Economic Consequence Analysis Using Applied General Equilibrium Models
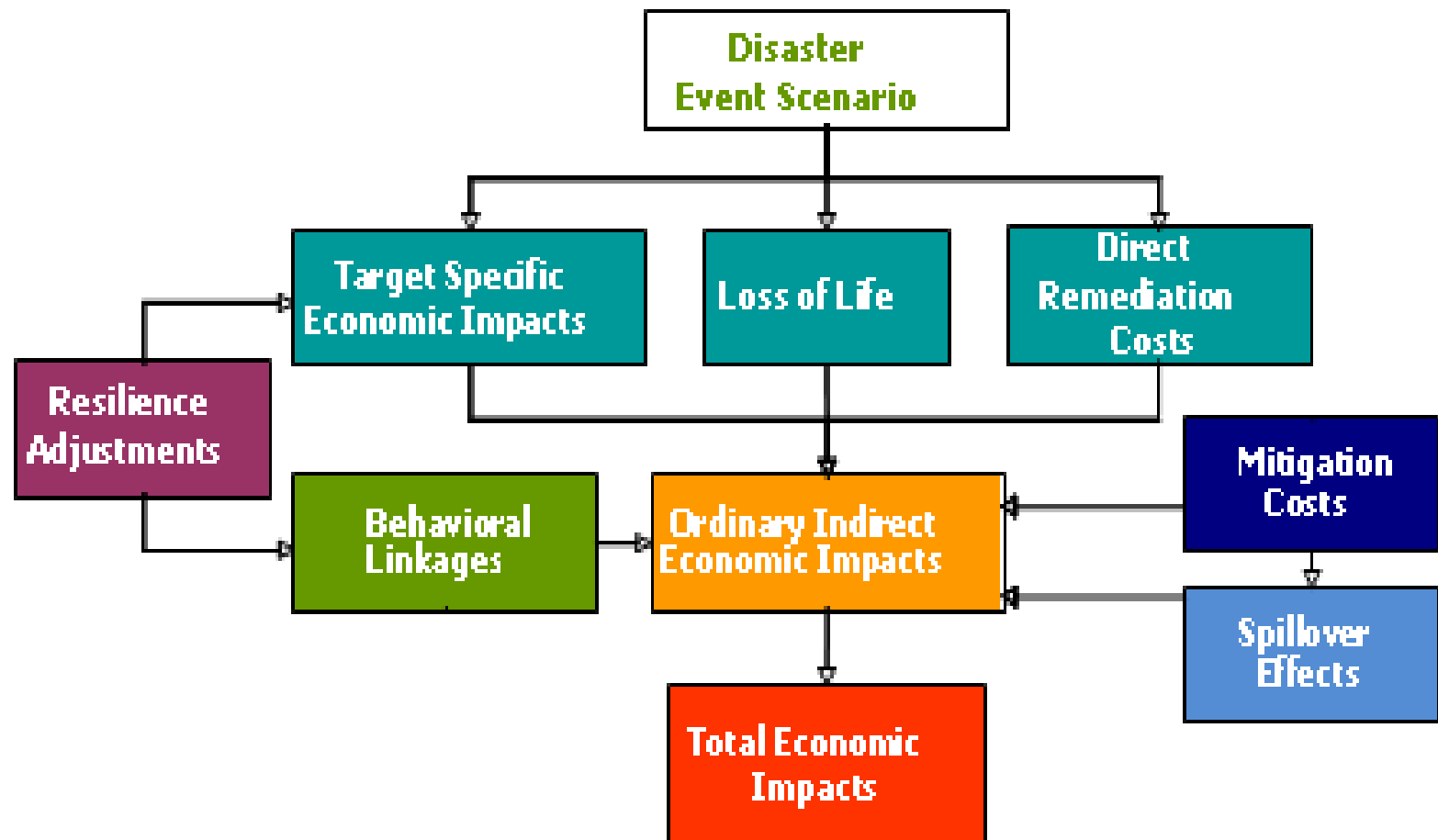
Adam Rose

