Potential for application of a probabilistic catastrophe risk modelling framework to poverty outcomes:

General form vulnerability functions relating household poverty outcomes to hazard intensity in Ethiopia



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### What we have done

- Bring together two strands of research that have thus far been developed independently:
  - Catastrophe risk modelling
  - Economic analysis of vulnerability to poverty.
- Aim to determine the validity/viability of applying a derived set of damage (vulnerability) functions based on realized shocks and household expenditure/consumption outcomes, onto a forward-looking view of drought risk.
- Q: Can the results be generalized/validated "enough" to bolt on to the flexible drought risk model?
- A: Tentatively yes, some concern around less probable but more extreme events





### Probabilistic Catastrophe Risk (CAT Risk) Models

- Frequently relied upon in international insurance markets
- Develop a view of risk beyond the historical occurrence of catastrophes, for calculation of potential future impacts
- Consider an extensive range of possible event scenarios well beyond the historical record
- Primarily developed to output risk in financial terms
- Potential to use them to support disaster risk management more broadly has been recognized in schemes such as the Pacific Risk Information System, CAPRA Program and Africa RiskView platform.
- Thus far CAT risk models have not been used to estimate likely poverty/welfare consequences of disaster risk at household level





# Microeconomic analysis of shocks (natural disasters)

- Body of evidence has consolidated past 10 years: micro studies on extreme events
  – drought, earthquake, flood, epidemic
- Evaluate ex-post impact of realized shock on welfare outcomes
  - Consumption/Expenditure
  - Child health (height)
  - Asset selling, child labor and other coping responses
- Short and Long-term studies
- Also evidence on smaller fluctuations mattering
- More sparce: forward looking studies, conceptual analysis of vulnerability
- *Ex-ante* analysis of potential poverty impacts for shocks







### CAT Risk meets microeconomics

- Typical in vulnerability literature "ideally we would need information on the ex-ante distribution of future consumption outcomes and their probability" (e.g. Hill and Porter 2013)
- If economists develop an externally valid (generalizable) model of shock impact on welfare across the distribution of the shock...
- If CAT risk model can simulate probability and severity of shock...
- ... Powerful combination for assessing future needs







### Modelling process for a household exposed to drought (rather than e.g. a building)

- 1) The hazard component is a (ex-post) index of drought (crop yield shortfall). How severe depends on geographic characteristics and rainfall model.
- 2) The resulting damage is determined based on the level of the hazard (community-specific crop loss) and characteristics of the household that mitigate or amplify the impact of the shock
- 3) The total financial loss can be conceptualized e.g. as the poverty gap of the household – the shortfall of expected household consumption from the poverty line (summed across all households)

Translated into economics: Reduced-form regression of shock on household consumption (with area fixed-effects)

Noting that this may underestimate the total welfare loss of the household due to risk, as incorporates actions of the household to "smooth" consumption (selling assets, undertaking low risk, (m low\_return activities)



Household characteristics	Interacting variables
Ability of head to access coping strategies	Head education level, sector of occupation, gender
Household composition that allows labour response	Dependency ratio, ratio of able- bodied
Household assets that mitigate shock	Cattle, other livestock, jewelry
Other shocks that compromise ability to mitigate shock	Illness, livestock disease, crop damage from pests
Access to institutional coping strategies	Distance to market, access to financial products (insurance, credit), public safety net access.







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## Vulnerability module: Crop loss and consumption



#### Results summary

- Drought shock fairly stable impact across models: approx 2% fall in consumption for 10% crop loss (base household)
- Cattle owners impact is less (unsurprising)
- PSNP consistently mitigates the impact
- Crop damage (self-reported) exacerbates impact
- Geographic differences shock: impact worst in lowlands reliable, highlands drought prone, lowlands enset, highlands reliable.
- Some support of a quadratic model (data paucity/support though)







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### **Extensions**

- From Headcount to Poverty Gap allows full analysis of full fiscal costs of poverty gap
- Building the full CAT risk model to "bolt-on" to the impacts
- Build in macroeconomic effects of covariate shocks
- Lagged shocks or multiplicative shock impacts
- Further stress testing of model?
  - Higher levels of drought?
  - Panel data (not nationally representative)?
  - Woreda level analysis of poverty rates and drought



### Summary

Aim: to explore whether it is possible to combine a regressionbased model of shocks and consumption (ex-post) impacts with an ex-ante CAT risk model

Results do show quite stable model within the 2005-2011 data

Key challenge – stability of the model over extreme events that are impossible to model econometrically based on existing data

Recommend trying to fit CAT model with the regression results

Comments most welcome





### References

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