Catastrophe Finance: An Emerging Discipline

While the recent disasters in the world’s financial markets demonstrate that finance theory remains far from perfected, science also faces steep challenges in the quest to predict and manage the effects of natural disasters. Worldwide, as many as half a million people have died in disasters such as earthquakes, tsunamis, and tropical cyclones in the last 20 years. But even more recent disasters may be impervious to market volatility. The evaluation of these new investments requires a scientific judgment of risk.

In academia, the environmental science and finance communities have little opportunity to interact. However, the rapid growth of markets for weather derivatives, cat bonds, and carbon emission trading presents evidence of a market in their domain. The markets constitute a real-world laboratory to support research and education and suggest new career opportunities for graduates.

Catastrophe Finance in the Market

Catastrophe finance is an emerging academic field at the intersection of geohazards and market finance. It analyzes, models, and predicts catastrophes for the efficient transfer of risk through derivatives markets and cat bonds, which allow individuals or corporations to buy and sell risk (see “Transferring Risk” sidebar).

Climate and weather derivatives are currently traded on the Chicago and New York mercantile exchanges. They are also integrated into risk management practices. In 2007 the cat bond market broke a billion in publicly disclosed transactions, up 45% from the previous year’s record of $4.7 billion and a 25% increase over the $2 billion placed during 2005 (Gray Congner, 2008). This is expected to increase at a compound annual growth rate (CAGR) of approximately 21% (as per Beach, 2007). There is an interesting silent partnership in the amount of property and casualty and the amount of available insurance and reinsurance capital globally. Rising to Keesen Schmidt, a partner at Nephila Capital, a Bermuda-based hedge fund specializing in insurance risk, cat bond prices are relatively immune to general market sentiment (bull and bear markets). In fact, the correlation between cat bond prices and the DJIA is extremely weak, as market slumps will not lead to more severe hurricanes (or earthquakes).

But more frequent or intense natural disasters are only a piece of the picture—even a weak earthquake can cause damage if a community has poor infrastructure. Thus, insurance against earthquake damage in seismic regions with poor infrastructure would likely come with a high premium.

The Need for Specialists in Catastrophe Finance

While the growth of cat bonds has been relatively rapid, it remains constrained by the investment community’s general lack of familiarity with quantifying the risks of a hurricane or earthquake catastrophe. Greater education in understanding the physical mechanisms behind the risk and in evaluating the probability of loss is needed in order to fully functioning and liquid market for these trading instruments.

The requisite education involves the combination of geosciences and environmental sciences and modern finance, particularly derivatives. These disciplines are similar in their reliance on applied probability, which should make it straightforward to combine them into a coherent whole. The ability to integrate financial and risk management will allow an education program to achieve a sharp focus while it uncovers new opportunities for research in each discipline.

According to John Rollins, vice president of AIR Worldwide, a leading risk-modeling company, companies exposed to hazard risks are now appraisingly seeking well-trained, well-rounded risk managers with strong back- grounds in insurance, finance and environmental sciences and technology. In fact, the insurance industry is at a crossroads. As the trends of smaller, more sophisticated insurance companies and computer modeling to assess the risk in a portfolio of catastrophe risks become more prevalent, the need for new professionals will rise.

The logic behind a graduate program in catastrophe finance would bring courses and expertise of environmental sciences and precautionary science into risk management and insurance. Learning outcomes for a graduate program in catastrophe finance would include the ability to analyze and model correlated “random” events, to forecast the viability of catastrophes in geosciences and finance, and to apply knowledge in the insurance, risk management, and investment banking industry. Successful catastrophe finance programs will have faculty and graduates that feel comfortable at the interface of science, finance, and insurance. It would likely provide the career skills and courses needed to succeed in a variety of career paths outside traditional geoscience disciplines, providing trillion opportunities for research in each discipline.

Transferring Risk

Imagine a scenario of a farmer awaiting the rainy season, which typically arrives at the beginning of June. For every month of rain, she earns $300. However, if it does not rain in June, she earns nothing. To mitigate her risk of earning nothing, she makes a bet with a farmer that if it does rain in June, she’ll pay him $25. The risk manager takes the bet, knowing that he will probably win. Thus, when it does rain, the farmer earns $25 and the farmer gets $25. But what happens when people want to buy insurance against a catastrophic event? Imagine an insurer of coastal properties concerned about the next hurricane season. A severe storm happens once every few decades; if the severe storm hits this year, she’ll have to pay out most of her money in claims. To help remain solvent, she could buy reinsurance. Alternatively, she could sponsor a catastrophe (cat) bond, which would pay $25 if no storm hits. An underwriter would buy the bond valued at, say, $300,000; over time, the insurer will repay the bond with, say, 15% interest. The logic behind a graduate program in catastrophe finance can help with the nuts and bolts of putting this idea into practice.

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Cont. on page 282

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Large Subduction Thrust Earthquake Shakes Southern New Zealand

At 9:12 PM local time on 15 July 2009, the largest earthquake in New Zealand in the past 80 years occurred in the southern Fiordland subduction zone of the country’s South Island. The Mw 7.1, 82 km deep event, the largest shallow thrust earthquake in the offshore outer rise has increased by up to 30 kilometers, and it ruptured about 15 July thrusting earthquakes to date. Aftershocks and Stress Changes

In the Fiordland region, the Austra-

lic plate and the overriding plate, with the seaward directivity of the rupture, 

to the earthquake (e.g., http://www.seri.or.jp/topics/200907_newZealand/index_e.html). The earthquake initiated at a depth of 30 kilometers updp and 70 kilometers south-westward along strike, with a maximum slip of about 5.5 meters.

Coseismic displacements measured by continuous GPS stations in the region agreed with the seismological rupture models. The continuous GPS receiver at Puys station, near the fi nger-tip of the Australian plate, was very active, with a series of six large, shallow earthquake (Mw 6.4, 6.8, 6.1, 7.2, and 6.7). In contrast, southern Fiordland had been relatively quiet. The recent earthquake has made up for this quiescence, with the after shock zone of the 15 July abortion thrusting that of the 2003 Mw 7.2 thrust earthquake in the Fiordland Basin.

Main Shock Rupture

Centroid moment tensor solutions for the main shock indicate low-angle thrusting, and the same strike and dip as the shallow part of the plate inter-

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