

Cambridge Centre for Risk Studies
Advisory Board Research Showcase – 24 January 2017



Adding Direct Stock Losses to the Pandora Framework

Centre for
Risk Studies

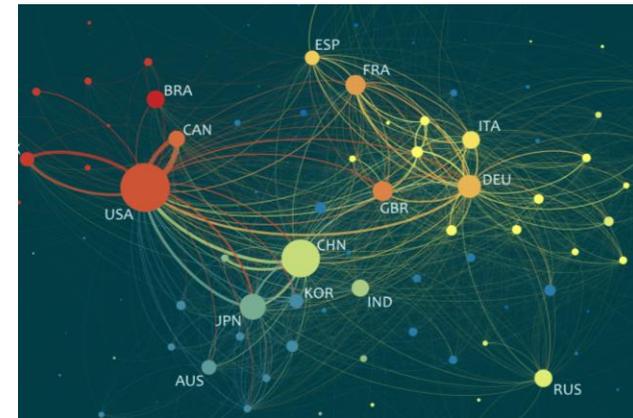
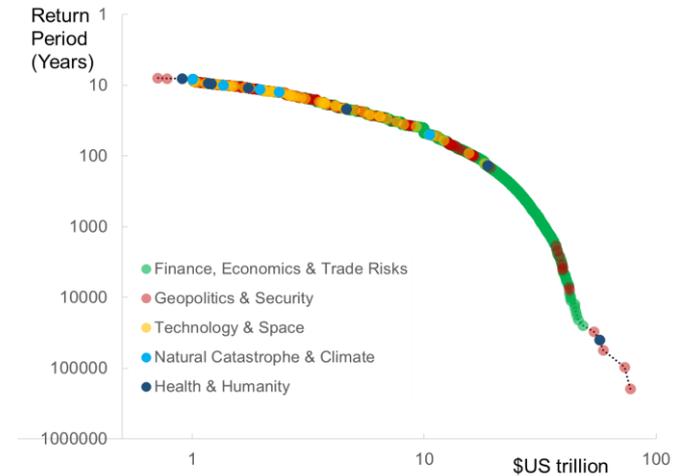


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Main Developments in the Pandora Project

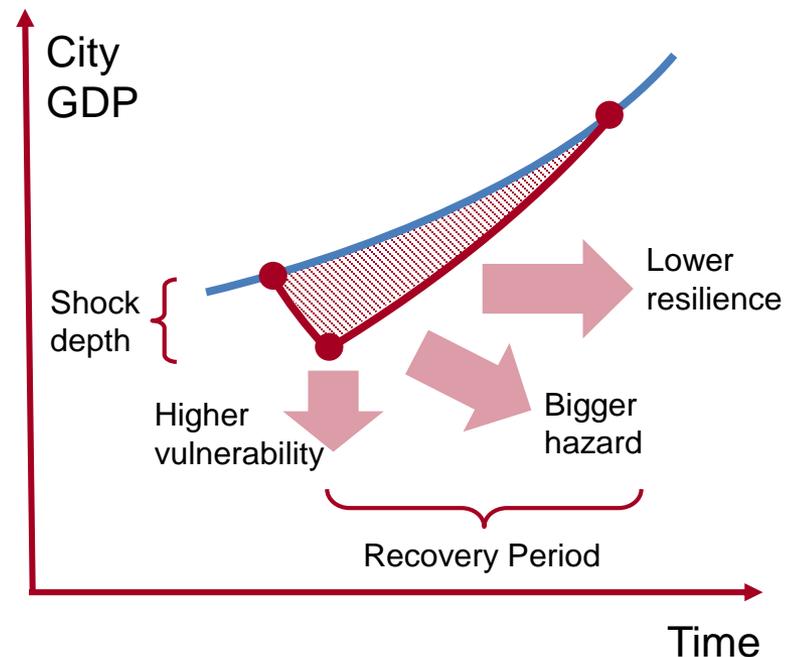
1. 2017 update of the **Global Risk Outlook**
2. **Multi-city scenario suites** for each threat type
 - I.e. scenarios with a geographical footprint
3. Estimating domestic and international **economic spillovers**
 - Bilateral trade network used as proxy for relative magnitude of international spillovers
 - Oxford Economics Global Model used for calibration
4. Developing an idea of how we might model **multi-threat cascades**



