challenges and potential future collaborations are also presented.

ESC2018-S34-855

LONG-RUN IMPACTS OF EARTHQUAKES ON ECONOMIC GROWTH

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The social science literature has so far not reached a consensus on whether and how earthquakes actually impact economic growth in the long-run. The same is true for most types of natural disasters in general. The long-run impacts of natural disasters on economic productivity have been widely discussed by the literature. The conclusions range from significant sizable negative impacts on growth to even positive impacts. However, studies that sufficiently take into account the physical nature of a natural hazard are scarce. Some progress has happened for other natural hazard types, such as cyclones. Nevertheless, in the case of earthquakes the predominant use of inadequate measures for the exogenous natural hazard of an earthquake is still a weakness in the literature. The most common problems are the lack of individual event size (e.g. earthquake dummy or number of events), the use of magnitude instead of a measure for surface shaking, and endogeneity issues when traditional qualitative intensity scales or actual impact data is used. This study uses strong ground motion data to tackle this weakness in the literature. Peak ground acceleration (PGA) is used as the ground motion intensity measure to investigate the impacts of earthquake shaking on long-run economic growth. I construct a data set from USGS ShakeMaps that can be considered the universe of global relevant earthquake ground shaking from 1973 to 2015. This data set is then combined with World Bank GDP data. A panel dataset of country-year observations of earthquake shaking and economic variables from 1973 to 2015 is constructed and the random within-country variation of shaking over years is exploited to identify the causal effect of earthquakes on economic growth. The econometric analysis is similar to the approach of Hsiang and Jina [1], who investigate the impact of cyclones on GDP. Furthermore, the impacts of earthquake shaking exposure on different industries and countries of different income levels is investigated, which can help to identify the mechanism of how earthquakes impact long-run growth. The results confirm that natural disasters do have a significant negative overall impact on GDP per capita years after an exposure. In particular, the results suggest a reduction in GDP of almost 2% 8 years after an average non-zero exposure. A comparison with an approach that uses magnitude instead of shaking data shows that using actual shaking data is crucial to identify the impacts of earthquake exposure. Unlike the findings of Hsiang and Jina [1] the results here suggest that the impacts are primarily incurred by low and middle-income countries and that high-income countries are potentially even able to experience positive "building back better" effects. Additionally, the importance of the spatial pattern of the natural hazard is discussed and empirically evaluated. I find that impacts are primarily driven by (local) high intensity events and not by spatially large exposure to lower intensity shaking. This result combined with other considerations suggest that the different natural hazard types might require systematically different approaches in how they are integrated in a quantitative model to study impacts, due to the geophysical differences between them. Particularly the inherent spatial pattern of a natural hazard and how it relates to the underlying assumptions of a spatial aggregation approach need to be considered. To my knowledge, this is the first application of global earthquake shaking data to investigate long-term earthquake impacts. This study illustrates how strong ground motion data can be used in social sciences to address questions on the socio-economic implications of earthquakes.

[1] Hsiang, S. M. and Jina, A. S. (2014). The Causal Effect of Environmental Catastrophe on Long-Run Economic Growth: Evidence From 6,700 Cyclones. National Bureau of Economic Research, No. w20352.

ESC2018-S34-872

SITE CHARACTERIZATION DATABASE OF INGV ITALIAN SEISMIC NETWORK

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A critical issue in the performance of a seismic network is the characterization of site response where stations are located. This information is essential to improve some aspects related to seismic surveillance and the publication of products in near-real time following an earthquake. A proper evaluation of the site effect is also necessary to improve the quality of recordings databases, facilitating their use for research purposes. The Italian National Seismic Network of the INGV (Rete Sismica Nazionale, RSN) consists of about 400 seismic stations equipped with a velocimeter and, for one-third of the sites, an accelerometer. They are connected in real time to the INGV data center in order to locate earthquakes for civil defense purposes and their records are distributed through the EIDA node (eida.rm.ingv.it/). Recently INGV has addressed the site characterization of RSN with an internal project (funded within the INGV research line T3 "Seismic hazard and contributions to the definition of risk"), as well as within the INGV-DPC Agreements (INGV-DPC Agreement 2016-17-18, Annex B2 Objective 1 - Task B "Characterization of accelerometric sites", funded by the Civil Protection Department), with the purpose of characterizing the seismic response of all the stations acquired in real time by its data center. The basic goal is building a geographic relational database, integrated with the other INGV infrastructures, designed to archive homogeneous parameters through the seismic network useful for a complete site characterization, including housing, geological, seismological and geotechnical features as well as site and topographic class according to the European and Italian building codes. The system resides on a dedicated server and the data are organized in an internal storage based on PostgreSQL DBMS (acronym CRISP). It will be directly related to SeisNet, the INGV database used for the network management, but it is still possible to insert new sites not belonging to the RSN. The backend of the system includes several procedures that allow the information updating through web services created ad-hoc, such as those of the Institute for Environmental Protection and Research (ISPRA) for geological and lithological attributes and for visualization of geological maps and related legends. On the other hand, specific programming interface services – API- expose the shared information to allow the transfer to other strong-motion data providers (e.g. ITACA, http://itaca.mi.ingv.it, and ESM, http://esm.mi.ingv.it) in semi-automatic way. The collection of geological, morphological and seismological data followed a nationwide approach, aimed at obtaining homogeneous data for the RSN sites. We started from the revision of all available geological and geophysical data and the analysis of noise waveforms, storing the analysis results as images and searchable data. Thanks to the collaboration with the Geological Survey of Italy (ISPRA-SGI), a review of the geological map of Italy (at a scale of 1:100,000 and 1:50,000) and their relative explanatory notes, including also many other available published data (borehole logs, local geographical portal, etc.), allowed to develop a stratigraphic conceptual model under each site. As for the attribution to each site of a topographic class according to the Italian building code, a morphometric analysis using an automatic procedure has been carried out on two DEM datasets with resolution at 30 m and 10 m. Regarding the seismological parameters, noise velocimetric records at all the stations were homogeneously analyzed by using mostly continuous data, as follow: 1) estimation of data quality with annual and seasonal noise analysis; 2) selection of noise traces (day/night and seasonal), horizontal-to-vertical spectral ratio computation and determination of directionality of the amplification peaks; 3) in case of directionality, we proceeded with the polarization analysis of the signal to identify the preferred direction of the movement, slope and straightness. A preliminary statistical analysis highlights that only 26% of the RSN accelerometric stations do not have amplification peaks, while 29% show a polarization of the signal in a preferential direction. Finally, we are collecting all the available information about the station housing, to account for possible soil-structure interaction. The database includes also 15 sites that have been fully characterized by performing a geological survey followed by the 1:5,000 geological and lithotechnical maps, a geological cross section and report, the S-wave velocity profile inferred through seismic noise arrays and, for one site, downhole measurements. With the contribution of the Site-Characterization Team: S. Amoroso, R. Azzaro, R. Bianconi, M. Cattaneo, R.

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