



USING PYTHON TO DESIGN A PARAMETRIC CATASTROPHIC (CAT) BOND FOR HEDGING AND PREDICT ITS CREDIT SPREAD & RATING

by
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PyData New York 2014

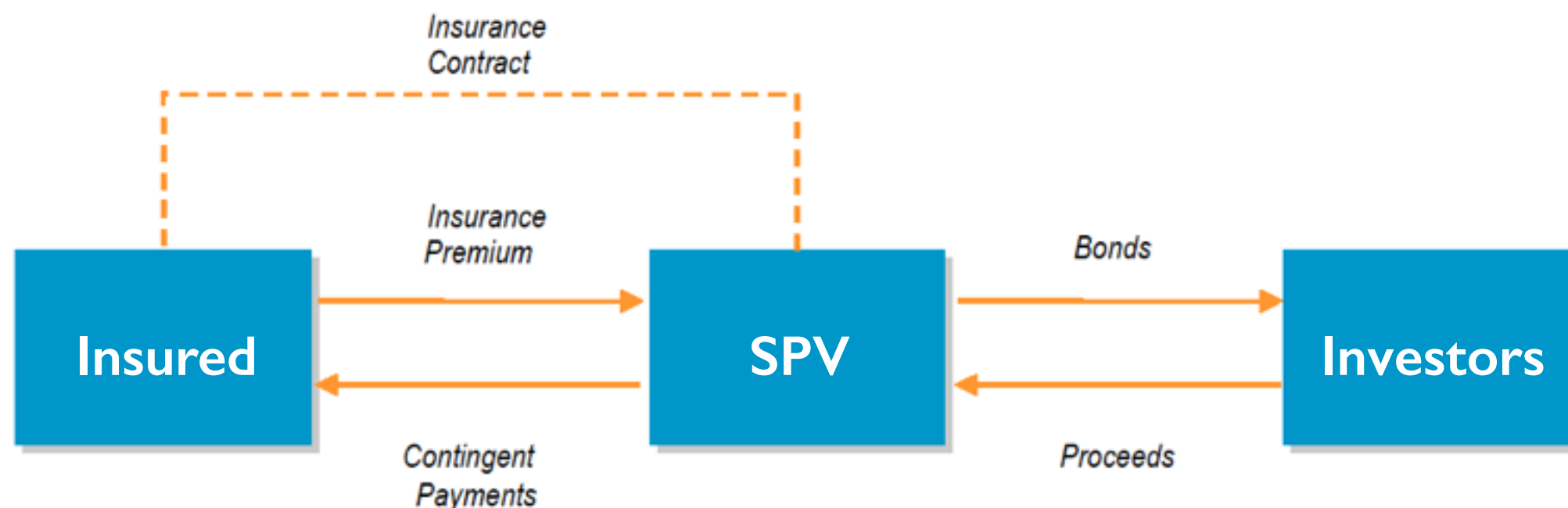


CAT Risk is a type of Insurance Linked Security (ILS)

- ILS is a highly structured security that requires knowledge of financial quantitative analysis plus domain expertise in credit, market, and operational risk, plus engineering (mechanical, civil, etc.), time series analysis and data science.
- ILS returns do not have significant correlation with the market's returns.
- ILS coupon and principal payments depend on a pool or index linked to natural or man made catastrophic risk instead of a credit event:
 - ✓ Earthquakes
 - ✓ Hurricanes
 - ✓ Weather
 - ✓ Windstorms
 - ✓ Terrorist attacks
 - ✓ Oil spills
 - ✓ Satellite launches
 - ✓ Other
- Generally, deals have the principal amount plus coupon payments fully collateralized by risk free and/or highly rated securities, which reduces credit risk.
- Rating of the transaction is isolated from the sponsor's rating, and it is tied to the probability of occurrence of the catastrophe.