- All hangs on our city-level assessments of economic impacts or **Local Impact Severities**

Pandora Local Impact Severities

- An LIS is a city **GDP@Risk** estimate (5yr GDP loss)
 - A generic impact severity is estimated for a given threat
 - **Depth of shock** scaled by ‘vulnerability’ factors (city & threat specific)
 - **Recovery period** scaled by ‘resilience’ factors (city specific)
 - Measured against a no-disaster baseline trajectory
- Measure disruption (and recovery) in economic **flow** (GDP)
 - Typically considered as the ‘**indirect**’ economic impact
 - Does not capture ‘**direct**’ **stock damages** to physical assets, human lives, or natural capital
 - Restrictive when considering potential **use cases** of the Pandora modelling framework



Vulnerability and Resilience

■ City **vulnerability**

- How exposed & fragile are assets, infrastructure, communities?
- Protection of physical assets
- Quality of infrastructure
- Level of development

■ City **resilience**

- Recovery based on capacity or measures taken to reduce or cope with potential negative consequences
- **Preparedness**
 - E.g. contingency planning and early-warning systems
- **Economic resilience**
 - Macroeconomic stability, trade openness, access to insurance markets, level of development
- **Societal resilience**
 - Ability to maintain public order, healthcare, social cohesion, and political stability

Questioning the Economic Impacts of Disasters

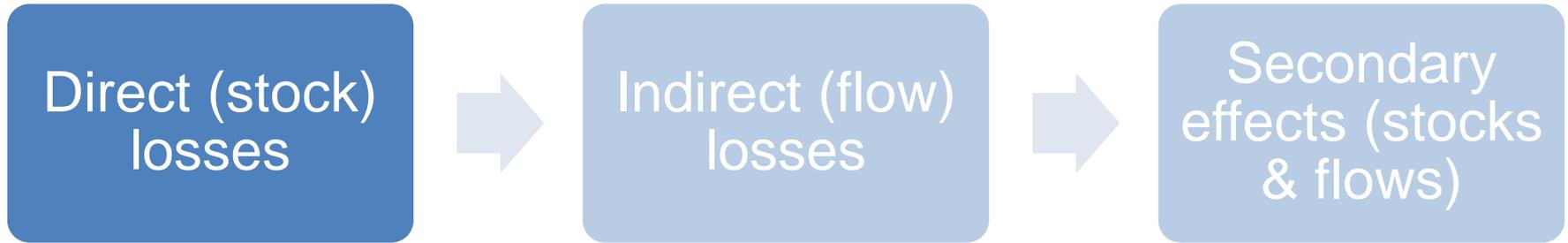
- Do different threat types cause different impacts?
- What factors most influence economic impacts?
- What can we learn from empirical analysis and economic theory?
- We already have a tractable way of estimating indirect (GDP) impacts
 - **How can we estimate direct (stock) impacts in a tractable and consistent way?**

A Typology of Disaster Impacts



1. Guha-Sapir, Debarati, and Indhira Santos, eds. *The Economic Impacts of Natural Disasters*. Oxford, New York: Oxford University Press, 2013.
2. Benson, Charlotte. Understanding the Economic and Financial Impacts of Natural Disasters. Disaster Risk Management. The World Bank, 2004. <http://elibrary.worldbank.org/doi/abs/10.1596/0-8213-5685-2>.
3. *The Indirect Cost of Natural Disasters and an Economic Definition of Macroeconomic Resilience*. Policy Research Working Papers. The World Bank, 2015. <http://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-7357>.
4. "Indirect Economic Impacts from Disasters - Publications - GOV.UK." Accessed January 22, 2017. <https://www.gov.uk/government/publications/indirect-economic-impacts-from-disasters>.

