Measuring the Business Value of Resilience in Disasters

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The Role of
Critical
Inputs in
Disasters:
Labor
Disruptions

The Role of Critical Inputs in Disasters:
Transportation Disruptions

The Role of Critical Inputs in Disasters: Supply Chain Disruptions

The Role of Critical Inputs in Disasters:
## Power Outages & Communication Outages

Key Concepts

Resilience, Mitigation, & BI

Key Distinctions: 'Mitigation,' 'Resilience,' & 'BI'

- Resilience: Often refers to *any action* that reduces hazard losses

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

- Best use of "resilience" – actions taken *after* an event
    - can *build up resilience capacity beforehand* – it's a process
    - (inventories, resource agreements, identify back-up locations)
    - but these tactics are *not implemented until after the event*

- Can only prevent property damage before the event, but can reduce *business interruption* afterwards

- BI begins when the disaster strikes & continues until recovered

- Measured in terms of lost sales revenue, GDP, employment

Resilience

Mitigation
(Pre-disaster)

Disaster

Property Damage $
+
Business
Interruption $
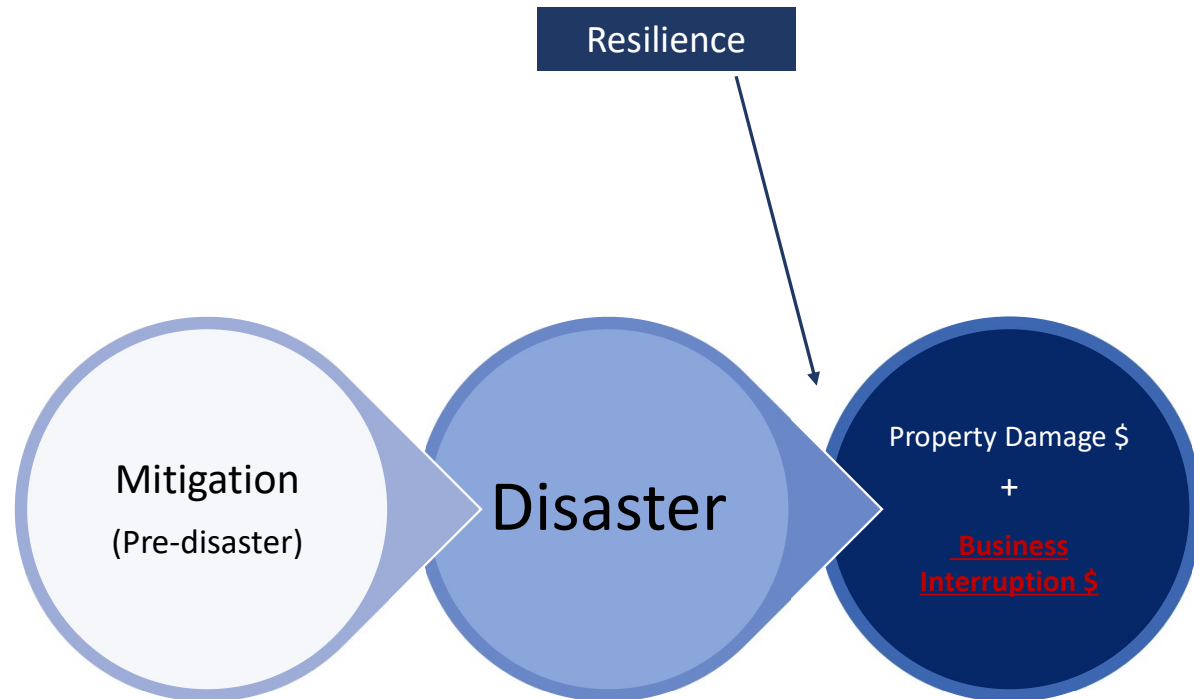
Economic Resilience

o **Static Resilience:**

   o General Definition: Ability of a system to *maintain function* when shocked.
   o Econ Definition: *Efficient use of remaining resources* at a given point in time to produce as much as possible.

o **Dynamic Resilience:**

   o General: *Ability & speed* of a system to *recover.*
   o Economic: *Efficient* use of resources *over time* for investment in repair and reconstruction, including expediting the process & adapting to change.

o *Resilience* essentially synonymous with *efficient business continuity*

o *Metric*: losses avoided by using a resilience tactic as % of potential losses without it

Why BI Matters

September 11 World Trade Center Attacks
- property damage (PD): $25 Billion
- business interruption (BI): $100 Billion

Hurricane Katrina
- PD: $75B
- BI: >$100B

ShakeOut San Andreas Fault Earthquake Simulation
- PD: $100B
- BI: $68B

Resilience Tactics (Actions)

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 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
Resource Pooling/Sharing	Recontracting, selective exchange of resources, creating new partnerships
Production Recapture	Making up for lost production by working overtime or extra shifts.

