Financial fragility and natural disasters: An empirical analysis

Jeroen Klomp *

Wageningen University, The Netherlands

ABSTRACT

Using data for more than 160 countries in the period 1997–2010, we explore the impact of large-scale natural disasters on the distance-to-default of commercial banks. The financial consequences of natural catastrophes may stress and threaten the existence of a bank by adversely affecting their solvency. After extensive testing for the sensitivity of the results, our main findings suggest that natural disasters increase the likelihood of a banks' default. More precisely, we conclude that geophysical and meteorological disasters reduce the distance-to-default the most due to their widespread damage caused. In addition, the impact of a natural disaster depends on the size and scope of the catastrophe, the rigorousness of financial regulation and supervision, and the level of financial and economic development of a particular country.

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1. Introduction

In 2001 an alarming report was published by the UNEP Finance Initiatives on banking in the wake of large-scale natural catastrophes.[1] The main message of this report was that the growing trend in the frequency and intensity of these severe natural events has the potential to stress and threaten banks to the point of impaired viability or even insolvency, primarily by increasing the share of non-performing loans, raising the leverage or through the occurrence of a bank run immediately after the disaster. It is, for instance, a well-known fact that there is an outflow of foreign private capital shortly after a disaster has struck as the uncertainty about future repayment increases (Yang, 2008; David, 2011). During the last three decades, there have been about 10,000 natural disasters worldwide, affecting more than 7 billion people, and causing over the $2 trillion in estimated damages, and these numbers are still steadily increasing (EM-DAT, 2013). According to the Basel Committee, natural disasters are considered as an operational risk as it adversely affects the smooth functioning of the various components of the financial system, i.e., financial markets, and payments, settlement and clearing systems (BCBS, 2010).

One common characteristic of any large-scale natural disaster is that it adversely affects large parts of the domestic financial sector at the same moment. To manage these correlated shocks, banking regulators and supervisors require that banks maintain adequate capital reserves. According to the UNEP report, supervisors should include the exposure of a bank to natural disasters in their assessment of these reserve requirements, for example, by connecting internal lending rates with local climatic conditions. Only, banks may be uncertain about their actual exposure to natural disasters, as assessing this complete risk can be quite difficult. For instance, banks are not only affected by the direct impact of a natural catastrophe, but also by the spillovers from the interbank market since banks are highly connected due to their lending activities (Goldberg, 2009; Cetorelli and Goldberg, 2011; Charnobai and Rachev, 2006). As a result, holding too little capital reserves threatens the solvency of the lender when a catastrophe occurs. However, as banks are typically highly leveraged with low capital-to-asset ratios, holding excessive reserves represents significant opportunity costs for lenders (Van Greuning and Bratanovic, 2009).

The existing empirical literature on the impact of natural disasters on the fragility and performance of commercial banks is rather limited and inconclusive. A first attempt was made by Steindl and Weinrobe (1983). They explore if the amount of deposits received by a sample of US savings and loan associations and commercial banks reacted to a number of major floods. Their main results

* Correspondence to: Wageningen University, Development Economics Group, P.O. Box 8130, 6700 EW Wageningen, The Netherlands. Tel.: +31 317482950.
    E-mail addresses: jeroen.klomp@wur.nl, klomp_j@yahoo.com

[1] The UNEP finance initiative is a partnership between the United Nations Environment Program and about three hundred banks, insurance companies and investment firms.

do not provide any significant support for the popular view that shortly after a natural disaster a bank run occurs. In contrast, in some econometric specifications, the authors find even evidence of an increase in the amount of deposits received by these financial institutions in the aftermath. This outcome is rather counterintuitive as one might expect at least some withdrawals of deposits to finance emergency expenditures and reconstruction investments. Skidmore (2001) gives one potential explanation for this outcome in the long run. He explores the effect of an increase in the probability of a future economic loss on savings. His empirical evidence point out that damages caused by natural disasters are positively correlated with household savings rates. This result suggests that households have attempted to self-insure against some catastrophic events as insurance markets have not provided a sufficient level of protection against possible losses arising from natural catastrophes.

In addition, using a panel model including more than 100 countries, Noy (2009) reports a contraction in the amount of credit supplied by banks to the private sector in the aftermath of a disaster as banks become more concerned with the uncertainty of repayment in the future. However, countries with more developed credit markets appear to be more robust and better able to endure natural disasters. Likewise, the results from David (2011) point out that bank lending activities reduce rapidly after a climatic disaster in developing countries. Berg and Schrader (2012) explore the impact of volcano eruptions in Ecuador on the loan demand and access to credit using data from microfinance institutions. Their results demonstrate that while credit demand increases due to volcanic activity, access to credit is restricted. Hosono et al. (2012) go one step beyond and find that an adverse natural disaster shock to bank lending capacity reduces client firms' activity even in an economy with well-developed financial markets and institutions.