A Typology of Disaster Impacts



■ Damage to **human lives**

- Loss of life
- Injury, illness (inc. trauma & anxiety)
- Migration

■ Damage to man-made **productive & social assets**

- Commercial & residential buildings
- Factories & industrial plant
- Schools & hospitals
- Infrastructure (energy, roads, telecoms, water etc)
- Sites of cultural significance
- Machinery, equipment & vehicles
- Crops, livestock & agricultural land
- Final goods, goods in process, raw materials, and spare parts

■ Damage to **natural capital**

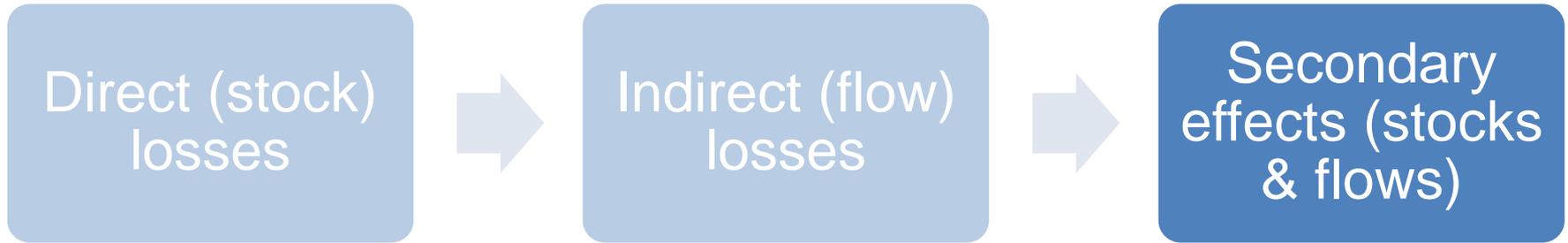
- Ecosystem services
- 'Damages' could simply involve a **crash in asset prices**
- Physical assets typically valued using proxies for replacements costs

A Typology of Disaster Impacts



- Typically measured by declines in **GDP**, stemming from:
 - **Direct damage & disruption** to productive assets, inventories, infrastructure and markets
 - **Disrupted labour supply**
 - Death, illness, injury
 - Infrastructure disruption
 - **Supply chain disruptions**
 - **Reduced consumer demand**
 - Confidence
 - Loss of income
- Losses **dampened by spare production capacity** (esp. during recessions) & flexible supply chain configurations
- Larger footprint & longer timescale than direct losses
- Highly dependent on pace of reconstruction
- GDP often poor measure of welfare losses (impact on poor typically hidden)

A Typology of Disaster Impacts



- Lost jobs leading to **lower consumer demand**
- Lost tax revenues and emergency budgets leading to **lower public demand**
- Major planned **investments delayed** or cancelled
- Increased **indebtedness** leading to risk of inflation
- Longer-term social and economic effects
 - Education
 - Health
 - Productivity
- Increased cost of **insurance**
- International **spillovers**
- Widening of **inequalities**
- Consecutive natural disasters create atmosphere of **uncertainty** that discourages potential investors

Long-term Macroeconomic Consequences

Theory provides contradictory conclusions about the impact of disasters on long-term growth rate

