Discussion of
Insurability of Pandemic Risks

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Aim and Method of the Paper

- In this paper, the authors want to explore the possibility for *insuring pandemic risk* and the scope of Government and financial markets contributions
- Assuming that pandemic risk is *catastrophic in nature*, they build a framework to explore the insurance supply based on skewed and *fat-tailed loss distributions*
- They calibrate the loss distribution of a hypothetical insurance contract for SME's, using the database tracking the *economic impacts* of the COVID-19 pandemic in the US

Main Definitions and Assumptions

- Insurability is defined as the *existence of positive gains* from trade between an insurer and a policyholder, i.e. the situation where the minimum premium acceptable by an insurer is lower than the policyholder's *willingness to pay*
- The authors use the *three-moments CAPM* to compare the equilibrium prices for pandemic risk insurance contracts to the maximal willingness to pay for purchasing such a coverage
- They claim that: "Including the third central moments of the claim distribution into the analysis allows us to adequately map "low frequency – high severity" situations, as they are typical for pandemic risks"

Models

- They model the individual demand for *catastrophic insurance* and the *income elasticity* of demand
- The loss distributions are modelled by *Lognormal distributions*
- These distributions are used to compute the premium for a hypothetical insurance providing monthly installments over one year
- The demand side is based on a calibration of the demand function that estimates the individual demand for catastrophic insurance and the income elasticity of demand
- Leaving aside the formalism, we end up with this formula for the demand of insurance:

$$\ln CT = e_p \ln P + e_w \ln W$$

where P is the premium, W the policyholder's wealth and $e_P < 0$ and $e_W > 0$

- This implies that the demand of insurance decreases with the premium and increases with the wealth (contrary to what is stated on page 23)

Conclusions of the Study

- There is *limited private market* for covering pandemic risk because the markup of the pandemic insurance contract is substantially higher compared to the markup insurers charge for insurance with exposure to natural catastrophes (12.1% for an insurer covering 15% of the market)

- Moreover, due to the *slowing economy* during pandemics, the demand for pandemic insurance will be *overly sensitive to* the insurance *price*, which may be a hurdle for insurance uptake for small and medium businesses or their workers

- The authors write: “our results suggest that though there can be some scope for private insurance market for business interruption losses generated by the pandemic, it may be limited and not sufficient to cover the losses comparable to those experienced by businesses in sectors with in-person interaction during the COVID-19 episode.”

My Take on This

- The authors tackle a very *important question* and come up with *sensible answers*
- They *provide a framework* to analyse both supply and demand of insurance
- They make *good efforts* for coming up with an *empirical calibration* of this framework using multidimensional data
- The same framework could be later used to *assess* public efforts and possible *transfer* to the *financial markets*

My Questions

- The use of *Lognormal distribution* for the pandemic loss is questionable. Lognormal distribution *do not present fat enough tails*

- My experience with pandemic risk modelling is that we rather use for the losses a *Fréchet distribution*, with a tail index between 0.76 to 0.83

- This also means that the *second and third moments* of the distribution *do not exist*

- This questions of course the usage of the three-moments CAPM. Why not using the *usual actuarial approach for premium*: given a rv L, for the losses, e for the rate of expenses, ρ_α for the risk measure, at threshold α, η the cost of capital, the premium P is equal to:

$$P = (1 + e)\mathbb{E}[L] + \eta\rho_\alpha(L)$$

- The study should be redone with a *real fat-tailed distribution* for the pandemic losses. For instance, with a mixed distribution (Lognormal in the center and Pareto in the tail*)

*N. Debbabi, M. Kratz, and M. Mboup. 2017, A self-calibrating method for heavy tailed data modelling. application in neuroscience and finance. Preprint, available at https://arxiv.org/abs/1612.03974v2,

Comparison between VaR and TVaR as a Function of the Weight of the Tails

Lognormal distribution

For all parameters the VaR at 99.5% is 100'000

CV*	Expectation	$TVaR_{0.99}$	$VaR_{0.995}/TVaR_{0.99}$
10	3'971	265'680	37.64%
1	16'564	134'641	74.27%
0.1	77'727	103'248	96.85%
0.01	97'462	100'317	99.68%

*) CV stands for Coefficient of Variation: σ/μ

Fréchet distribution

For all parameters the VaR at 99.5% is 100'000

Alpha	Expectation	$ES_{0.99}$	$VaR_{0.995}/TVaR_{0.99}$
1.1	8'523	1'102'299	9.07%
1.3	6'714	434'013	23.04%
1.5	7'846	300'376	33.29%
1.9	11'516	211'300	47.33%

The TVaR and the VaR at threshold κ of Pareto type distributions (with tail index a) are related through the following relation:

$$\frac{\mathrm{TVaR}_\kappa}{\mathrm{VaR}_\kappa} = \lim_{\kappa \to 1} \frac{\alpha}{\alpha - 1}$$

Fréchet Distribution

- Definition of the Fréchet distribution:

$$f_{\alpha,s}(x) = \begin{cases} 0 & \text{if } x \leq 0 \\ \exp\left(-\left(\frac{x}{s}\right)^{-\alpha}\right) & \text{if } x > 0 \end{cases}$$

- The expectation can be written as: $\mathbb{E}\left[f_{\alpha,s}(x)\right] = \mathrm{s} \cdot \Gamma\left(1 - \frac{1}{\alpha}\right)$

- And the TVaR for a threshold κ: $\mathrm{TVa}R_\kappa\left(f_{\alpha,s}(x)\right) = \mathrm{s} \cdot \Gamma\left(1 - \frac{1}{\alpha}, -\ln\kappa\right) \cdot \frac{\mathrm{s} \cdot \Gamma\left(1 - \frac{1}{\alpha}\right)}{1 - \kappa}$

  where $\Gamma(a, z)$ is the incomplete gamma function*

$*)\ \Gamma(a,z) = \frac{\int_0^z x^{a-1} e^{-x} dx}{\int_0^\infty x^{a-1} e^{-x} dx}$