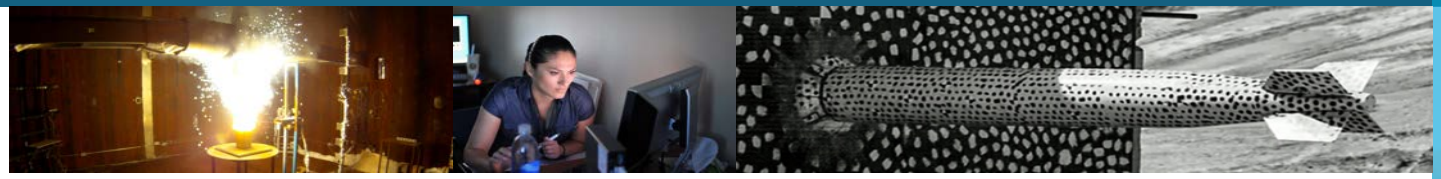
REMI Webinar: Epidemiological and Economic Modeling of a Pandemic



Vanessa Vargas and Patrick Finley

Sandia National Laboratories
vnvarga@sandia.gov, pdfinle@sandia.gov

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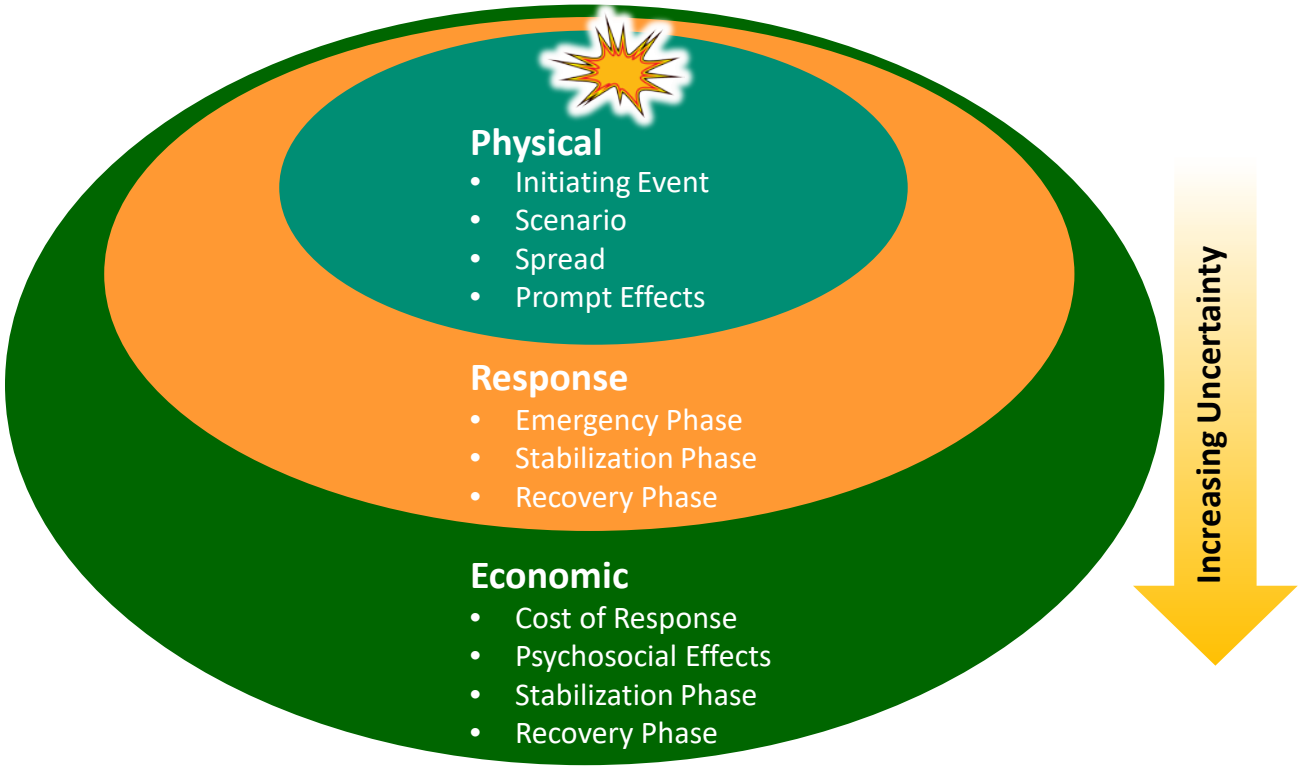
SAND2020-3570 PE

Analysis in three parts:
Physical, Response, and Economic

Tools/Data

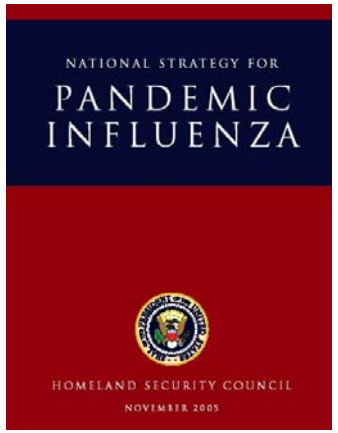
- **Modeling:** Epidemiological modeling, effects modeling; new drugs or countermeasures, resource modeling and machine learning.
- **Prompt Effects:** Psychosocial, morbidity/mortality.
- **Response Efforts:** Use policy responses by States.
- **Costs:** Resource modeling and countermeasures.
- **Economic Analysis:** Modeled over multiple years with REAcct* and REMI.

