Measuring Total Economic Benefits of USCG Marine Safety Programs

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Objectives of the Study

- Evaluate the benefits of Marine Safety Programs by estimating all potential regional and national economic losses of a port disruption.

- Refine the consequence analysis methodology to factor in various resilience adjustments.

- Estimate the effectiveness of resilience tactics related to port disruptions.

Economic Losses of Port Disruptions

- Direct losses
  - damage to port facilities
  - damage to ships and cargo

- Indirect losses
  - direct business interruption at the port
  - indirect business interruption to the economy
  - environmental damage

$\Rightarrow$ Probability-weighted avoided losses

= benefits of safety programs

Defining Economic Resilience

- <u>Static</u>: Ability of a system to maintain function when shocked (efficient use of remaining resources at a given point in time).

- <u>Dynamic</u>: Speed of a system to recover from a shock (efficient use of resources over time for investment in repair and reconstruction).

Measuring Econ Resilience of 9/11

- 95% of over 1,100 WTC area firms relocated after 9/11

- If all of firms in the WTC area went out of business, direct business interruption (BI) loss would = $58.4B

- If all relocation were immediate, then no BI

- Businesses relocated within 8 months , BI = $16.1B

- Resilience Metric: Avoided Loss ÷ Max Potential Loss

$$\$42.3B \div \$58.4B = 72\%$$

Resilience to Port Disruptions

- Strategic Petroleum Reserve

- Ordinary Inventories of all goods

- Conservation by Customers

- Import Ship Diversion & Overland Rerouting

- Export Diversion (to replace imports)

- Production Rescheduling (Recapture)

Input-Output Analysis Approach

- Definition: A linear model of all purchases and sales between sectors of the economy, based on the technological relations of production.

- Most widely used tool of impact analysis

- Will use two versions:
  - Demand-side (upstream in supply-chain)
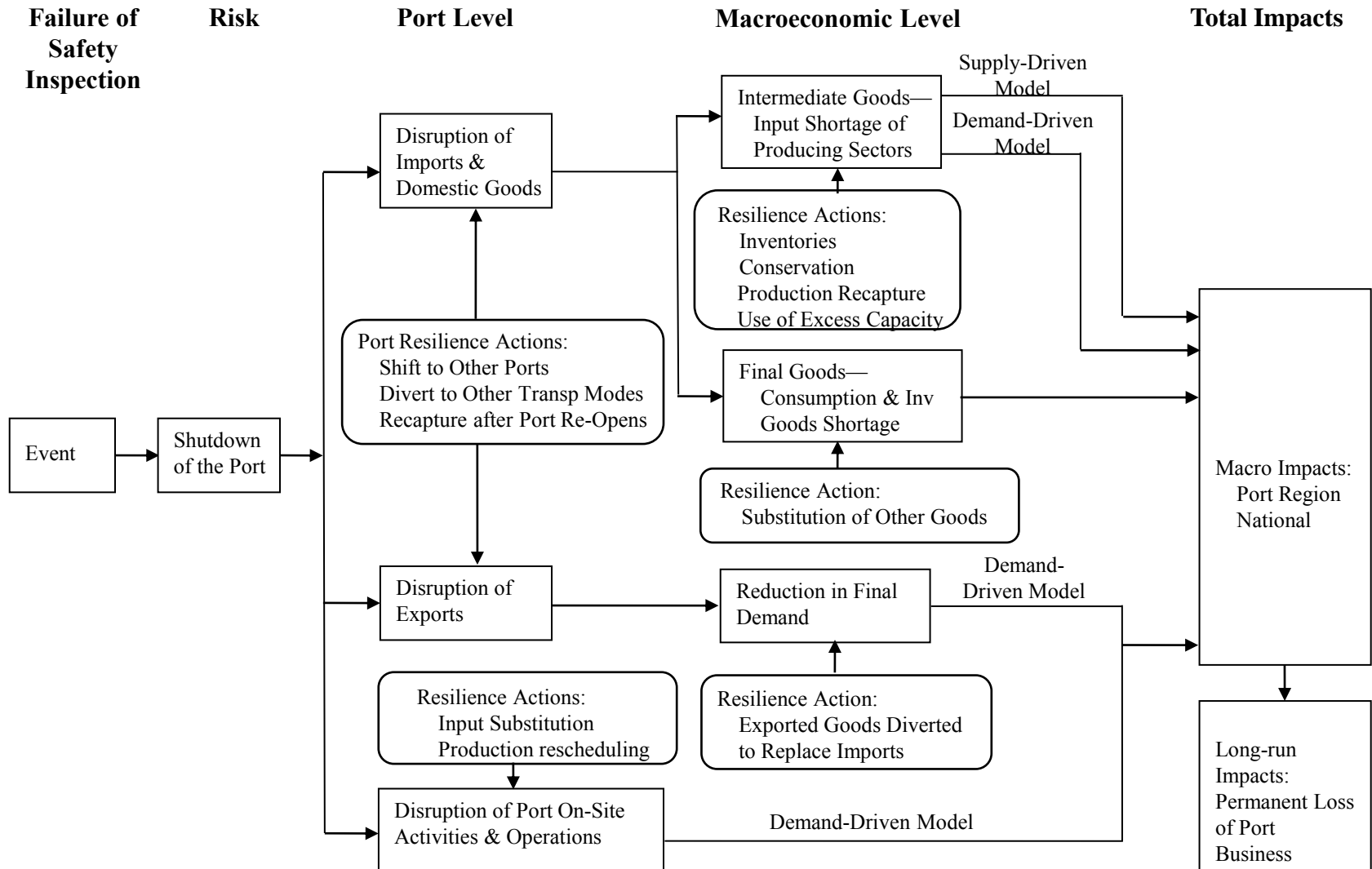 - Supply-side (downstream in supply chain)