Hypothesis 1

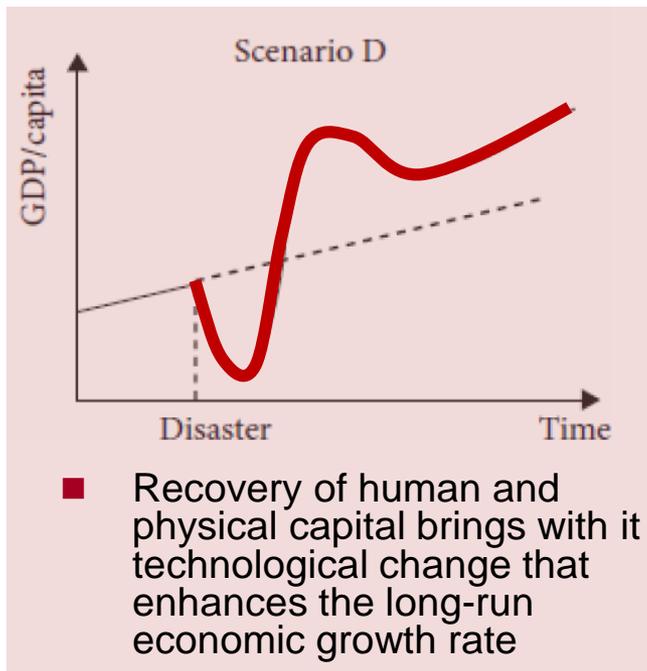
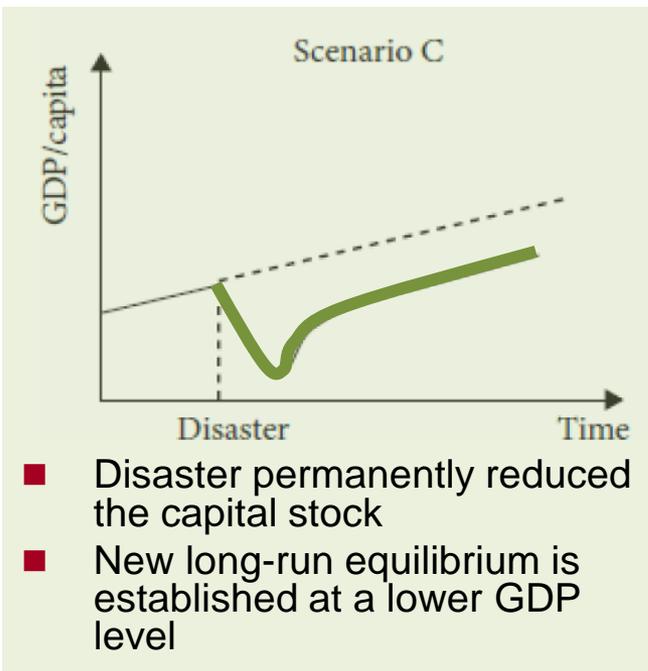
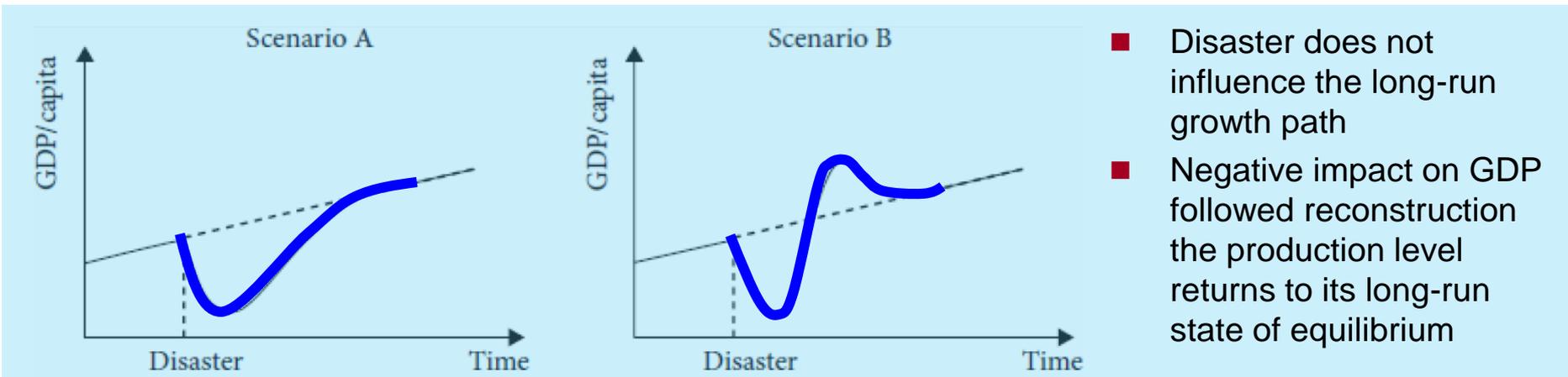
- Disasters **destroy existing productive & social capital**
- **Diverts scarce resources** away from planned investments
- Vulnerable activities move to less-risky locations
- A major disaster could be expected to force an economy onto a **lower growth trajectory**
- A **permanent negative shock** for a region

Hypothesis 2

- Disasters can also generate **construction-led booms** and offer an opportunity to **upgrade capital** and stimulate new sectors
- **Technological change** that is embedded in new capital replacement needed after the disaster **generates growth**
- However, it is difficult to attribute such benefits to a disaster as it implies such a transition could also be possible without the suffering/welfare losses associated with a disaster...

