Economic Consequences of and Resilience to 21st Century Disasters

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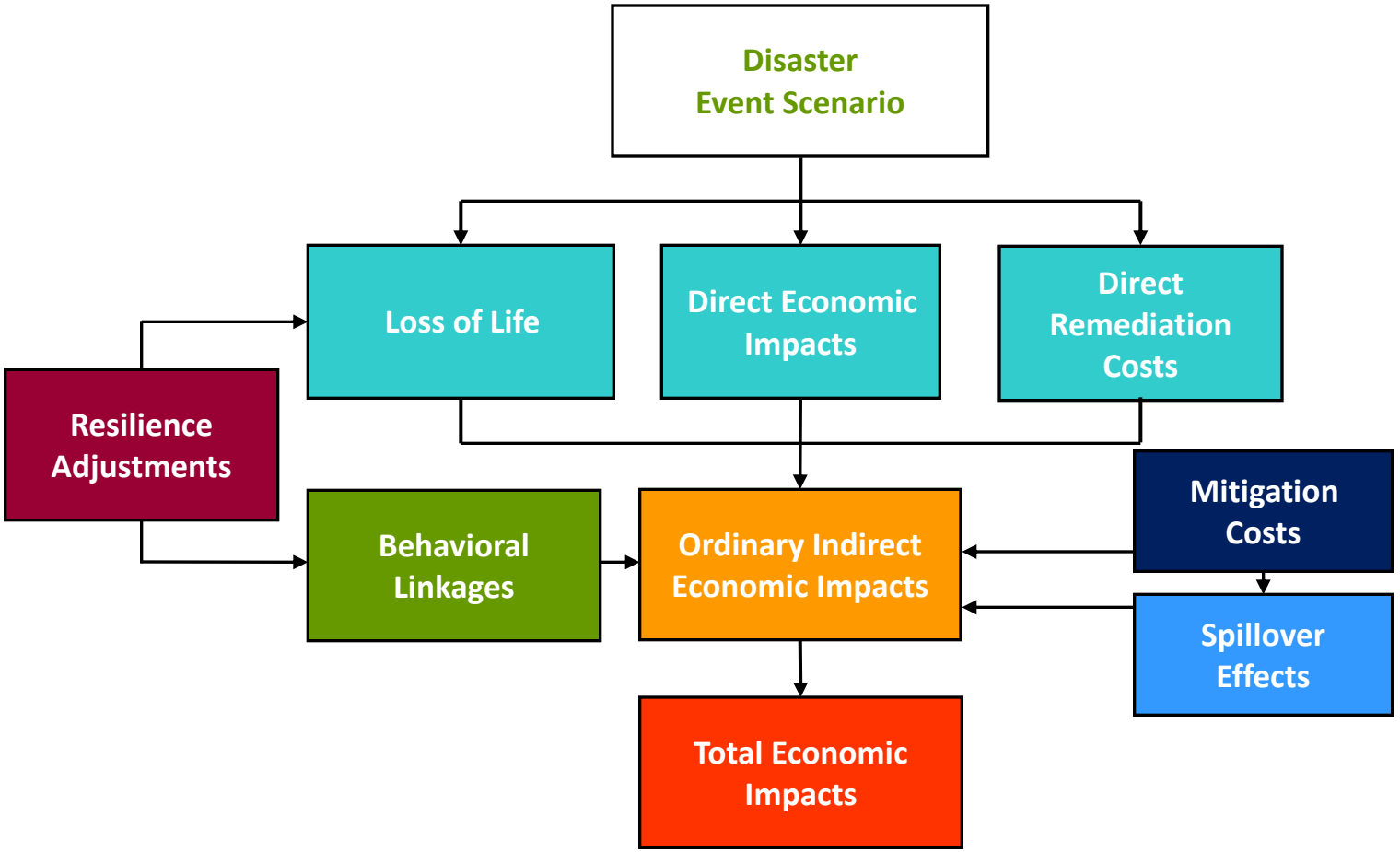
Major Themes

- *New* Threats
  - pandemics => deaths/political tensions
  - insidious terrorist threats => fear/expense
  - climate change => constant emergencies
- *Unprecedented* in magnitude and scope
- Key Role of *Resilience* and *Adaptation*
  - refocus on asset services and lives
  - emphasize improvisation & lasting strategies
  - consider equity of underrepresented groups

Cost of Major Disasters in the U.S.

