



# **Economic Resilience: Concepts and Measurement**

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# Interpretations of Resilience

- Often refers to *any action* that reduces hazard losses
- But, there's a perfectly good word for actions taken ***before*** the disaster strikes – “mitigation”
- Best use of “resilience” – actions taken ***after*** it 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 the disaster strikes*
- Can only prevent property damage before the event, but can reduce ***business interruption*** afterwards
  - begins when the disaster strikes & continues until recovered
  - measured in terms of lost sales revenue, GDP, employment

# Prominence of Business Interruption

- 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

# Defining Economic Resilience

- Static:
  - General Definition: Ability of a system to *maintain function* when shocked.
  - Economic Definition: *Efficient use of remaining resources* at a given point in time to produce as much as possible.
- Dynamic
  - General: *Ability & speed* of a system to *recover*.
  - Economic: *Efficient* use of resources *over time* for investment in repair and reconstruction, including expediting the process & adapting to change
- *Metric: averted losses as % of potential losses*

# Economic Resilience Tactics

Resilience Tactic	Definition (Activities Involved)
<b>Conservation</b>	Maintaining production or service levels using lower amounts of an input
<b>Resource Isolation</b>	Modifying a portion of business operations to run without a critical input
<b>Input Substitution</b>	Replacing a production input in short supply with another
<b>Inventories</b>	Using emergency stockpiles and ordinary working supplies of inputs
<b>Excess Capacity</b>	Using plant or equipment that was idle
<b>Relocation</b>	Moving some or all of the business activity to a new location
<b>Mg't Effectiveness</b>	Improving the efficiency of business operations
<b>Import Substitution</b>	Obtaining needed production inputs from other regions
<b>Technological Change</b>	Improvising a production process
<b>Production Recapture</b>	Making up for lost production by working overtime or extra shifts
<b>Resource Pooling</b>	Re-contracting, creating new partnerships, clearinghouses, etc.