More consistent when type of hazard & level of development accounted for...

Hypothetical Recovery Path Scenarios



Earthquake more likely B or D

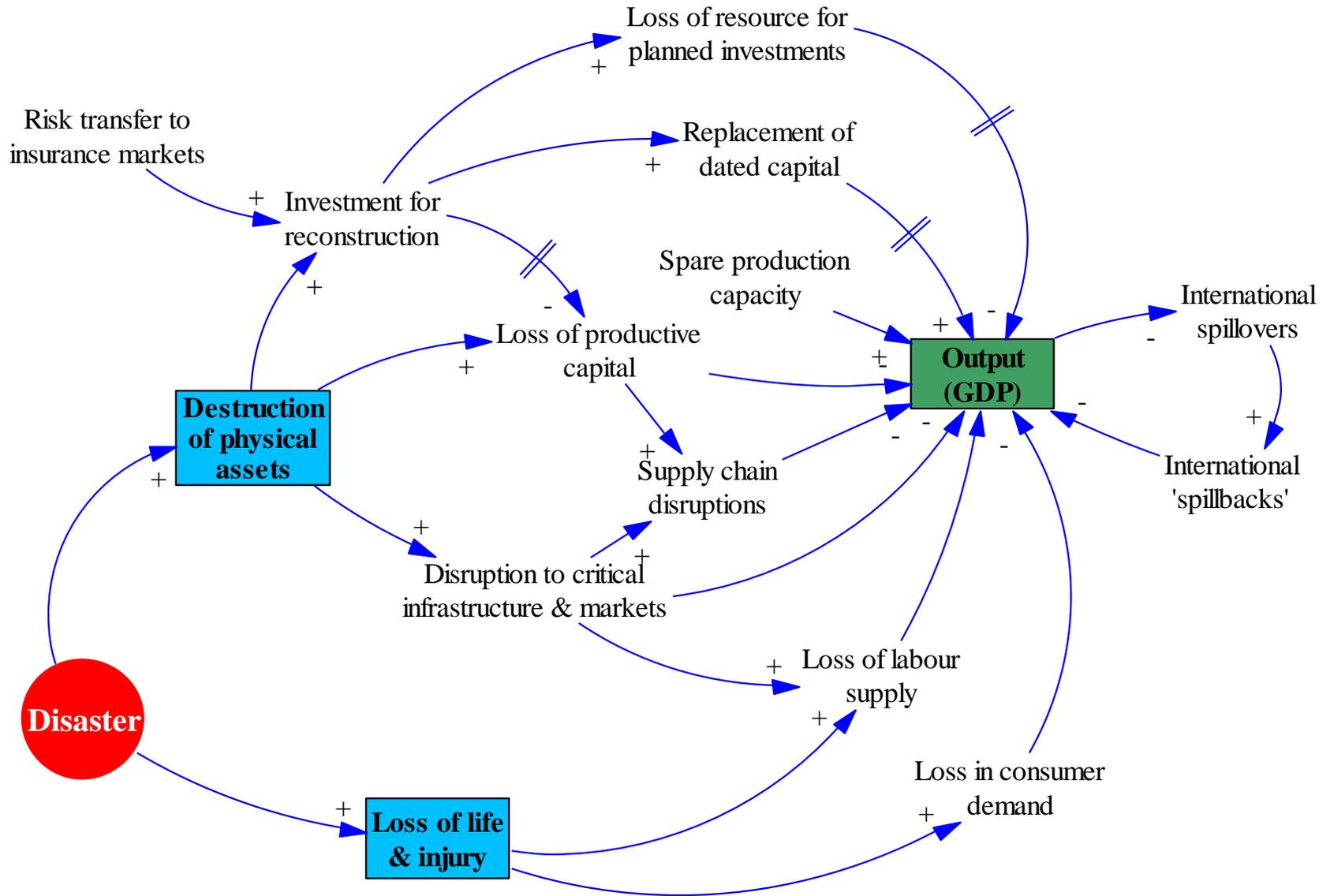
Drought more likely A or C

Insights from Econometrics

- Disasters have larger relative **adverse impacts on developing countries**
- Nature and magnitude of impact varies between **types of hazard**
 - Climatological and hydrometeorological hazards are typically associated with negative long-term economic impacts
 - Higher frequency of events can also lead to uncertain investment conditions
 - Geological hazards associated with positive impacts in more developed countries
 - Less frequent but typically more cataclysmic - considerable reconstruction required that could lead to technological change
- Very severe disasters unlikely to have any positive impacts

1. Benson, Charlotte. Understanding the Economic and Financial Impacts of Natural Disasters. Disaster Risk Management. The World Bank, 2004. <http://elibrary.worldbank.org/doi/abs/10.1596/0-8213-5685-2>.
2. *The Indirect Cost of Natural Disasters and an Economic Definition of Macroeconomic Resilience*. Policy Research Working Papers. The World Bank, 2015. <http://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-7357>.