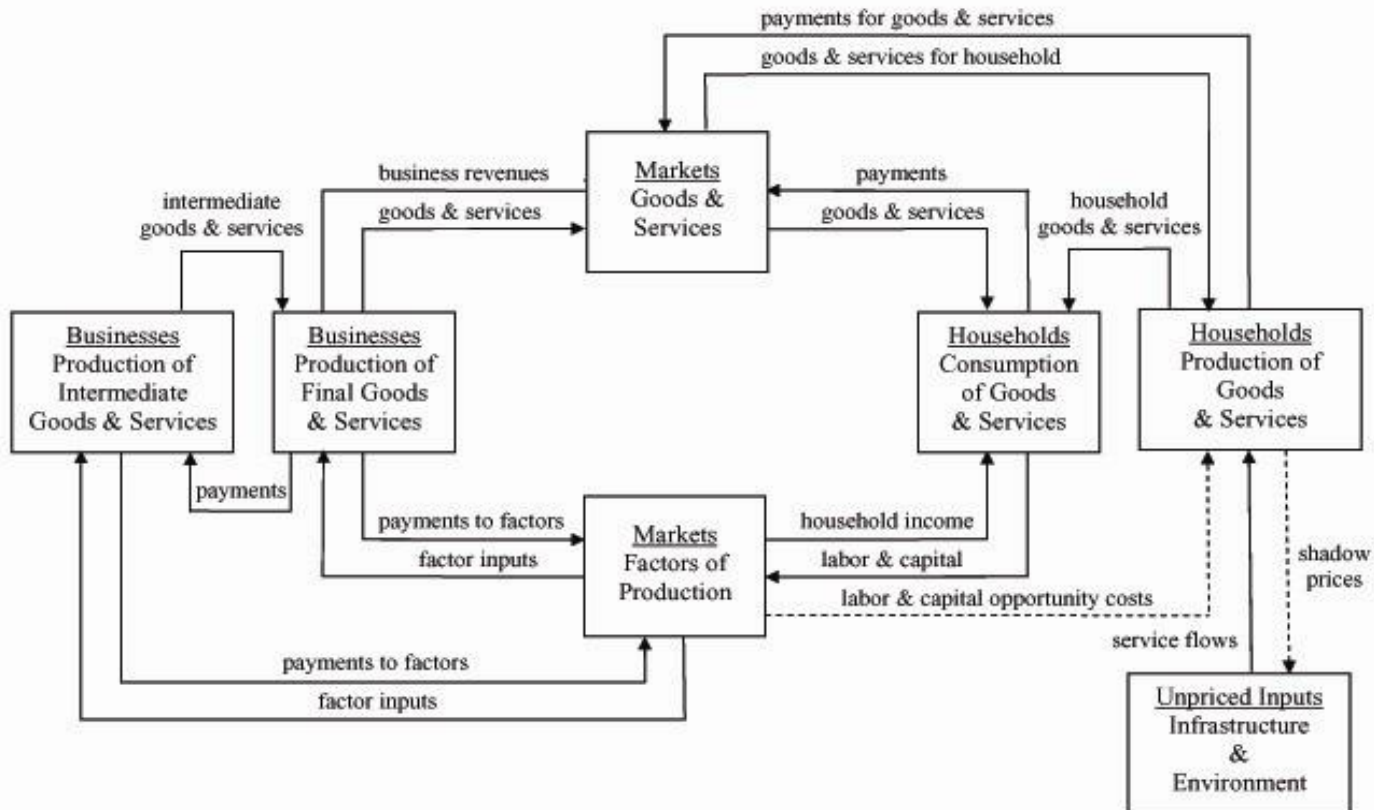## CREATE Director

August 21, 2020

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

CREATE Economic Consequence Analysis Framework

Expanded Circular Flow of the Economy

Computable General Equilibrium Analysis

- A model of the entire economy based on decisions by individual producers & consumers in response to price signals, regulations & external shocks within limits of available capital, labor & natural resources.

  (The economy as a set of interrelated supply chains)

- ImpactEcon Model
  - Extension of the GTAP Model
  - 141 countries
  - 65 goods and services (or sectors)
  - Static & Dynamic versions

Industry-Occupation Matrix

	11-0000 Management	15-0000 Computer and Mathematical	19-0000 Life, Physical, and Social Science	25-0000 Education, Training, and Library	29-0000 Healthcare Practitioners and Technical	35-0000 Food Preparation and Serving Related	37-0000 Building and Grounds Cleaning and Maintenance	41-0000 Sales and Related	43-0000 Office and Administrative Support	45-0000 Farming, Fishing, and Forestry	47-0000 Construction and Extraction	51-0000 Production	53-0000 Transportation and Material Moving
11	2,410	100	250		60		1,430	660	5,780	206,380	0	5,840	9,770
21	1,300	190	650		240			200	1,410	50	8,520	2,080	1,710
22	5,160		760		200		40	1,170	9,470	50	3,520	7,070	650
23	53,500	1,970	270		1,260		4,640	17,710	82,380	0	547,650	13,220	16,910
31-33	104,360	78,250	18,160	70	2,510	10,630	6,640	60,800	131,410	5,790	12,730	551,960	83,490
42	58,690	20,400	1,260	80	3,020	830	2,410	147,860	172,060	3,670	1,970	34,200	149,990
44-45	55,870	6,690		970	45,580	50,210	9,330	928,180	290,180	2,340	4,180	46,660	119,480
48-49	20,540	2,140	90	50	470	1,660	3,540	7,550	171,050	130	1,080	7,040	394,150
51	49,230	101,330	160	1,230	590	8,390	760	53,150	57,680		4,330	3,410	10,210
52	47,660	28,840	190	40	2,230	0	520	98,500	197,620		0	80	0
53	45,220	2,870		0	120	2,350	12,220	75,560	52,250	390	2,210	830	21,160
54	155,400	238,270	60,790	1,370	20,710	1,280	3,400	53,670	207,790	660	7,410	13,070	7,130
61	64,700	23,220	25,390	908,310	18,710	38,840	45,250	4,910	165,050	230	2,540	720	6,350
62	92,930	16,840	21,070	60,840	676,270	48,220	45,860	7,410	310,670	940	1,350	7,380	13,740
72	50,730	650		480	730	1,356,000	76,090	55,580	52,660	30	410	14,190	20,120
99	57,810	34,320	40,100	28,890	39,290	8,400	25,110	4,200	188,090	4,120	31,480	18,900	44,340