Survey

Design of Two Large-area Surveys to Empirically Measure Economic Resilience

Survey Methodology

- **Two random samples: Superstorm Sandy (NY and NJ) and Hurricane Harvey (TX)**

- **Administered 60- and 13- months post-disaster for Sandy and Harvey, respectively**

- **Stratified by firm size and property damage (oversampled PD and firms >10 FTE employees)**

- **62% of firms in sample had *both* BI + PD**

- **Median firm of 30 FTE employees, mean 2,696 FTE employees (max of 90K FTEs)**

- **Sample size: 249 firms using 722 resilience tactics**

Designed to Estimate Resilience Metrics (RM) & (BCR)

Resilience Metric (RM)

$$RM_{i,j} = \frac{AvoidedLoss_{i,j}}{MaximumPotentialLoss_i}$$

Example: an RM of 0.08 means that firm *i* avoided 8% of its maximum potential losses using resilience tactic *j*

Benefit Cost Ratio (BCR)

$$BCR_{i,j} = \frac{AvoidedLoss_{i,j}}{Cost_{i,j}}$$

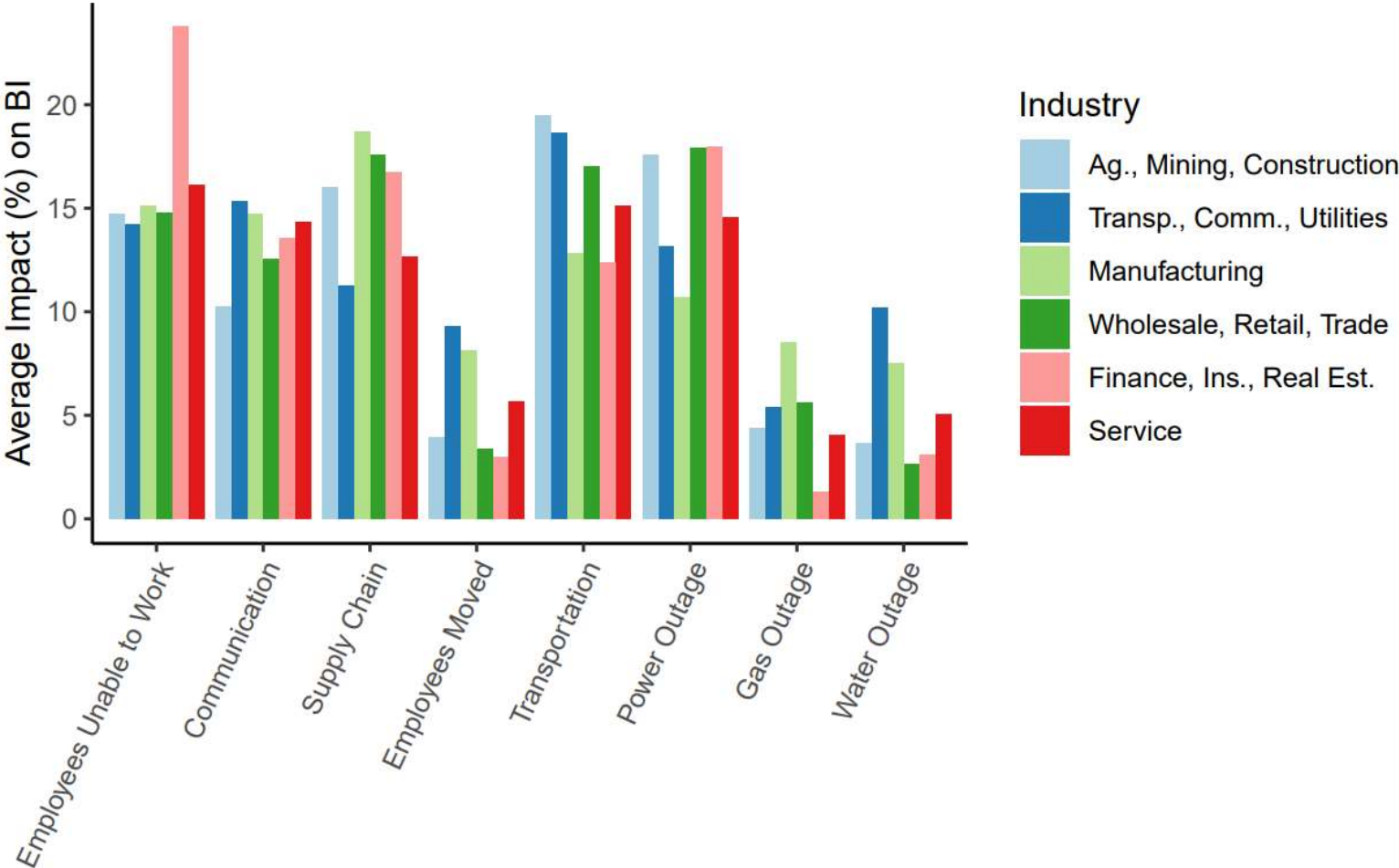*Example*: a BCR of 8.2 means that firm *i* avoided $8.20 for each dollar it spent implementing resilience tactic *j*