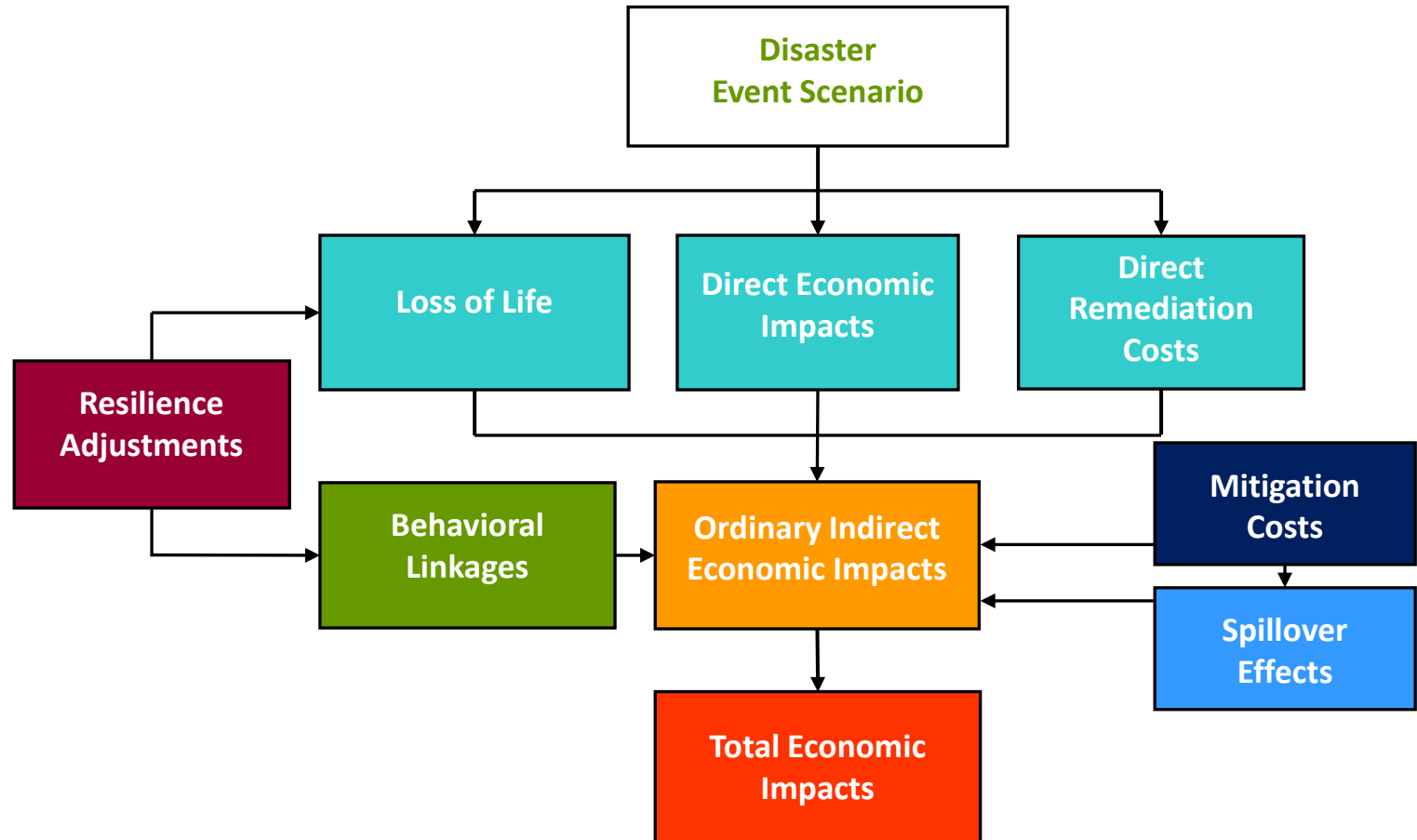
# Resilience Metric: 9/11 Relocation

- 1,100 firms in WTC; 95% survived by relocating
- If all of firms in the WTC area went out of business, direct Business Interruption loss would = \$43B GDP
- If all relocation were immediate, then BI = 0
- Delays took place; still most businesses relocated within 2-4 months, so BI loss = \$12B
- *Metric:* avoided loss / max potential loss  
$$\$31\text{B}/\$43\text{B} = 72\%$$

# Hurricane Harvey Survey Results

Tactic	Implementation Cost			Effectiveness (Avoided Losses)			Cost-Effectiveness
	Total Cost (Net)*	Average	Median	Total Effectiveness (Net)	Average	Median	Effectiveness/Marginal Cost Ratio**
Conservation	-\$921,120	-\$25,586	-\$1,000	\$1,0695,663	\$297,101	\$27,250	-11.6
Resource Isolation	441,090	11,921	0	6,149,022	170,806	39,000	14.3
Input Substitution	1,201,875	38,770	100	9,539,292	307,719	38,750	7.9
Inventories	\$3,490,610	\$64,640	0	\$4,119,222	\$77,721	\$30,000	1.2
Excess Capacity	-\$2,357,800	-\$157,186	\$0	\$2,834,450	\$188,963	\$67,850	-1.2
Relocation	\$676,100	\$18,780	\$4,750	\$11,706,813	\$325,189	\$42,618	17.3
Mgt Effectiveness	-\$4,870,720	-\$69,581	-\$125	\$12,469,063	\$180,711	\$29,375	-2.6
Import Substitution	-\$1,016,700	-\$46,213	\$0	\$8,457,967	\$422,898	\$25,000	-9.2
Technological Change	-\$1,513,625	-\$40,908	\$2,000	\$4,565,845	\$130,452	\$24,500	-3.2
Production Recapture	\$6,543,615	\$145,413	\$250	\$11,723,025	\$266,432	\$31,062	1.8
Resource Pooling	\$504,855	\$9,708	\$0	\$9,872,387	\$201,477	\$32,250	20.8

# CREATE Economic Consequence Analysis Framework





# COVID-19 Causal Factors

- Mandatory closures [Behavioral Linkage in part]
- Reopenings [Behavioral Linkage in part]
- Resilience through telework [Resilience]
- Workforce declines due to health issues
- Consumption & workforce declines due to avoidance [Behavioral Linkage]
- Changes in net demand for health care services [Behavioral Linkage in part]
- Increases in net demand for communication services [Resilience]
- Pent-up demand [Resilience]

# Telework Potentials

Industry	% Workers Who Could WFH	% of Workers Who Did WFH at Least Occasionally	Average
Agriculture, forestry, fishing, hunting	11.1	10.4	10.8
Construction	17.2	14.4	15.8
Manufacturing	30.3	25.7	28.0
Wholesale and retail trade	16.5	13.9	15.2
Transportation and utilities	14.0	12.5	13.3
Information	53.3	45.1	49.2
Financial activities	57.4	46.7	52.1
Professional and business services	53.4	47.4	50.4
Education and health services	25.9	23.7	24.8
Leisure and hospitality	8.8	6.8	7.8
Other services	27.7	22.6	25.2
Public administration	29.8	21.8	25.8
Federal government	31.4	24.5	28.0

Source: Adapted from BLS (2019).

# Real GDP Impacts (billions of 2018\$ U.S.)

Country/ Region	Mandatory Closure & Reopening	Avoidance Behavior	Communi- cation Demand	Deaths & Illness	Health Expenses	Pent-up Demand	Total Impacts
<b>Scenario 1</b>							
<b>USA</b>	-4,780.8	-6.7	208.7	-0.7	21.4	1,394.3	-3,163.7 (-14.8)
<b>China</b>	-1,210.9	-7.9	83.3	0.0	0.2	394.2	-741.2 (-5.2)
<b>ROW</b>	-8,301.9	-66.7	710.8	-0.3	4.5	2,503.7	-5,123.1 (-9.8)
<b>Scenario 3</b>							
<b>USA</b>	-12,996.8	-885.1	577.8	-5.1	189.8	8,186.6	-4,932.8 (-23.0)
<b>China</b>	-3,513.0	-539.8	119.3	-0.2	1.2	2,993.5	-939.0 (-6.6)
<b>ROW</b>	-26,251.3	-2,596.3	1,768.1	1.1	22.1	17,697.1	-9,359.3 (-17.8)

# Interpretation

- Negative impacts are considerable world-wide
- Impacts greater than direct effects of closures
  - unemployed workers have less money to spend
  - supply chains are impacted: e.g., restaurants close => demand for agriculture declines, and so on . . .
- Impacts on US are larger than other areas due to:
  - Higher portion of country impacted by closures/for longer
  - Greater importance of non-essential sectors to the economy
  - Large share of workers in non-essential services sectors (tend to be more labor-intensive than essential sectors)

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