Mechanics:

- An offshore special purpose vehicle (“SPV”) is established for the sole purpose of entering into a insurance contract with the insured.
- The SPV issues liabilities to the capital markets to collateralize its obligations under the insurance contract.
- The proceeds from the SPV liability issuance are invested in highly rated securities, i.e: US Treasuries or corporate “AAA” rated securities.
- Earnings on the SPV’s investments as well as the insurance premiums received from the insured are used to cover the coupons on the SPV’s liabilities as well as the SPV’s operating costs.



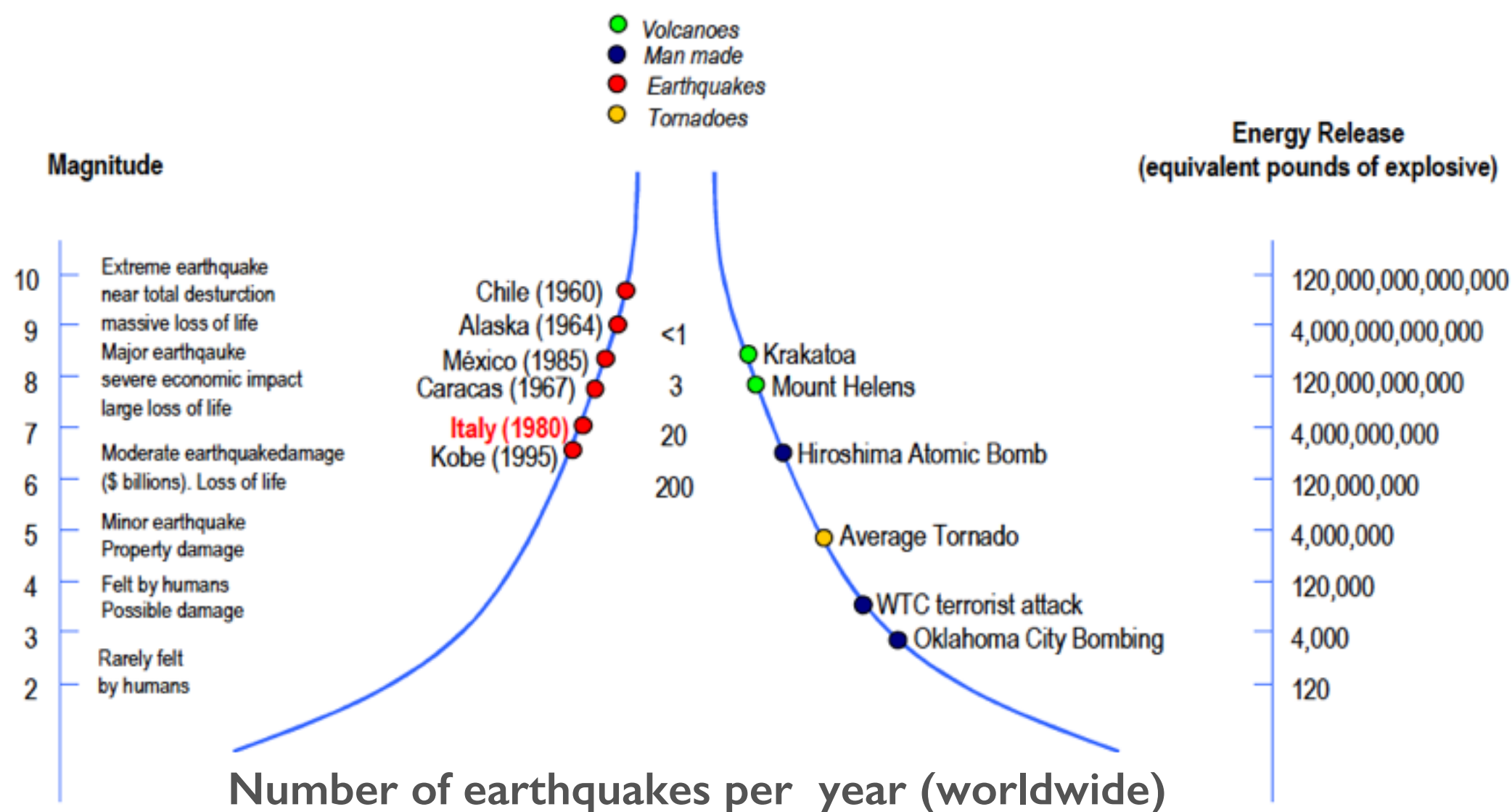
Insurance risk structures

Insurance Risk Structure	Characteristics	Issuer's Concerns	Investors Concerns	Report of Losses
