catastrophic earthquake is greater. The estimation of DDI, for all public buildings, to implement a disaster risk financing strategy is the next step.

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