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Modeling the Economic Impact of COVID-19

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HOMELAND SECURITY UNIVERSITY PROGRAMS
TODAY'S RESEARCH & EDUCATION, TOMORROW'S SECURITY

Objectives and Overview

- Causal Factors
- Scenario Overview
- Behavioral Considerations
- Resilience
- Review of Our Previous Studies

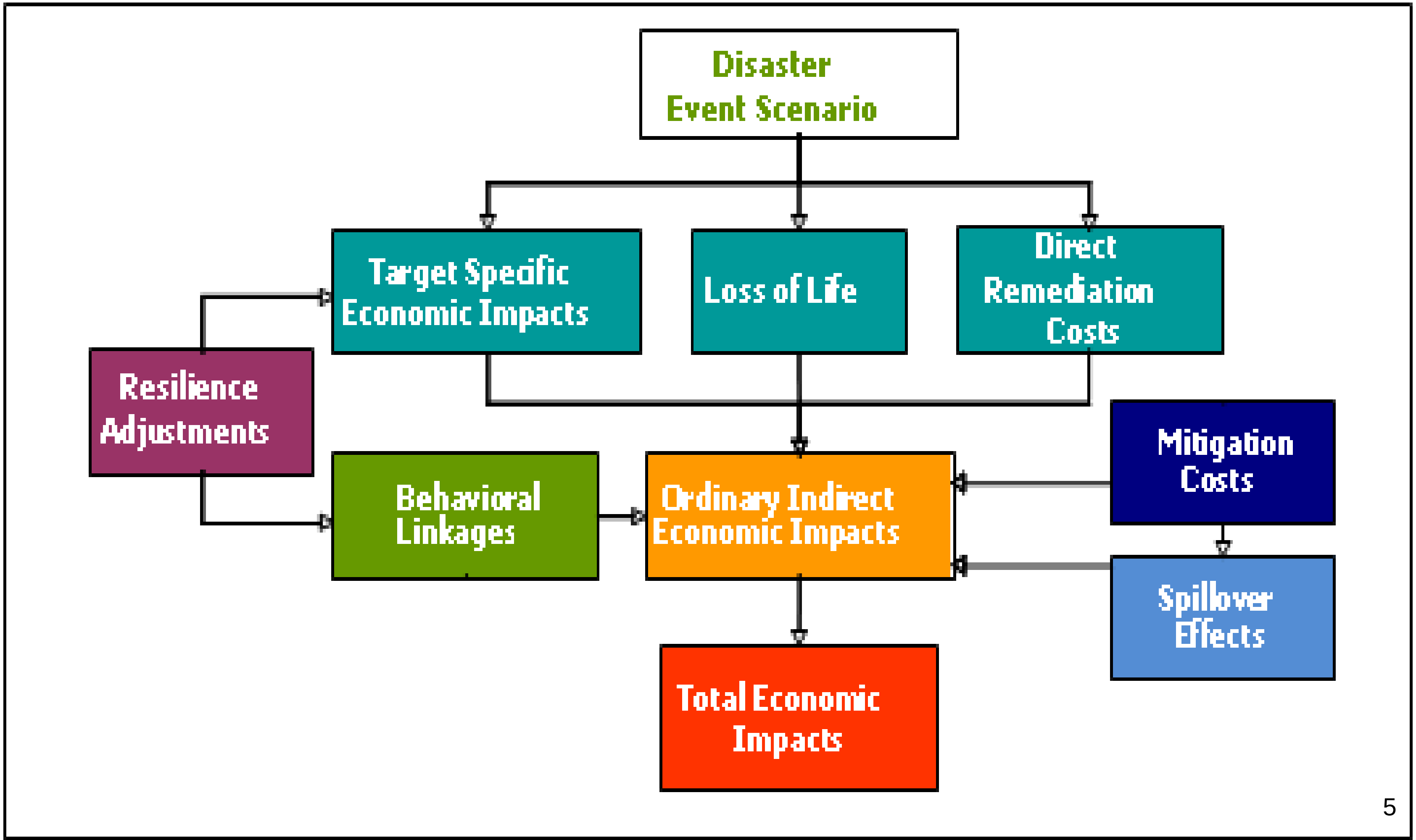
Causal Factors

- Factors affecting Labor Force Participation
  - death, hospitalization, home care-giving
  - inability to get to work
  - voluntary mandatory business and school closures
  - vaccination
- Factors affecting Supply
  - voluntary mandatory business closures
  - interruption of critical inputs from domestic and foreign sources
- Factors affecting Demand
  - drop in demand for output from both domestic & foreign customers
  - surge sectors (health care, medical supplies, delivery, construction)
- Behavioral Factors (avoidance, panic buying)
- Resilience (telecommuting, production rescheduling)