Real GDP Impacts of COVID-19
(billions of U.S. dollars and % change)

Country/ Region	Mandatory Closure & Reopening	Avoidance	Commun-ication Demand	Deaths and Illness	Health Care Expenditure	Pent-up Demand	Total Impacts
Scenario 2							
USA	-8,040.1 (-37.5)	-853.2 (-4.0)	263.2 (1.2)	-23.7 (-0.1)	966.3 (4.5)	3,821.1 (17.8)	-3,866.5 (-18.0)
China	-2,392.3 (-16.9)	-758.8 (-5.4)	174.1 (1.2)	0.2 (0.0)	531.4 (3.8)	1,434.4 (10.1)	-1,010.9 (-7.1)
ROW	-13,943.1 (-26.6)	-3,282.2 (-6.3)	1,395.4 (2.7)	3.5 (0.0)	1,613.2 (3.1)	7,852.4 (15.0)	-6,360.8 (-12.1)

Economic Consequence Analysis Publications

- Walmsley, T. L., A. Rose, D. Wei. 2020. "Impacts on the U.S. Macroeconomy of Mandatory Business Closures in Response to the COVID-19 Pandemic," *Applied Economic Letters*, forthcoming.

- Wei, D., Z. Chen and A. Rose. 2020. "Evaluating the Role of Resilience in Recovering from Major Port Disruptions: A Multi-Regional Analysis," *Papers in Regional Science*, forthcoming. https://rsaiconnect.onlinelibrary.wiley.com/doi/10.1111/pirs.12553

- Rose, A. and Z. Chen. 2020. "Resilience to a Cyber-Attack on the Detroit Automobile Industry: A Computable General Equilibrium Approach," in P. Nijkamp, E. Glaeser and K. Kourtit (eds.), *Urban Empires*, Heidelberg: Springer, forthcoming. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3084867

- Rose, A., F. Prager, Z. Chen, and S. Chatterjee. 2017. *Economic Consequence Analysis of Disasters*: *The E-CAT Software Tool.* Singapore: Springer. doi.org/10.1007/978-981-10-2567-9

- Rose, A. 2017. "Benefit-Cost Analysis of Economic Resilience Actions," in S. Cutter (ed.) *Oxford Research Encyclopedia of Natural Hazard Science,* New York: Oxford. doi: 10.1093/acrefore/9780199389407.013.69

- Prager F., D. Wei, and Rose. 2016. "Total Economic Consequences of an Influenza Outbreak in the United States," *Risk Analysis* 37(1): 4-19. https://onlinelibrary.wiley.com/doi/abs/10.1111/risa.12625

- Geisecke, 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

Back-Up Slides

Economic Consequence Analysis Tool (E- CAT)

- Develop a standardized capability to estimate economic consequences of 30+ types of threats
  - includes a comprehensive set of impact categories
  - standardization facilitates comparisons

- Transition the research into a user-friendly, fast software tool for high-level decision-makers
  - risk mgt: resource allocation across multiple threats
  - rapid response: estimates for remediation/aid/recovery

- With Fynn Prager, Zhenhua Chen, Sam Chatterjee

E-CAT User Interface

CREATE | National Center for
HOMELAND SECURITY CENTER | 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!

Business Resilience Calculator

- Based on survey results (& real-time updates)

  - not just effectiveness, but *cost-effectiveness*

  - solve thorny issue of *weights* in Resilience Index

- Results serve as *checklist* & *reference point*

  - *default* & *best-practice* values until full self-assessment

  - firms set *targets* for resilience improvement

- Business can also use BRC to *gauge progress*

  - use *guidelines* from survey for *self-improvemen*t

  - identify ways *gov't can help* (deregulation, subsidies

- Acknowledge Noah Dormady & CIRI