Using a simulation approach for Peruvian microfinance institutions, Collier et al. (2013) indicate that natural catastrophes can be considered as a type of systemic risk. Their results indicate that there is a drop in the capital ratio, equity and loan origination immediately following a disaster. The conclusion is strengthened by Collier and Skees (2013) who find, by using a sample of more than 900 microfinance institutions, that there is a drop in the capital ratio when the number of people affected by a natural catastrophe increases.

These studies so far provide only some circumstantial evidence on the relationship between bank survival and natural disasters as they only study specific risk aspects (cf. capital ratios, loan portfolio quality) or activities (cf. credit supply, deposits). In turn, our contribution to the literature is instead that we examine more directly to what extent large-scale natural disasters are accountable for changes in the default risk faced by commercial banks. For this purpose, we use a dynamic panel model including about 170 large-scale natural disasters over 160 countries in the period 1997–2010. Our measure of default risk is based on the distance-to-default taken from the Database on Financial Development and Structure reported by the World Bank.[2] The distance-to-default reflects the number of standard deviations that a bank's return on assets has to drop below its expected value before equity is depleted and the bank is insolvent. In addition, we construct several measures on the frequency and intensity of natural disasters based on the information provided by EM-DAT. We address the potential endogeneity problems of the economic consequences of natural disasters by presenting a system-GMM model.

After extensive testing for the sensitivity of the results, our main findings suggest that natural disasters increase the likelihood of a banks' default. More precisely, we conclude that geophysical and meteorological disasters reduce the distance-to-default the most due to their widespread damage caused. In addition, the impact of a natural disaster depends on the size and scope of a natural disaster, the rigorousness of financial regulation and supervision, and the level of financial and economic development of a particular country.

The remainder of the paper is organized as follows. In the next section, we discuss our theoretical foundation underlying our hypothesis. In Section 3, we describe our data and methodology used, while in Section 4, we present our estimation results on the relationship between natural disasters and the default risk in the banking sector. Finally, we end in Section 5 with our conclusion and discussion.

2. Theoretical foundation

According to the existing literature, the occurrence of natural disasters affects the default risk of banks through various channels (cf. Collier et al., 2011; Collier and Skees, 2012; Berg and Schrader, 2012). To illustrate the impact of large-scale natural disasters on the default risk, we use the different risk dimensions identified by the International Monetary Fund (IMF)'s core set of Financial Soundness Indicators or CAMEL indicators—i.e., capital adequacy, asset quality, management, earnings and profitability, and liquidity (IMF, 2000). The first dimension of risk refers to capital adequacy. According to the IMF (2000), capital adequacy ultimately determines the robustness of banks to withstand adverse shocks to their balance sheets. The reserves of a bank may deplete due to the large write-off of loan losses or the occurrence of a bank run immediately after a natural disaster. As a result, disasters may make banks over-leveraged or even insolvent.

The second risk dimension is related to asset quality. When a major disaster strikes, the degree of asset quality decreases significantly by the death or disability of borrowers. Physical unscathed borrowers may be inhibited to attain earnings and pay interest or principles. An increasing non-performing loans ratio in the aftermath of a disaster therefore signals a deterioration of the quality of the credit portfolio, which increases the fragility of the bank. Besides, asset risk may be also enhanced by the destruction of the collateral used by borrowers to obtain a loan.

The third risk dimension that is identified by the IMF is associated with managerial qualities. A high ratio of expenses to total revenues may indicate that financial institutions are not operating efficiently due to management deficiencies. The increase in the operational risk after a disaster arises from the disruption of the operational activities through physical damages, e.g. the destruction of offices, equipment or information systems, or through indirect implications like the inability of clients to reach offices. The fourth risk dimension is related to the profitability of a bank. After a natural disaster, the profitability of a bank may under pressure due to a combination of the large write-offs, the decrease in efficiency and the increased interbank interest rate as the uncertainty of repayment increases.

The final dimension the IMF distinguishes is liquidity risk. Insufficient liquidity may threaten the survival of a bank after the occurrence of a large-scale natural disaster, notably so in case of severe maturity mismatches. Liquidity risk is tightened in the aftermath of a disaster by missing savings and immediate withdrawals of existing deposits to replace lost physical capital or afford medical care. Those who are not in possession of deposits will probably demand emergency loans, whether they are already existing clients or non-clients.

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[2] One advantage of measuring financial fragility using the *z*-score is that it is rather objective compared to more subjective credit ratings (Demirgüç-Kunt et al., 2008; Demirgüç-Kunt and Detragiache, 2011).