Parametric Structure	Bondholder losses are based on model that takes parameters from the event	Basis risk, if model does not accurately represent the losses of the sponsor	Potential financial gain for the sponsor	Losses based on parameters observed by independent reporting agencies

Parametric bonds: loss triggers

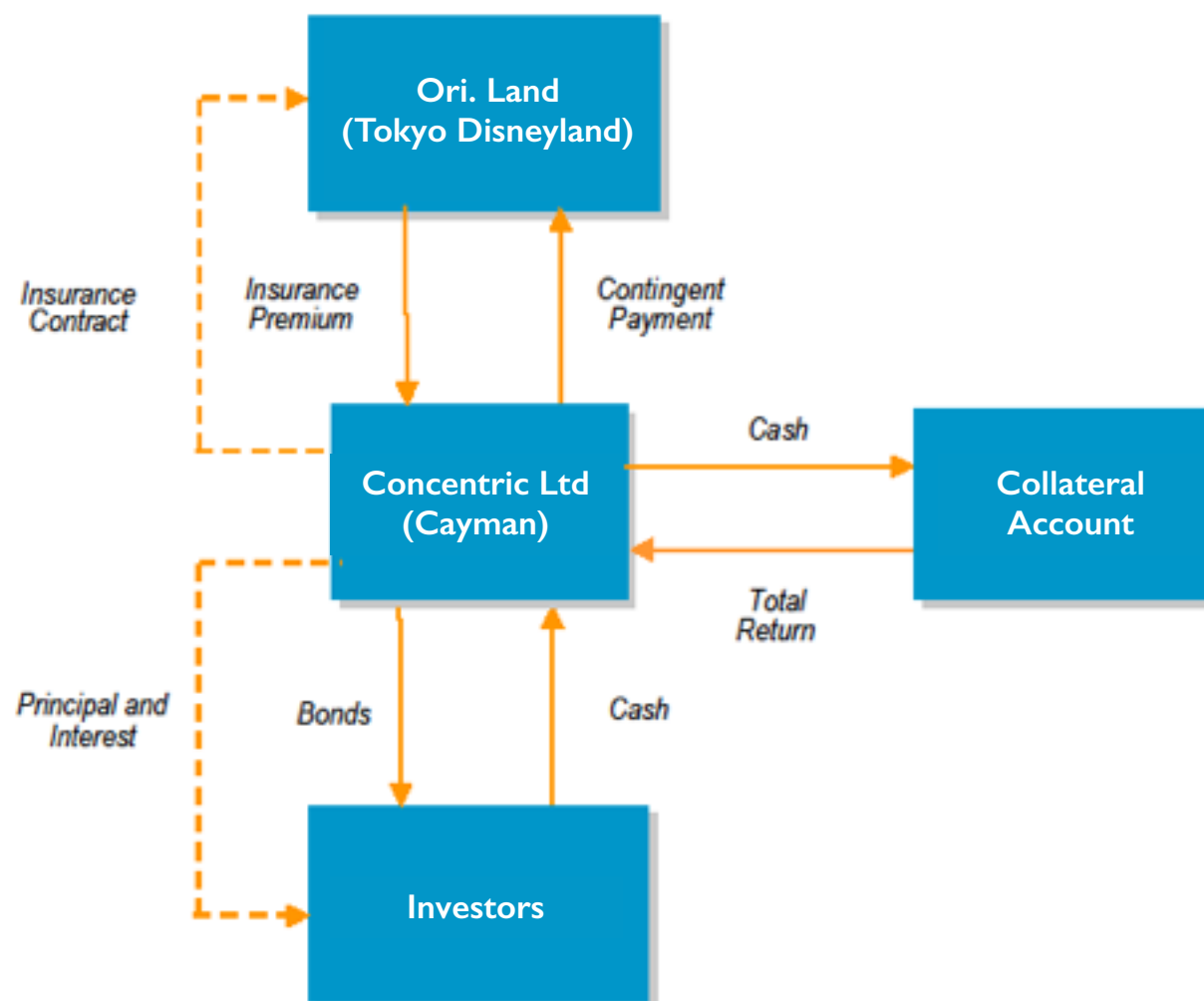
Risk	Parameter	Intermediate steps	Loss to investors occurs when
Earthquake	<ul style="list-style-type: none"> - Magnitude - Epicenter - Depth 	<ul style="list-style-type: none"> - Creation of a time series earthquake risk - Selection of area - Probability of survival 	<ul style="list-style-type: none"> - Magnitude is equal or higher than a defined trigger level - Location is within a defined area specified in the offering circular
Terrorist attacks	<ul style="list-style-type: none"> - Mortality risk - Landmark damages - Backstop limit 	<ul style="list-style-type: none"> - Regulatory approval - Insurance facility 	<ul style="list-style-type: none"> - Loss of life exceeds a pre-determined threshold - Designated landmarks are totally or partially destroyed - Monetary damage exceeds pre defined thresholds
Windstorm	<ul style="list-style-type: none"> - Wind speed 	<ul style="list-style-type: none"> - Creation of a time series wind indices 	<ul style="list-style-type: none"> - Location is within a defined area specified in the offering circular
Temperature	<ul style="list-style-type: none"> - Accumulated temperature in a defined region and period of time 	<ul style="list-style-type: none"> - Creation of a CDD and HDD time series indices 	<ul style="list-style-type: none"> - HDD or CDD value is greater or lower than a predetermined value ("Strike")

