Differing economic impacts and policy requirements of earthquakes, floods and storms: A case study of Nicaragua

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1 Introduction

Each year, more than 700 major natural catastrophes shatter lives, destroy assets, and disrupt communities across broad geographic regions. The frequency and cost of these events are rising. In the past decade the number of events has tripled, while economic losses have risen by a factor of nine (MunichRe 1999). A study by Munich Reinsurance Company indicates that losses are unevenly distributed among catastrophe types. Floods account for 47 percent of economic losses, followed by windstorms (38 percent), and earthquakes (one percent of economic losses) (MunichRe 1999). These hazards impose different costs on an economy and require different policy responses. This analysis, which uses Nicaragua as an example, shows that the nature of hazard risk combined with the macroeconomic characteristics of a country affect the cost and policy response for different types of catastrophes.

Different events have different policy requirements. As hazard modeling tools have improved, and with the development of a model at IIASA which estimates the economic impacts of natural catastrophes, it is possible to foresee and account for disaster impacts in the economic planning process. To make this planning meaningful the impacts of different types of events, governments must address public risk management strategies of different natural hazards. This involves identifying the impacts of events on public assets, the response capacity of private agents, and the government's role in resource (re)distribution.

A government faces at least three sources of risk from different types of natural catastrophes. First, the government bears the financial risk of damage to public assets such as infrastructure. Next, the government faces the cost of assuming the risk of other economic agents, such as cases in which market failure occurs. Finally, the government faces the financially difficult task of wealth and resource redistribution following a disaster. Each of these sources of risk requires public decisions on the level of risk the government can assume, the available resources to pay for the risk which the government assumes, and the most efficient and equitable means to use those resources.

2 Methodology

The first step is to estimate the overall exposure to all types of natural disasters. For this purpose, one must first measure both the expected severity and the expected frequency of all catastrophic events. One must then develop a methodology to integrate this loss exposure with the expected macroeconomic conditions of the country when the catastrophe strikes. For the research partnership's evaluation of hazard risk in Nicaragua, Swiss Re conducted studies to estimate the country's potential losses from hurricanes, floods, earthquakes, and landslides. Swiss Re derives its estimates of potential losses using geological and meteorological models and its extensive databases of historical catastrophic events and resulting economic losses. The annual expected loss is the sum of all the possible losses weighted by the probability of each loss occurring in a given year. The annual expected loss represents the amount of money that on average will need to be set aside every year to fund catastrophic losses when they occur. Swiss Re's loss figures estimate the direct costs of natural catastrophes. Long-term development impacts of catastrophes depend on how direct stock losses lead to indirect and secondary flow losses depending on the country's capacity to absorb losses (cf. figure 1). IIASA developed a catastrophe module to incorporate Monte Carlo simulations sampling from Swiss Re's loss-frequency distribution into the World Bank's macroeconomic projection model RMSM-X. In this national accounting framework, the CAT module analyses sources and uses of financing post-catastrophe reconstruction. In order to shock the capital stock and effective labor force with simulated catastrophe events, the module contains a Cobb-Douglas production function with both capital and labor inputs.