• COVID-19:	$6 trillion GDP	1 million lives
• CA Wildfires:	$100 billion GDP	103 lives
• Great Recession:	$3 trillion GDP	-
• Hurricane Katrina:	$120 billion GDP	1,833 lives
• September 11:	$150 billion GDP	3,004 lives
• Climate Change:	$100 billion annually	thousands
• ShakeOut EQ:	$90 billion GDP	1,800 lives
• CA Severe Storm:	$300 billion GDP	hundreds
• Seattle Anthrax:	70,000 foreclosures	thousands
• Major Cyber Attack:	?	?

CREATE Economic Consequence Analysis Framework



The Unthinkable -- CBRN

- Dirty Bomb Attack in Downtown LA
  - Fear of contamination is immense (social amplification of risk & stigma effects)
  - Behavioral losses 15X ordinary brick/mortar & BI losses

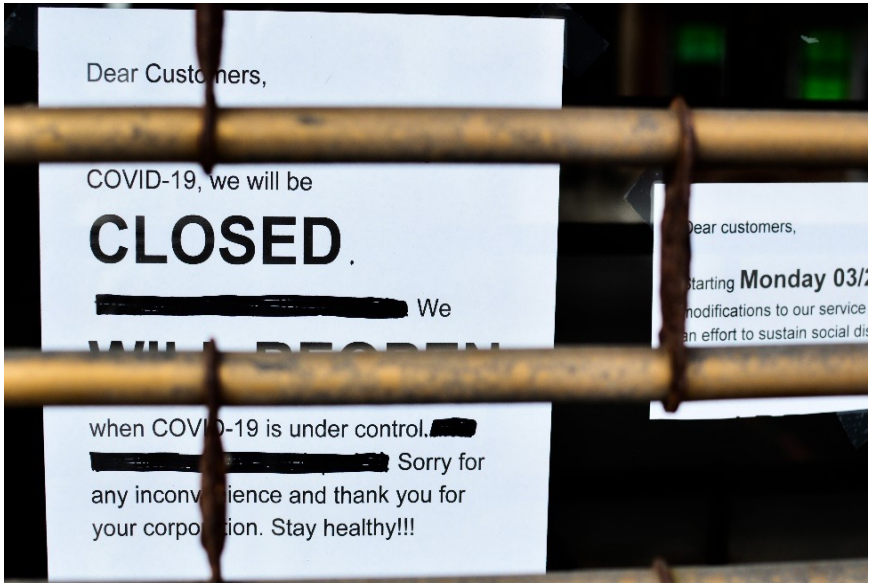
- Keys to Recovery
  - Improved decontamination effectiveness
  - Improved risk communication: reduce fear

The Inevitable: Climate Change

- Consensus: it is happening/accelerating (IPCC)
  - Increased short-term climate variability (magnitude & severity of storms, droughts, wildfires)
  - Chronic long-term issues in terms of sea-level rise, heat stress, vector-borne diseases
- Keys to coping: Adaptation/Threat Mitigation

The New Normal: Pandemics

- Governments' key role in containing disease spread had major implications for the economy
- Other strong influences:
  - avoidance behavior (mandatory & voluntary)
  - resilience (telework, supply-chain workarounds)



Interpretations of Disaster Resilience

- One refers to *any action* that reduces hazard losses

  But, there's a perfectly good word for actions taken ***before*** the event – "mitigation"