Scenarios

Case	Severity & Timing	Avoidance	Vaccination	Import/ Export	Resilience
1.	Mild & Contained (3 months)	minimal	no	delay	high
2a.	Moderate & Slow Onset (6 months)	minimal	no	delay	high
2b.	Moderate & Slow Onset (6 months)	moderate	yes	delay	high
2c.	Moderate & Slow Onset (6 months)	panic	no	disruption partial	moderate
3a.	Pandemic & Exponential (18 months)	moderate	yes	disruption partial	moderate
3b.	Pandemic & Exponential (18 months)	mandatory	no	disruption	low

CREATE Economic Consequence Analysis Framework



Disaster Event Scenario

Target Specific Economic Impacts

Loss of Life

Direct Remediation Costs

Resilience Adjustments

Behavioral Linkages

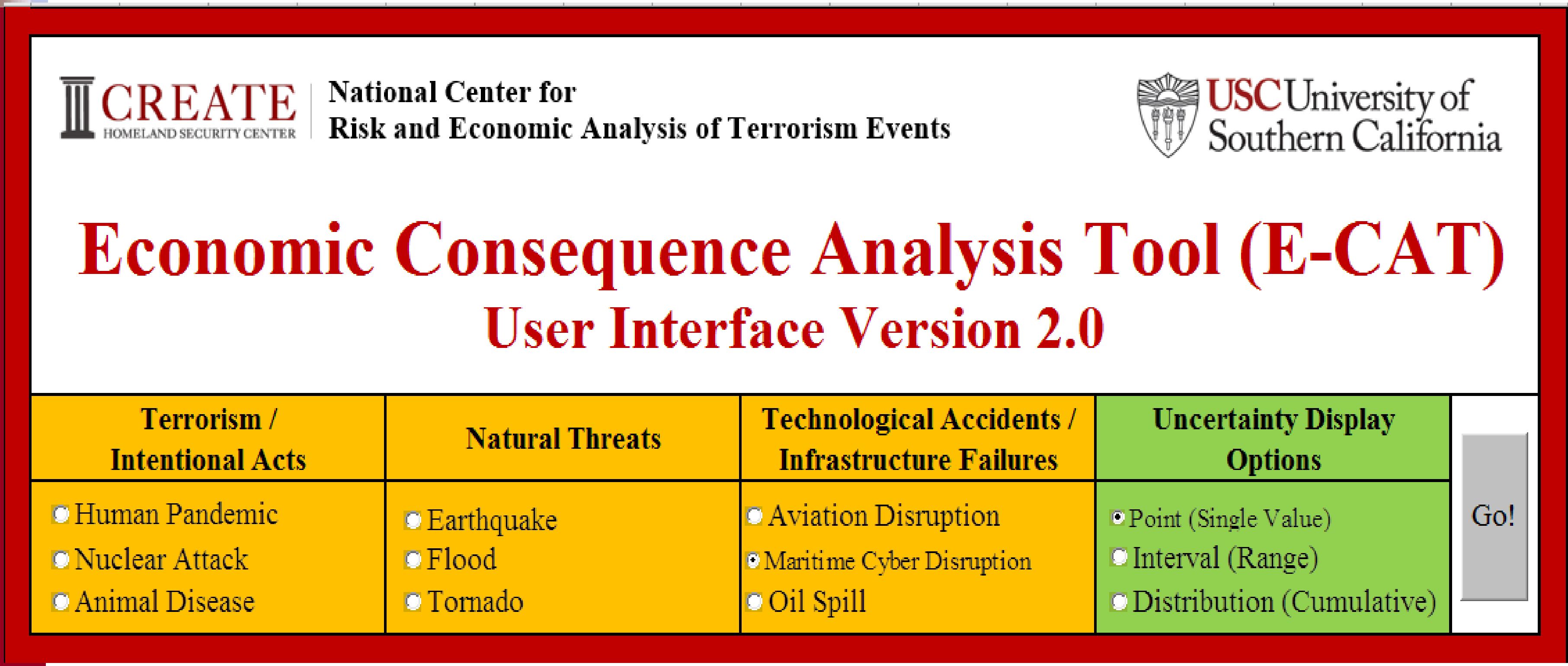
Ordinary Indirect Economic Impacts

Mitigation Costs

Spillover Effects

Total Economic Impacts

E-CAT User Interface



CREATE HOMELAND SECURITY CENTER

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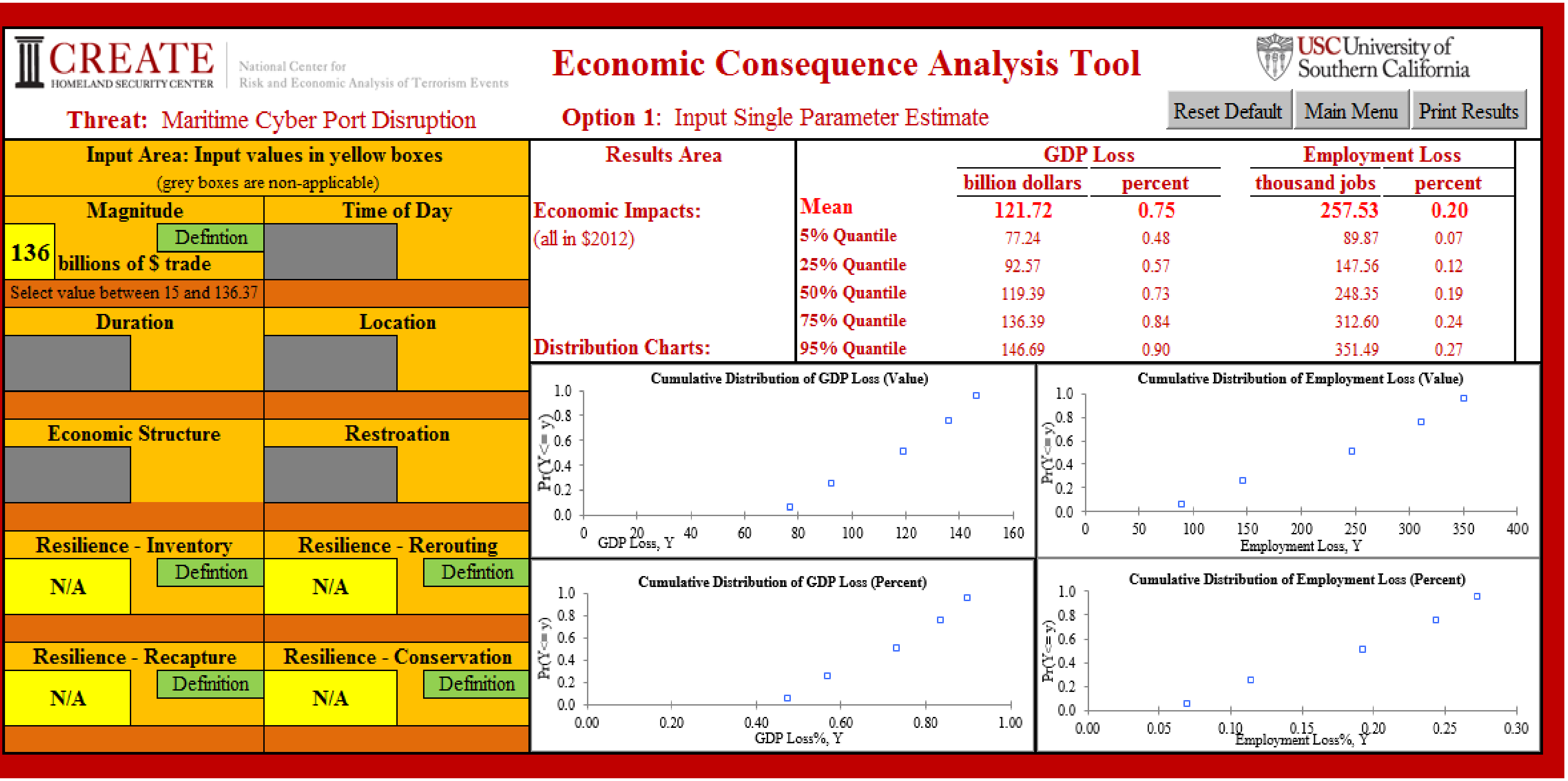
Economic Consequence Analysis Tool (E-CAT)