Figure 1. Estimating Total Economic Impacts of A Port Shutdown

Port Arthur/Beaumont Case Studies

- Two Scenarios:
    1. Complete Port Shutdown (90 days)
    2. Medium Consequence (4 days)

- Evaluate Impacts for Two Geographic Areas:
    - 3-County Beaumont-Port Arthur MSA
    - U.S. as a whole

- Factor in 6 types of resilience

Port Arthur Economy

- Total Gross Output in 2008: $71 billion

  - Petroleum Refining nearly 50%

  - Petro & Other Chemicals 15%

  - Other sectors (Construction, Business Svcs)

- Imports by ship:

  - More than 60% are Crude Oil

  - Other commodities (Petroleum and Other Chemical Products about 25%)

Resilience to Port Disruptions: Ship Diversion & Overland Rerouting

- USCG estimate: 90% re-routing of import shipping

- Assume no re-routed crude oil and refined petroleum products are transported back to the Port Region

- Direct output losses reduced from $7.0 to $4.5 billion

Resilience: Strategic Petroleum Reserve (SPR)

- Release 4.16 million barrels of crude oil from SPR (= 20% of total SPR drawdown in the aftermath of Hurricane Katrina)

- Major Presidential political decision

- Aim in this case: to maintain minimum level operation of key refineries in the Region

- Direct output losses reduced from $7.0 to $6.5 billion

Resilience: Ordinary Inventories of All Goods

- Use of inventories by port customers to reduce the impact from import disruptions

- Direct output losses reduced from $7.0 to $5.0 billion

Resilience: Export Diversion (to replace imports)

- Diversion of export commodities to importers of the same commodities

- Reduce potential losses on both import and export sides

- Direct output losses reduced from:

  $7.0 to $6.0 billion on the import side

  $3.3 to $1.5 billion on the export side

Resilience: Conservation

- More careful use of scarce materials

- Assume the ability to conserve 2% of all material inputs

- Direct output losses reduced from $7.0 to $6.8 billion

Resilience: Production Rescheduling (Recapture)

- Ability to make up lost production through working overtime or extra shifts after the crisis is over