Experimenting with Causal Diagrams

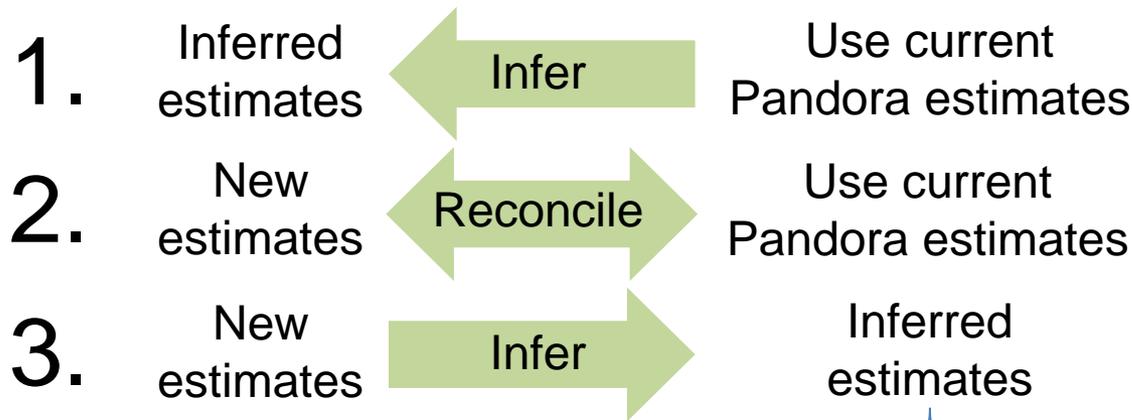


Hidden Opportunity Costs of Disasters

- Resources used following a disaster are **not necessarily additional** and can have high opportunity costs
- Public and private reconstruction investments may be diverted away from **planned investments**
- International reconstruction aid typically diverted from **development aid flows**
 - Donors tend to advance commitments within existing programs
- **Increased national debt** due to borrowing for reconstruction can lead to inflation and interest rate adjustments
- Also opportunity costs associated with buying **insurance**
- **We need to develop a deeper understanding of where opportunity costs occur in order to assess the full economic impact of disasters**

Improving Our Estimates of Economic Impacts

- Scale and nature of indirect impacts and secondary effects heavily dependant on direct impacts
- **How to estimate direct impacts?**
 - Disaggregate into high-level sub-categories
 - Should be aligned with multi-line data schema