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 Value


CREATE
HOMELAND SECURITY CENTER
National Center for Risk and Economic Analysis of Terrorism Events
USC University of Southern California
Reset Default
Main Menu
Print Results
Defintion
Defintion
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Defintion
Defintion
Cumulative Distribution of GDP Loss (Value)
Pr(Y<= y)
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
140
160
GDP Loss, Y
Cumulative Distribution of Employment Loss (Value)
Pr(Y<=y)
1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
200
250
300
350
400
Employment Loss, Y
Cumulative Distribution of GDP Loss (Percent)
Pr(Y<=y)
1.0
0.8
0.6
0.4
0.2
0.0
0.00
0.20
0.40
0.60
0.80
1.00
GDP Loss%, Y
Cumulative Distribution of Employment Loss (Percent)
Pr(Y<=y)
1.0
0.8
0.6
0.4
0.2
0.0
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Employment Loss%, Y

Economic Consequence Analysis Tool

Threat: Maritime Cyber Port Disruption

Option 1: Input Single Parameter Estimate

Input Area: Input values in yellow boxes

(grey boxes are non-applicable)

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

Results Area

Economic Impacts:
(all in $2012)

	GDP Loss		Employment Loss	
	billion dollars	percent	thousand jobs	percent
Mean	**121.72**	**0.75**	**257.53**	**0.20**
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
95% Quantile	146.69	0.90	351.49	0.27

Distribution Charts:

Behavioral Linkages

- Off-site responses associated with behavioral changes (business, household, investor, worker)
- Emanates from social amplification of risk & stigma effects (media coverage, rumor)
- Fear feeds on itself and spreads
- Translates into direct and indirect BI losses
- Can be 2 to 3 orders of magnitude higher

Behavioral Linkage Examples

- 9/11 led to a 2-year reduction in air travel
- Workers fear of riding the subway/bus
- Business fear of staying open after dark
- Investor fear of taking high risk
- General avoidance behavior
- Gov’t premature shutdown or evacuation

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: *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*

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 BI = $0
- Businesses relocated 2 to 4 months, BI = $16.1B
- Resilience Metric: Avoided Loss ÷ Max Potential Loss

$42.3B ÷ $58.4B = 72%

Total Economic Consequences of an Influenza Outbreak in the United States

Fynnwin Prager, Dan Wei, and Adam Rose

Broader Context

- **National Biosurveillence Integration Center (NBIC) Project on Value of Economic Information**
- **Broaden the scope of econon consequence analysis**
  - current focus on direct (partial equilibrium) impacts; narrow interpretation of benefit-cost analysis
  - we seek to incorporate ordinary indirect impacts
- **Also include new set of impacts**
  - behavioral linkages (fear leading to avoidance/aversion)
  - resilience (actions that maintain economic function & accelerate recovery)

Simulation Scenarios

- Case 1: No Vaccination, Seasonal Outbreak
- Case 2: No Vaccination, Pandemic Outbreak
- Case 3: Vaccination, Seasonal Outbreak
- Case 4: Vaccination, Pandemic Outbreak

Direct Impacts (Case 4)

Impact Category	USCGE Modeling Approach	Level Impact[a]	% Impact
Workforce Participation	Reduction in labor workforce participation	-68.5M	-0.31%
Medical Expenditures	Increase household spending on medical services	$65.59B	3.79%
Avoidance Behavior	Staying home from work (reduction in labor workforce participation)	-$8.09B	-0.09%
	Keeping children from school (reduction in attendance of educational facilities)	-$0.45B	-0.13%
	Keeping children from school (caregiver avoidance; reduction in labor workforce participation)	-$0.77B	-0.01%
	Reduction in Inbound International Travel	-$11.94B	-14.88%
	Reduction in Outbound International Travel	-$5.92B	-14.88%
	Reduction in Domestic Travel/Leisure Activities	-$15.54B	-2.34%
	Reduction in Public Transportation Use	-$140.36M	-2.34%
Economic Resilience	Recapture Production thru Overtime or Extra Shifts	27.4M	0.19%