Results

Empirical Results from Surveys

Results

Impact on Business Interruption, by Disruption Type

Results: PD versus BI

Superstorm Sandy (NY/NJ)	Property Damage Median	Business Interruption Median	Ratio
Among *only* firms physically damaged	$100,000	$180,000	180%
All firms	$25,000	$100,000	400%

Hurricane Harvey (TX)	Property Damage Median	Business Interruption Median	Ratio
Among *only* firms physically damaged	$56,000	$725,000	1,294%
All firms	$5,000	$575,000	11,500%

Results: How Many Tactics Did Firms Use?

	Agriculture, Mining & Construction	Transportation, Communication & Utilities	Manufacturing	Wholesale & Retail Trade	Finance, Insurance & Real Estate	Service Sectors	All Sectors TOTAL
Business Interruption & Property Damage	3.2	4.7	4.1	2.8	3.1	3.9	3.6
Business Interruption Only	2.4	2.6	1.5	2.1	1.8	2.3	2.2

o Compared to firms observing only BI, firms observing Property Damage used, on average, **1.4 additional tactics**

o Generally, capital-intensive sectors such as transportation, communications, utilities and manufacturing used the greatest number of tactics

Results: Overall Metrics (BCR and RM)

	Net Avoided Losses ($)	Net Cost ($)	Net Maximum Potential Losses ($)	Net BCR	Net RM
Sandy	57,340,503	12,051,427	167,840,729	$4.76:1	0.3416
Harvey	27,102,750	6,440,180	1,111,919,004	$4.21:1	0.0244
Total	84,443,253	18,491,607	1,279,759,733	$4.57:1	0.066

Overall, firms avoided $4.57 for every dollar spent on resilience tactics

Overall, firms avoided 6% of max potential losses, considerably lower RM results for higher-severity Harvey results (2.4%) than Sandy results (34.1%)
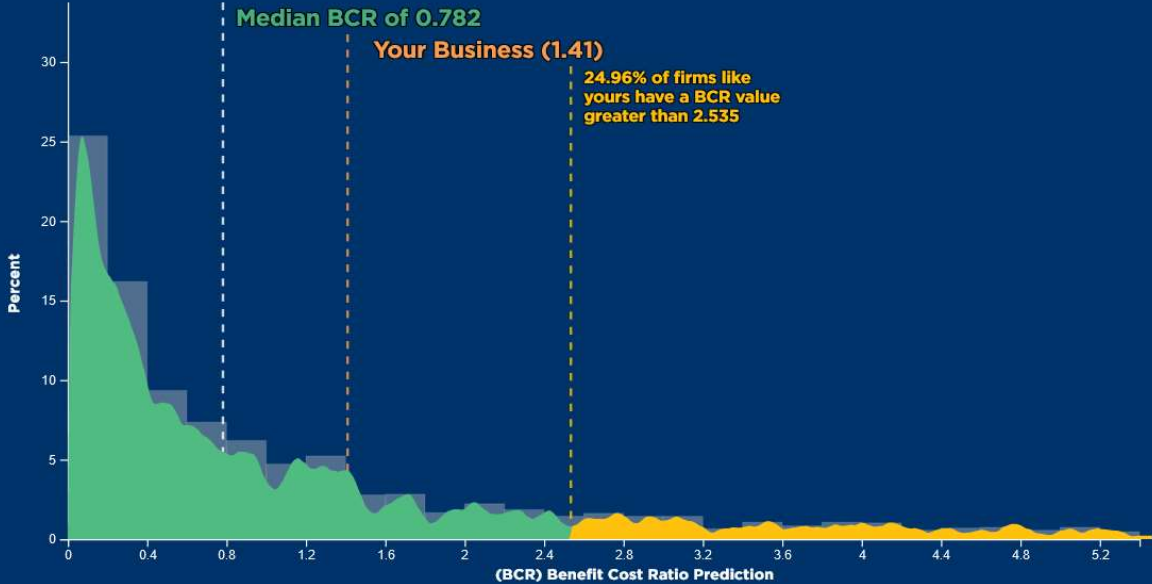
BRC Decision-support Software

Business Resilience Calculator

Provisional Patent No. 63/314,650

Policy Implications

What does this all mean? And, for whom?