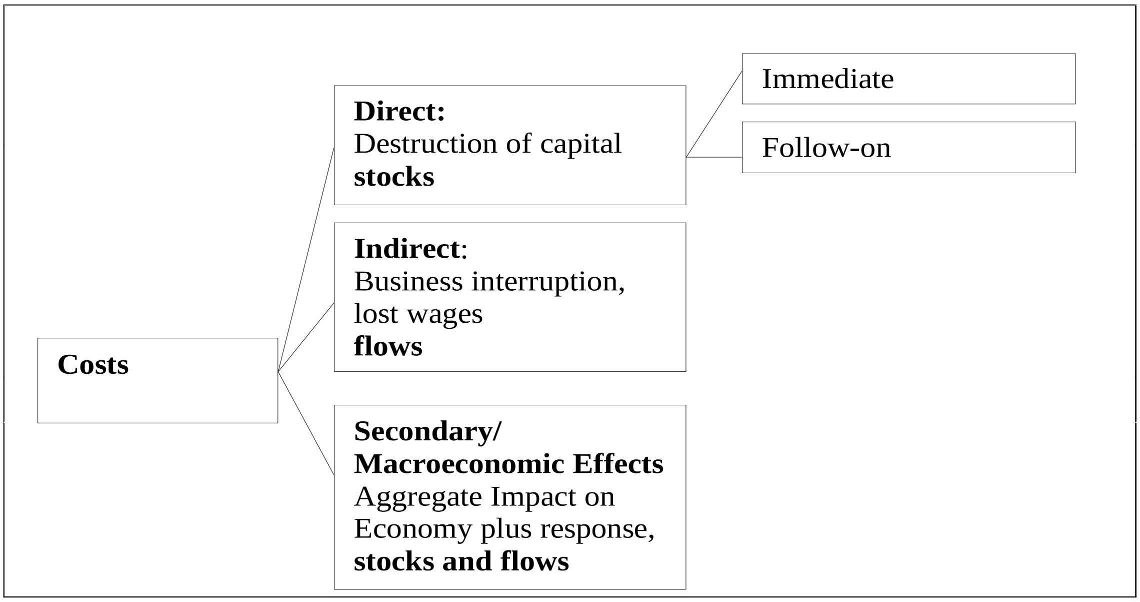

Figure 1: The different costs due to catastrophes

3 Costs differ for types of events

In addition to estimating the overall economic costs due to all types of disasters, analyzing the impacts of different events can provide useful information. In general the physical impacts of earthquakes, tropical cyclones, and floods differ in the following ways (Otero/Marti 1995):

- Earthquakes affect constructions (factories, public and social buildings), roads, bridges and *underground* structures. They cause minimal damages to agriculture.

- Tropical cyclones affect structures, break and interrupt lifeline infrastructure. They cause *above ground and underground* damages due to wind or flooding of conduits. They have heavy impact on agriculture.
- Floods do minor damage to structures and lifelines, but heavily impact agriculture.

For the case study of Nicaragua, direct loss exposure due to earthquakes and floods and storms was estimated. While the expected annual costs due to earthquakes (9 million USD) were lower than for floods and storms (11million USD), the expected portion of infrastructure affected was also lower for earthquakes (9% vs. 25% of total damages). The lower absolute amount and lower proportion of infrastructure damages has implications for the magnitude of indirect and secondary damages. As infrastructure is considered a complimentary production input to the other inputs capital and labor (Worldbank 1994), infrastructure loss and failure to immediately reconstruct will have negative production and distribution effects. For earthquakes in Nicaragua these indirect costs will thus be smaller than for floods and storms.

The secondary costs, the ripple effects in the economy triggered by the indirect effects and the costs due to additional reconstruction efforts, will also be smaller for earthquakes because indirect damages tend to be lower. Second, infrastructure reconstruction costs to the government tend to be lower in the case of an earthquake. As a consequence, a government facing earthquake risk will likely need fewer additional domestic (taxation) or external (borrowing, insurance) resources than it would if faced with other types of natural catastrophes.

4 Policy responses differ

Knowing the type and exposure to disaster aids a government in choosing the appropriate policy response. Policy responses to different events vary. The methodology outlined above, combined with improved natural catastrophe modeling techniques, allows incorporation of estimated catastrophe losses into the general economic planning process. The ability to separate the different costs of various events allows a government to prepare appropriately, both in terms of mitigation as well as having the necessary post-catastrophe resources available for emergency response and reconstruction.

The methodology creates a basis to evaluate different tools to address hazard risk. Once different hazard exposures and the macroeconomic impacts of these potential hazards is assessed, policy makers can begin to evaluate different pre- and post-event hazard responses. This can occur in terms of event mitigation, which differ significantly according to the type of hazard exposure anticipated and in terms of resources needed to alleviate the impacts of the event. For floods, ex ante mitigation efforts may focus on policies that encourage settling and construction of infrastructure in areas less exposed to flood waters. For earthquakes ex ante mitigation efforts may focus on fitting building codes. Each event affects infrastructure and populations differently, making it important to employ different policy responses. The methodology reveals the different costs of various events and allows policy makers to anticipate the costs and impacts, which in turn plays an important role in successful response to natural catastrophes.

References

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