- Often found to be the most effective resilience measure in the literature

- Apply directly to total losses (direct + indirect)

Summary Table 1. Gross Output Impacts

Scenario	Output Impact w/o Resilience		Output Impact w/ Resilience	
	Million 2008$	Percent	Million 2008$	Percent
Medium Consequence				
Port Region	452.2	57.8%	93.7	12.0%
U.S.	3,735.6	1.2%	342.4	<0.1%
Complete Port Shutdown				
Port Region	12,729.4	71.4%	4,021.7	22.5%
U.S.	164,903.5	2.4%	8,506.1	<0.1%

Economic Impacts of the 3-Month
Port Arthur/Port Beaumont Import Disruption
(in million 2008 dollars)

Case	Direct Output Loss	Total Impacts	Total Impacts (%)
A. Base Case (No Resilience)	$6,959	$9,622	(53.9%)
B. With Ship Re-routing	$4,549	$5,498	-23.1%
C. With Export Diversion	$5,962	$8,372	-7.0%
D. With SPR	$6,555	$9,178	-2.4%
E. With Use of Inventories	$4,958	$6,757	-16.0%
F. With Conservation	$6,820	$9,475	-0.8%
G. W/ Production Rescheduling	b	$5,078	-25.4%
H. With All Resilience Adjusts	c	$2,092	-42.2%

Summary

- Input-Output approach valid for S-R disruptions, if supplemented by resilience adjustments

- 90-day Port Arthur/Beaumont disruption could reduce economic activity in MSA by $13 billion, 71% of GDP (resilience can reduce total losses to $4 billion, 23%)

- 90-day Port Arthur/Beaumont disruption could reduce economic activity in US by $165 billion, 2.4% of GDP (resilience can reduce total losses to < 0.1% of GDP)

- Production rescheduling and re-routing are the two most effective resilience tactics for port disruptions

Future Work

- Apply SOA Computable General Equilibrium Model

- Factor in cost increases of ship diversion

- Factor in input substitution

- Factor in market resilience from price adustments

Summary Table 2. Miscellaneous Costs

Category	Cost (million 2008$)
Economic Costs of Oil Spill	0.7
Delay Costs of Shipping	4.0
Security Value of Oil Release from SPR	15.6
Total	20.3

Total Sectoral and Regional Economic Impacts of the Port Disruption

#	Sector	Total Output Impacts of Imports, Exports, Port On-Site Operation Disruptions ($M)	After Cap Total Impacts ($M)	% Output Impacts	Total Output Impacts of Imports, Exports, Port On-Site Operation Disruptions (After Resilience Adjs) ($M)	% Output Impacts (After Resilience Adjs)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
9	Construction	299.5	299.5	36%	24.3	3%
⋮	⋮	⋮	⋮	⋮	⋮	⋮
17	Petroleum refineries	7,467.3	7,467.3	85%	2,782.1	32%
⋮	⋮	⋮	⋮	⋮	⋮	⋮
20	Petrochemical mfg	2,194.5	1,668.0	100%	313.9	19%
⋮	⋮	⋮	⋮	⋮	⋮	⋮
22	Other basic organic chemical mfg	1,163.9	579.3	100%	350.4	60%
⋮	⋮	⋮	⋮	⋮	⋮	⋮
25	Other chemical mfg	628.3	556.2	100%	81.4	15%
⋮	⋮	⋮	⋮	⋮	⋮	⋮
30	Iron and steel mills and ferroalloy mfg	201.3	180.2	100%	121.3	67%
⋮	⋮	⋮	⋮	⋮	⋮	⋮
33	Other machinery and equipment mfg	226.3	226.3	61%	15.9	4%
⋮	⋮	⋮	⋮	⋮	⋮	⋮
47	Other business services	309.3	309.3	43%	37.3	5%
⋮	⋮	⋮	⋮	⋮	⋮	⋮
	Total	**13,933.7**	**12,729.4**	**71%**	**4,021.7**	**23%**