Policy Implications

o First wide scale attempt to measure the cost effectiveness of resilience actions

o Results help tailor resilience recommendations; recommendations have a theoretical foundation in production theory

o Public Sector: DHS/FEMA, SBA, US Coast Guard, Economic Development Administration, State/County Office of Emergency Management, National Guard

o Private Firms: Predominantly SMEs without resilience officers/resilience analytics

o Insurance Industry: Insurance/Reinsurance

o Natural and human-induced hazards are increasing in economic disruptions → mitigation has not kept pace

o BI > property damage
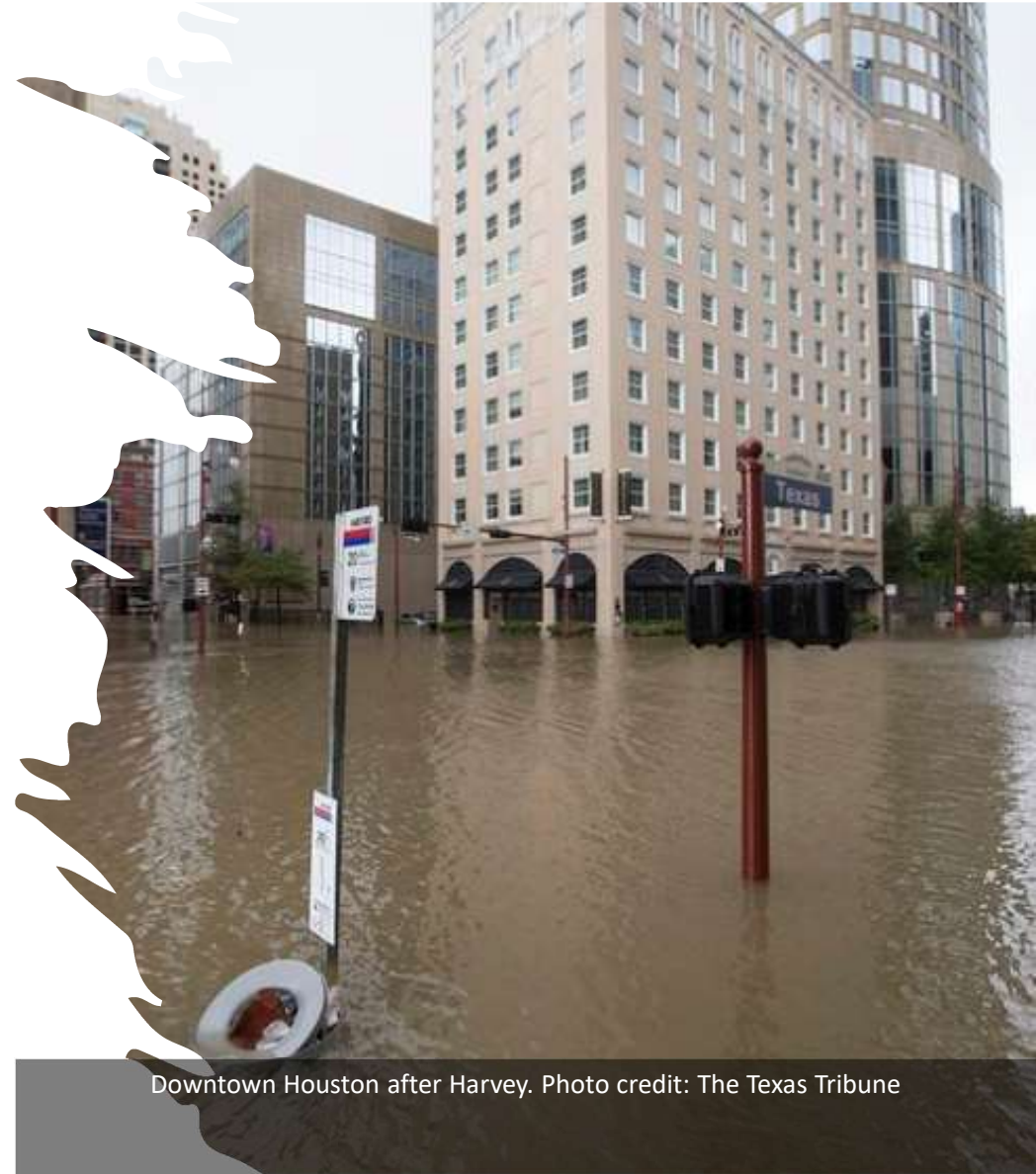
Downtown Houston after Harvey. Photo credit: The Texas Tribune

Thank you