Energy released in several types of natural and man made catastrophes compared to annual frequency of earthquakes



Real life example: Monetization of earthquake data via structured finance using proprietary analytical models

- First ever data/securitization product of this type: bypassed completely the insurance industry.
- Cayman Islands' SPV set by investment banking team with feedback from Front Office Quants (FOQ)¹

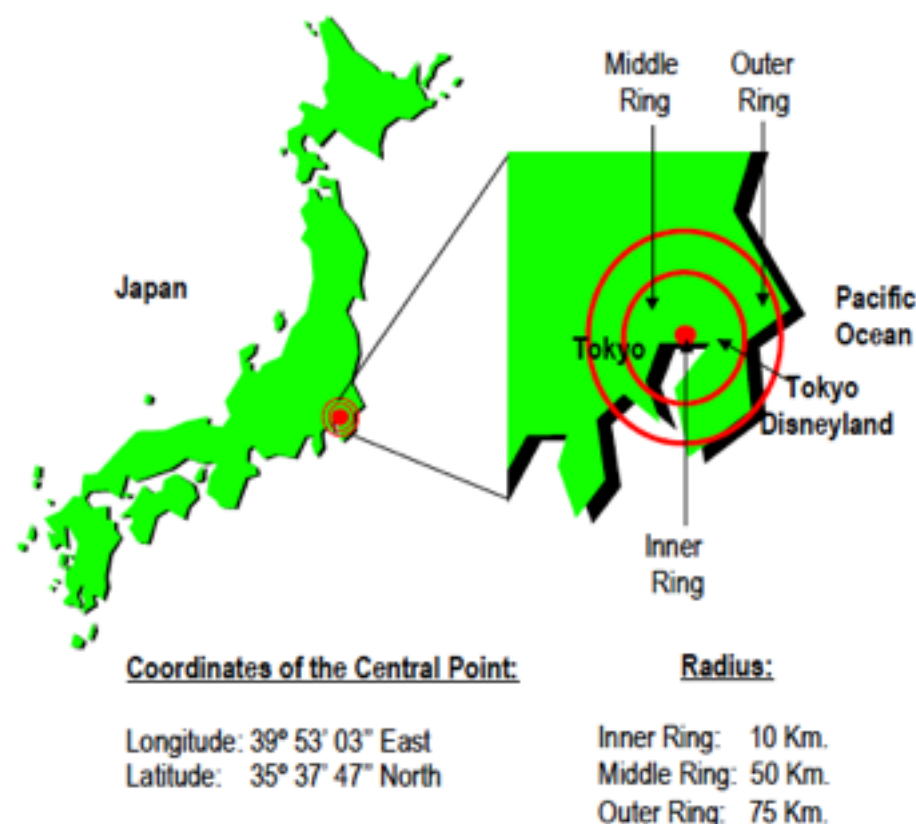


¹http://en.wikipedia.org/wiki/Quantitative_analyst#Front_office_quantitative_analyst

Real life example: Monetization of earthquake data via structured finance using proprietary analytical models

- Total issuance amount was \$100 million and obtained a Ba1 rating from Moody's, and a BB+ rating from Standard and Poor's.
- Bonds paid 6m LIBOR + 310 bps.








Geographical Parameters



Bond Loss Parameters

Richter Magnitude measured by the JMA	If the epicenter is in the Inner Ring, the loss to investors is (%):	If the epicenter is in the Middle Ring, the loss to investors is (%):	If the epicenter is in the Outer Ring, the loss to investors is (%):
6.5	25.0	0.0	0.0
6.6	32.5	0.0	0.0
6.7	40.0	0.0	0.0
6.8	47.5	0.0	0.0
6.9	55.0	0.0	0.0
7.0	62.5	0.0	0.0
7.1	70.0	25.0	0.0
7.2	77.5	37.5	0.0
7.3	85.0	50.0	0.0
7.4	92.5	62.5	0.0
7.5	100.0	75.0	0.0
7.6	100.0	87.5	25.0
7.7	100.0	100.0	50.0
7.8	100.0	100.0	75.0
7.9 or greater	100.0	100.0	100.0

Some reporting agencies for trigger events

Country	Agency	Risk
	- Japan Meteorological Agency (JMA)	- Earthquakes, Storms, Typhoons
	- Météo-France	- Windstorm, Temperature
	- The Meteorological Office	- Windstorm, Temperature
	- Deutscher Wetterdienst	- Windstorm, Temperature
	- Royal Meteorological Institute of Belgium	- Windstorm, Temperature
	- Royal Netherlands Meteorological Institute	- Windstorm, Temperature
	- National Hurricane Center (NHC) - US Geological Survey (USGS)	- Hurricane, Windstorms - Earthquakes