[a] If not dollars; person work-days

Magnitude and Length of Avoidance Behaviors

Avoidance Responses	Literature Review Findings	Direct Impacts Adapted from the Literature	Adapted Values Used in the Analysis (Case 4)
Staying home from work	60% avoid, 1 week	-1.25%	-0.09%
Keeping children from school (education sector impacts)	60% avoid, 1 week	-1.67%	-0.13%
Keeping children from school (caregiver avoidance)	60% avoid, 1 week	-1.25%	-0.01%
Avoiding medical professionals	22% avoid, 1 month	-1.83%	N/A
Reducing shopping	69% avoid, 1 month	-5.75%	N/A
Avoiding entertainment venues	75% avoid, 5 months	-31.25%	-2.34%
Avoiding public transportation	75% avoid, 5 months	-31.25%	-2.34%
Rescheduling travel plans	16% avoid, 5 months	-6.67%	N/A

GDP Impacts on the U.S. Economy

(billions of 2012 dollars)

Results	No Vaccination		Vaccination	
	Seasonal	Pandemic	Seasonal	Pandemic
GDP impacts (without avoidance and without resilience)	-4.95	-25.40	-4.71	-19.94
Avoidance impacts	-6.19	-33.39	-4.59	-25.12
Resilience impacts	2.22	13.47	2.31	10.63
Summation	-8.92	-45.32	-6.99	-34.43

Aggregate Impacts on the U.S. Economy (with & without recapture)

Direct Impact	Case	Direct Impacts to GDP ($B)	Total Impact on GDP		Employment ('000s Jobs)	
			Level ($B)	%	Level	%
Summation (no recapture)	Case 1	-4.1	-11.2	-0.07	-88	-0.12
	Case 2	-5.6	-58.8	-0.36	-464	-0.56
	Case 3	-0.8	-9.3	-0.06	-73	-0.10
	Case 4	-2.3	-45.1	-0.28	-356	-0.43
Summation (with recapture)	Case 1	-2.8	-8.9	-0.06	-70	-0.09
	Case 2	2.2	-45.3	-0.28	-358	-0.41
	Case 3	0.6	-7.0	-0.04	-55	-0.07
	Case 4	3.9	-34.4	-0.21	-272	-0.31

Conclusions

Direct impacts

- Mild outbreak has net negative direct impacts
- Severe outbreak net positive: +ive medical spending
- Vaccination impact is twofold: 1) reduces medical treatment expenditure and illness related workday losses; 2) incur medical cost and workday lost itself

General equilibrium impacts

- Mild and Severe outbreaks negative impacts: hh budget constraints and substitution reduce direct impacts
- Vaccination is more effective to reduce GDP and employment impacts in Pandemic Outbreak scenario

Policy Implications

- Behavior is key factor
  - avoidance and aversion behavior
  - gov’t policy and public health officials can focus on influencing behavior thru risk messaging
- Resilience is significant but less so
  - business (labor) production recapture
  - encourage flexible working hours can help

Macroeconomic Impacts of Shutting Down the U.S. Borders to a Security or Health Threat

Adam Rose, Garrett Asay, Dan Wei, and Billy Leung

Impact Categories Modeled

- Halt in all imports from rest of the world
- Border cessation of all U.S. exports
- International travel ban outbound & inbound traffic
- Halt of documented & undocumented migrants

Trade Simulations

- Export closure -- straightforward

- Import closure -- complicated
  - REMI assumes full domestic substitution
  - doesn't automatically assume price increases

- Export-Import interaction
  - could divert exports to sub for imports; however, not perfectly substitutable
  - REMI cannot distinguish export diversion from domestic substitution anyway

Export Closure Results

Economic Indicator	Difference from Baseline Level	Difference from Baseline Percent
Employment (thousands)	-17,240	-9.9
GDP (billion 2000$)	-1,360	-11.9
CPI	-0.82	-0.73