- Best use – actions taken ***after*** the disasters strikes:
  - can *build up resilience capacity beforehand* – it's a ***process*** (inventories, emergency drills, identify back-up locations)
  - but these tactics are *not implemented until after* the disaster begins

- Can only prevent property damage before the event,

  But, can reduce *business interruption losses* afterwards:
  - BI begins when the disaster strikes & continues until recovery
  - measured in terms of lost sales revenue, GDP, employment
  - *Resilience is synonymous with business continuity*

Economic Resilience

- Static:
  - General Definition: Ability of a system to *maintain function* when shocked.
  - Econ Definition: *Efficient use of remaining resources* at a given point in time to produce as much as possible.
- Dynamic
  - General Definition: Ability of a system to *recover and in an accelerated manner*.
  - Econ Definition: *Efficient* use of resources *over time* for investment in repair and reconstruction, including adapting

- *Metric*: losses prevented by use of a resilience tactic as a % of potential losses without implementation of the tactic

Resilience Example: 9/11Relocation

- 1,100 firms in WTC; 95% survived by relocating
- If all of firms in the WTC area went out of business, direct BI loss would = $43B
- If all relocation were immediate, then BI = 0
- Delays took place; still most businesses relocated within 2-4 months, so BI loss = $12B
- Resilience: avoided loss / max potential loss

$31B/$43B = 72%

Business Resilience Tactics

Resilience Tactic	Definition (Activities Involved)
Conservation	Maintaining intended production using lower amounts of an input or inputs
Resource Isolation	Modifying a portion of business operations to run without a critical input
Input Substitution	Replacing a production input in short supply with another
Inventories	Continuing business operations using emergency and ordinary stockpiles
Excess Capacity	Using idle plant or equipment idle in place of a damaged ones
Relocation	Moving some or all of the business activity to a new location
Management Effectiveness	Improving the efficiency of business operations in the aftermath of a disaster
Import Substitution	Importing needed production inputs when not available from local suppliers
Technological Change	Improvising the production process without requiring a major investment
Production Recapture	Making up for lost production by working overtime or extra shifts.
Resource Pooling/Sharing	Recontracting, selective exchange of resources, creating new partnerships

E-CAT User Interface

CREATE HOMELAND SECURITY CENTER | National Center for Risk and Economic Analysis of Terrorism Events

USC University of Southern California

Economic Consequence Analysis Tool (E-CAT)

User Interface Version 2.0

Terrorism / Intentional Acts	Natural Threats	Technological Accidents / Infrastructure Failures	Uncertainty Display Options	
○ Human Pandemic ○ Nuclear Attack ○ Animal Disease	○ Earthquake ○ Flood ○ Tornado	○ Aviation Disruption ◉ Maritime Cyber Disruption ○ Oil Spill	◉ Point (Single Value) ○ Interval (Range) ○ Distribution (Cumulative)	Go!

Point Estimate (Default Values)

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Economic Consequence Analysis Tool

USC University of Southern California

Threat: Maritime Cyber Port Disruption

Option 1: Input Single Parameter Estimate

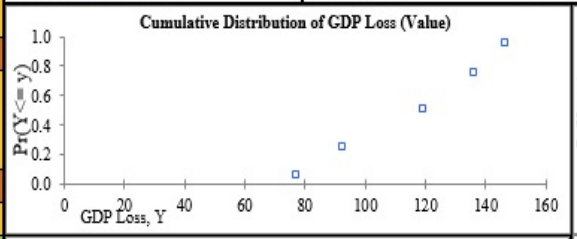
Reset Default | Main Menu | Print Results

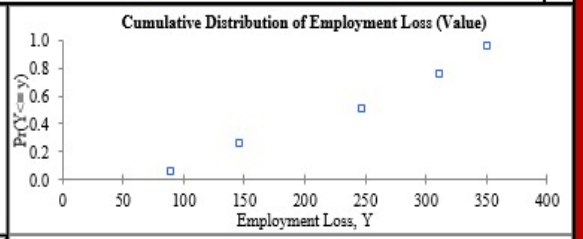
Input Area: Input values in yellow boxes
(grey boxes are non-applicable)