Some sovereigns with high cat risk exposure



USA



China



India



Japan



Italy



Mexico



Chile



Venezuela



St. Kitts and Nevis



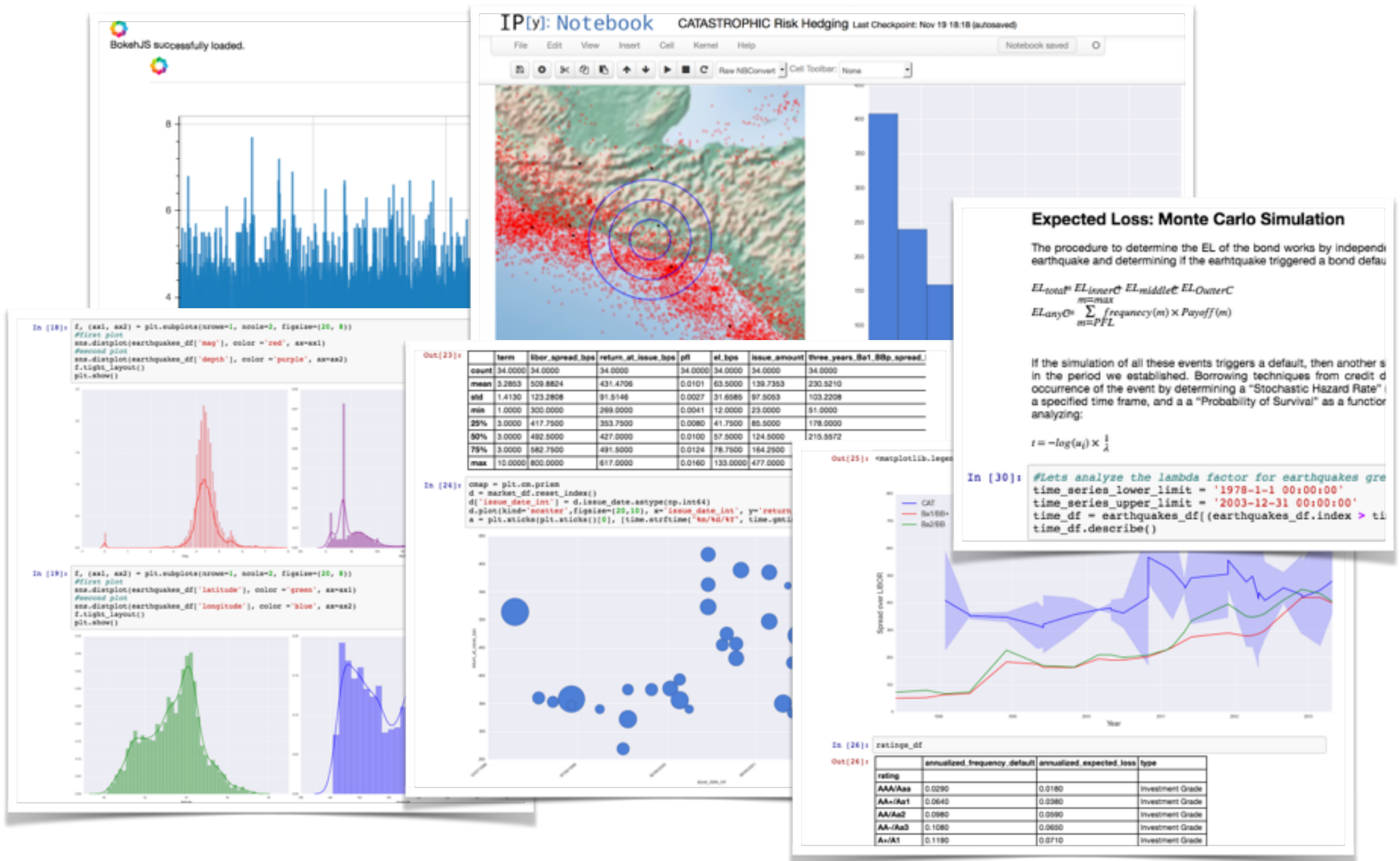
El Salvador

Some multilateral agencies with significant cat risk exposure



Now some code!

Using Python code, let's structure a CAT bond and compare it to a reinsurance deal





Senator Senator John McCain

\$15bn is the estimated shortfall among some financial groups to cover “extreme loss scenarios” of catastrophic risk

Senate Permanent Subcommittee on Financial Investigations

November 19, 2014

referring to JP Morgan, Morgan Stanley and Goldman Sachs

Thank you for your attention



Luis Miguel Sanchez

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Using Python to design a parametric catastrophic (CAT) earthquake bond and predict its credit spread.,

Luis has over 20 years of experience in capital markets, insurance, consulting, and engineering, with emphasis on quantitative analysis. Luis has held multiple senior executive positions and quantitative analyst roles for Barclays Capital, Lehman Brothers, Deutsche Bank, NetRisk, AIG, and a couple of hedge funds, where he structured and launched over 10bn USD worth of deals, many with exposure to exotic assets. Luis obtained his MBA on a Fulbright LASPAU scholarship, and a BSc in Civil Engineering with double concentration in Hydraulics and Structural Analysis from the University of the Armed Forces of Venezuela. He is the founder and CEO of ttwick, Inc.

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For Value at Risk (VaR) for Physical Infrastructure due to Cat Risk, please don't hesitate to contact me