Direct (stock) losses

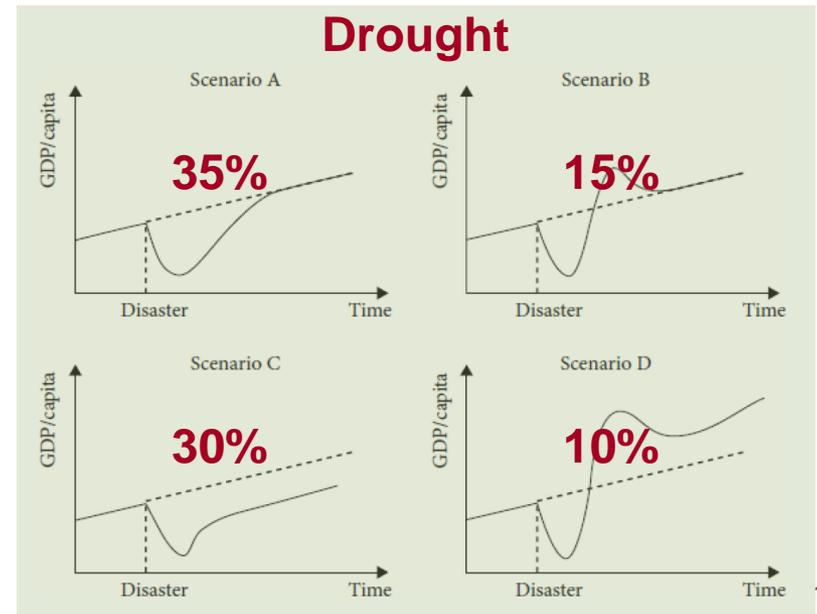
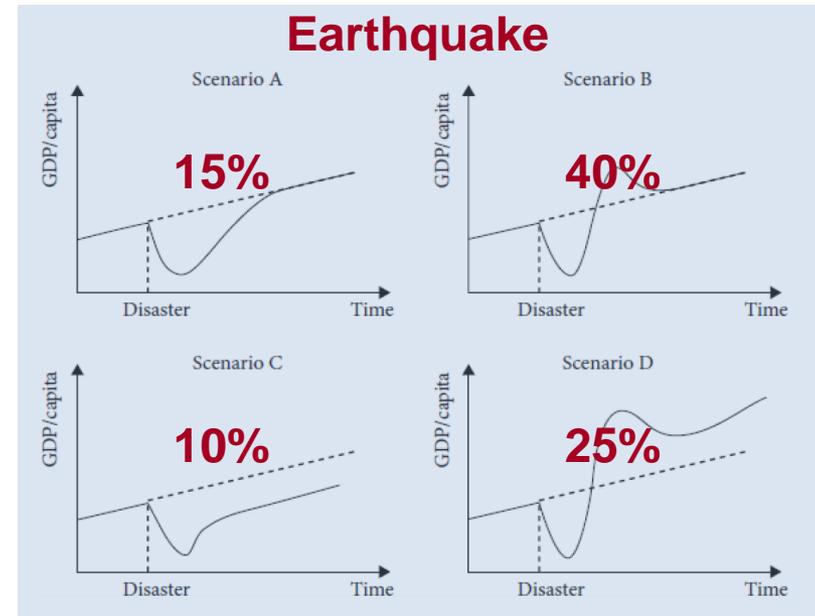
Indirect (flow) losses

Secondary effects (stocks & flows)

Always considerable **uncertainty over shape of recovery path...**

Modelling Probabilistic Recovery Scenarios

- We could approximate the solution space by saying these are the only possible paths
 - Each recovery path scenario is representative of a sub-set of plausible recovery paths
- The four scenarios would need to be scalable in terms of estimated vulnerability and resilience factors
- The probability of the recovery path scenario would vary depending on the threat type and resilience factors



Conclusions

- Our advances in modelling **multi-city scenarios**, economic **spillovers**, and multi-threat **cascades** all hang on our ability to assess city-level economic impacts
- We are in the early stages of developing a **typology of economic impacts**
- We are reviewing our framework for assessing city economic impacts
 - Aim to capture both direct and indirect losses (without double counting)
- **Overall objective is to develop a practical tool to estimate economic & business impacts of future catastrophes**

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