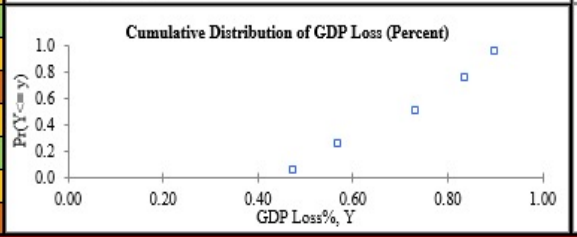
Magnitude	Time of Day
136 billions of $ trade (Defintion)	
Select value between 15 and 136.37	
Duration	**Location**
Economic Structure	**Restroation**
Resilience - Inventory	**Resilience - Rerouting**
N/A (Defintion)	N/A (Defintion)
Resilience - Recapture	**Resilience - Conservation**
N/A (Definition)	N/A (Definition)

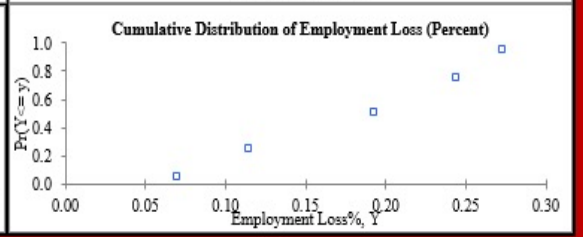
Results Area

		GDP Loss		Employment Loss	
		billion dollars	percent	thousand jobs	percent
Economic Impacts:	**Mean**	**121.72**	**0.75**	**257.53**	**0.20**
(all in $2012)	5% Quantile	77.24	0.48	89.87	0.07
	25% Quantile	92.57	0.57	147.56	0.12
	50% Quantile	119.39	0.73	248.35	0.19
	75% Quantile	136.39	0.84	312.60	0.24
Distribution Charts:	95% Quantile	146.69	0.90	351.49	0.27









Business Resilience Calculator

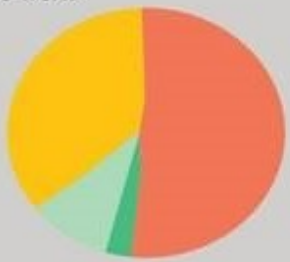
BRC

Pandemic

The disruption caused by a pandemic is represented by this range of problems. You can adjust the proportion of these problems now if you wish:

It is important that you think critically about those types of disruptions that are (or possibly will be) contributing to your business interruption. In other words, which of the below-listed problems are impacting (or will impact) your ability to produce pre-disaster levels of goods and services? Suggested starting values are provided, which may or may not accurately represent the situation your organization is facing or will face. Please adjust the percentages by selecting the plus and minus buttons for each source of disruption, ensuring that the total of all the sources accounts for 100 percent of your organization's business interruption.

52%	Employees unable to travel to work
0%	Employees moved away
3%	Communication problems
10%	Supply chain problems
35%	Power outages
0%	Natural gas outages
0%	Water outages
0%	Transportation problems



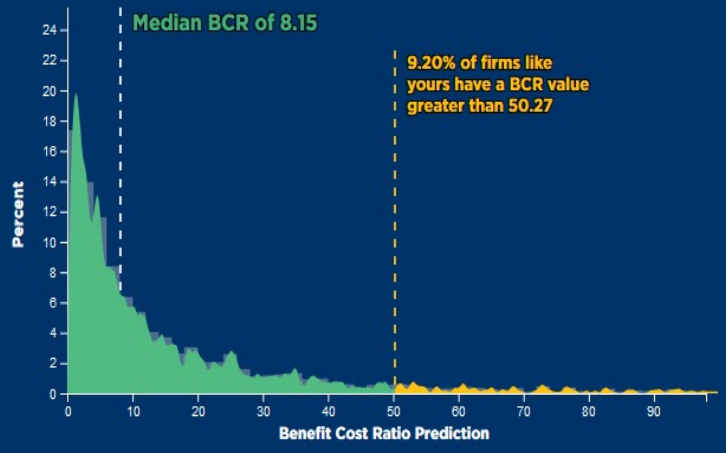
BRC

Results

Of the 3 tactics you chose, Input Substitution is likely to yield the greatest benefit-cost ratio (BCR) in a hurricane.