Export Closure Results, Sectoral

	Difference from Baseline[a]			
	Direct Effect		Total Effect	
Sector	Level	Percent	Level	Percent
Computer, electronic prod mfg	-173.49	-27.78	-215.9	-34.57
Chemical mfg	-69.27	-14.96	-111.2	-24.01
Machinery mfg	-65.40	-23.76	-81.17	-29.49
Motor vehicle mfg	-65.31	-13.67	-107.8	-22.56
Food mfg	-19.92	-4.52	-59.92	-13.60
Primary metal mfg	-12.86	-9.10	-44.92	-31.77
Total	-988.99	-5.60	-2,602.86	-14.74
Implicit multiplier (total effect /direct effect)			2.63	

[a] in billion 2000 dollars

Export Closure Results

- A border shutdown of all exports results in significant negative impacts on the U.S. economy due to the loss of demand from foreign markets.
- An associated import reduction of around 12%
  - reduction in inputs demand from the international market due to decrease in production for exports

Import Closure Inputs

- Assume loss in import is compensated by the use of excess capacity at the level of 20%

- Estimate sectoral production cost increases
  - Estimate import replacement gap after the use of excess capacity for each REMI sector
  - Estimate price differentials between imported goods and their domestic substitutes for REMI sectors that have import replacement gap
  - Estimate sectoral production cost increase based on proportion of total import value of GDP for the sector

Import Closure Results

Assume import replacement by utilizing excess capacity at the level of 20%

	Difference from Baseline	
Economic Indicator	Level	Percent
Employment (thousands)	-19,040	-10.99
GDP (billion constant 2000$)	-666.3	-5.82
CPI	32.33	29.02

Import Closure Results

- A closure of all imports will cause significant negative impacts to the U.S. economy.
- Negative impacts from production cost increase more than offsets the positive impacts from increased demand for domestic substitutes.

International Travel

- Simulated costs associated w/ cutoff of international travel to & from U.S.
- Input values based on:
  - Travel Industry Association of America (2002)
  - Bureau of Transportation Statistics (2005)
    - International visitors in 2005 spent $88.1 billion
    - U.S. & foreign citizens spent $49.5 billion on airline tickets

International Travel Results

	Difference from Baseline	
Economic Indicator	Level	Percent
Employment (thousands)	-3,375	-1.95
GDP (billion constant 2000$)	-175	-1.53
CPI	-0.17	-0.15

Most negatively impacted sectors include Air Transportation, Accommodation, and Food Services and Drinking Places

Migration Results

	Difference from Baseline			
	Documented		Undocumented	
Economic Indicator	Level	Percent	Level	Percent
Employment (thousands)	-277	-0.16	-393	-0.23
GDP (billion constant 2000$)	-18	-0.16	-24	-0.21
CPI	0.02	0.02	0.27	0.24
Population (thousands)	-1012	-0.34	-0.031	-0.03

All Cross-border Activities Shutdown -- Simple Summation

Assume import replacement by utilizing excess capacity at the level of 20%

	Difference from Baseline				
Economic Indicator	Imports	Exports	Travel	Migration	Total
Employment (thousands)	-19,040	-17,240	-3,375	-671	-40,326
GDP ($B)	-666	-1,360	-175	-43	-2,243
CPI	32.33	-0.82	-0.17	0.29	31
Population (thousands)	*	*	*	-1,012	-1,012

All Cross-border Activities Shutdown -- Simultaneous Simulation

- Estimate the economic impacts on the U.S. economy of a one year border closure for all goods & people
- Simultaneously utilize all the inputs in individual border closure cases in REMI Model
- Assume import replacement by utilizing excess capacity at the level of 20% plus Export Diversion

All Cross-border Activities Shutdown -- Simultaneous Simulation Results

Assume import replacement by utilizing excess capacity at the level of 20% plus Export Diversion

	Difference from Baseline	
Economic Indicator	Level	Percent
Employment (thousands)	-22,130	-12.77
GDP (billion constant 2000$)	-1,194	-10.44
CPI	16.68	14.98
Population (thousands)	-1,012	-0.3

Conclusions

- A one-year border shutdown likely to lead to U.S. GDP losses of $1.4 trillion (2006$), or about a 10.5% reduction and employment losses of 22 million, or more than 12% below base level.

- Two largest negative components are export and import shutdowns

- Estimates should be considered upper bounds.

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