Production Recapture | $8.15 | $0.90 | $21.10

Typical firms like your avoided $8.15 for every dollar spent on this tactic. The sector median benefit-cost ratio for this tactic is $0.90. Best performers avoided $21.10 for every dollar spent on this tactic.



Conclusions

- New threats require new approaches to recovery
  - risk communication to dispel fear
  - short-term resilience, but cumulative lessons learned
  - long-term adaptation to chronic problems
- Economic analysis tools are useful in estimating consequences and evaluating recovery options
- Governments' important roles:
  - improved risk communication
  - facilitate private sector self-motivated resilience

Economic Consequence Publications

- Dormady, N., A. Rose. 2021. *The Business Resilience Calculator*. https://resiliencecalculator.com/
- Dormady, N., T. Szelazek, and A. Rose. 2014. "The Potential Impact of an Anthrax Attack on Real Estate Prices and Foreclosures in Seattle," *Risk Analysis* 34(1): 187-201. doi.org/10.1111/risa.12059
- Dormady, N., A. Rose, C. B. Morin and A. Roa-Henriquez. 2022. "The Cost-Effectiveness of Economic Resilience," *International Journal of Production Economics* 244: 108371 doi.org/10.1016/j.ijpe.2021.108371
- Giesecke, J., A. Rose, P. Slovic et al. 2012. "Assessment of the Regional Economic Impacts of Catastrophic Events: A CGE Analysis of Resource Loss and Behavioral Effects of a Radiological Dispersion Device Attack Scenario," *Risk Analysis* 32: 583-600. doi.org/10.1111/j.1539-6924.2010.01567.x
- Prager F., D. Wei, and Rose. 2017. Total Economic Consequences of an Influenza Outbreak in the United States," *Risk Analysis* 37(1): 4-19. doi:10.1111/risa.12625
- Rose, A. 2021. "COVID-19 Economic Impacts in Perspective: A Comparison to Recent U.S. Disasters," *International Journal of Disaster Risk Reduction*, electronic preprint. doi.org/10.1016/j.ijdrr.2021.102317
- Rose, A., D. Wei and A. Wein. "Economic Impacts of the ShakeOut Scenario," *Earthquake Spectra: Special Issue on the ShakeOut Earthquake Scenario* 27(2): 539-57. doi.org/10.1193/1.3563624; doi.org/10.1193/1.3587204; doi.org/10.1193/1.358284
- Rose, A., G. Oladosu, B. Lee and G. Beeler Asay. 2009. "The Economic Impacts of the 2001 Terrorist Attacks on the World Trade Center: A Computable General Equilibrium Analysis," *Peace Economics, Peace Science, and Public Policy* 15: Article 6. 10.2202/1554-8597.1161
- Rose, A., F. Prager, Z. Chen and S. Chatterjee. 2017. *Economic Consequences Analysis Tool* (*E-CAT*). Singapore: Springer. doi.org/10.1007/978-981-10-2567-9
- Rose, A., I. Sue Wing, D. Wei and A. Wein. 2016. "Economic Impacts of a California Tsunami," *Natural Hazards Review* 17(2): 04016002. doi.org/10.1061/(ASCE)NH.1527-6996.0000212
- Walmsley, T., A. Rose and D. Wei. 2021. "The Impacts of the Coronavirus on the Economy of the United States," *Economics of Disasters and Climate Change* 5(1): 1-52. 10.1007/s41885-020-00080-1