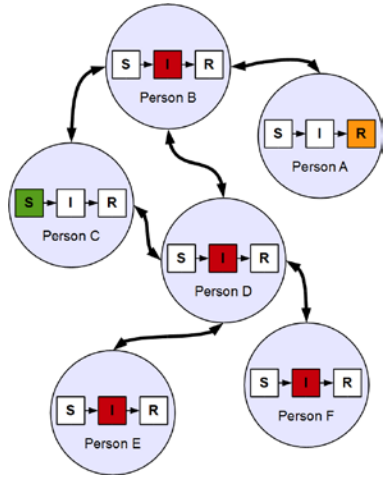


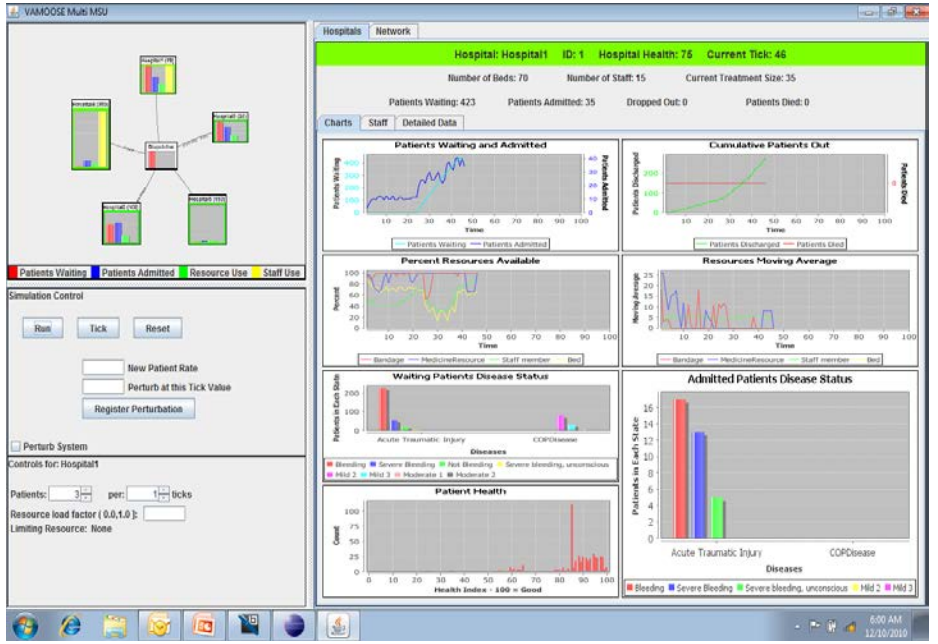
The present study uses new tools and data, which raised the level of rigor.

Sandia Disease and Public Health Modeling

- **Long history**
- **Differentiating factors**
  - Problem oriented
  - Rigorous uncertainty analysis
  - Quick-turn Modeling
- **Examples**
  - Zoonotic diseases
  - Hospital acquired diseases
  - Healthcare system models
  - Ebola crisis response
  - Biosurveillance

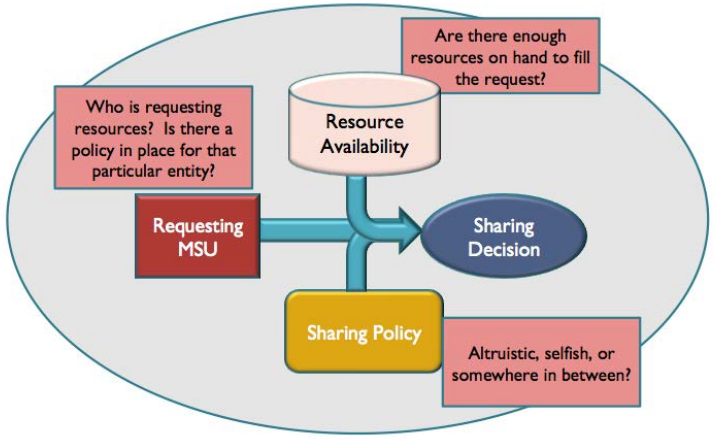


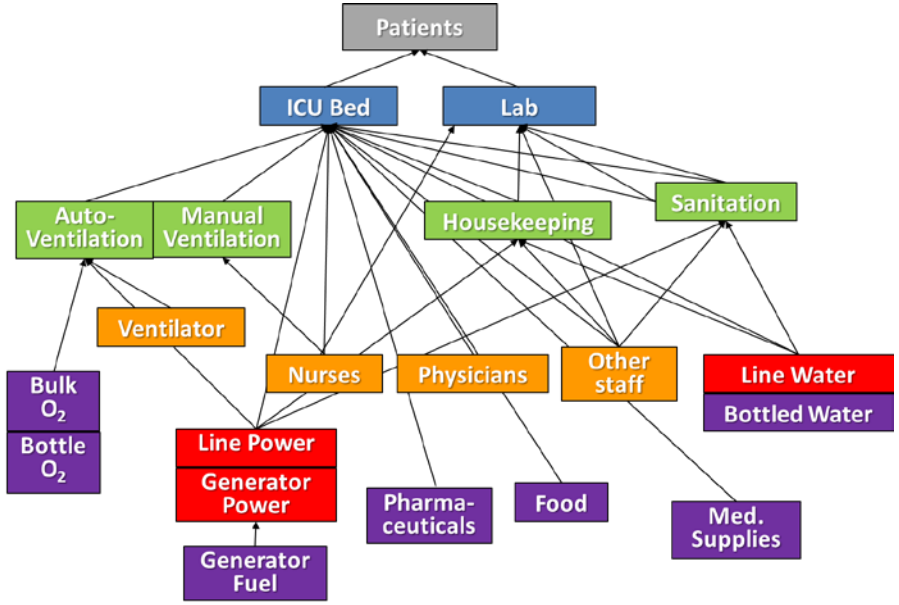




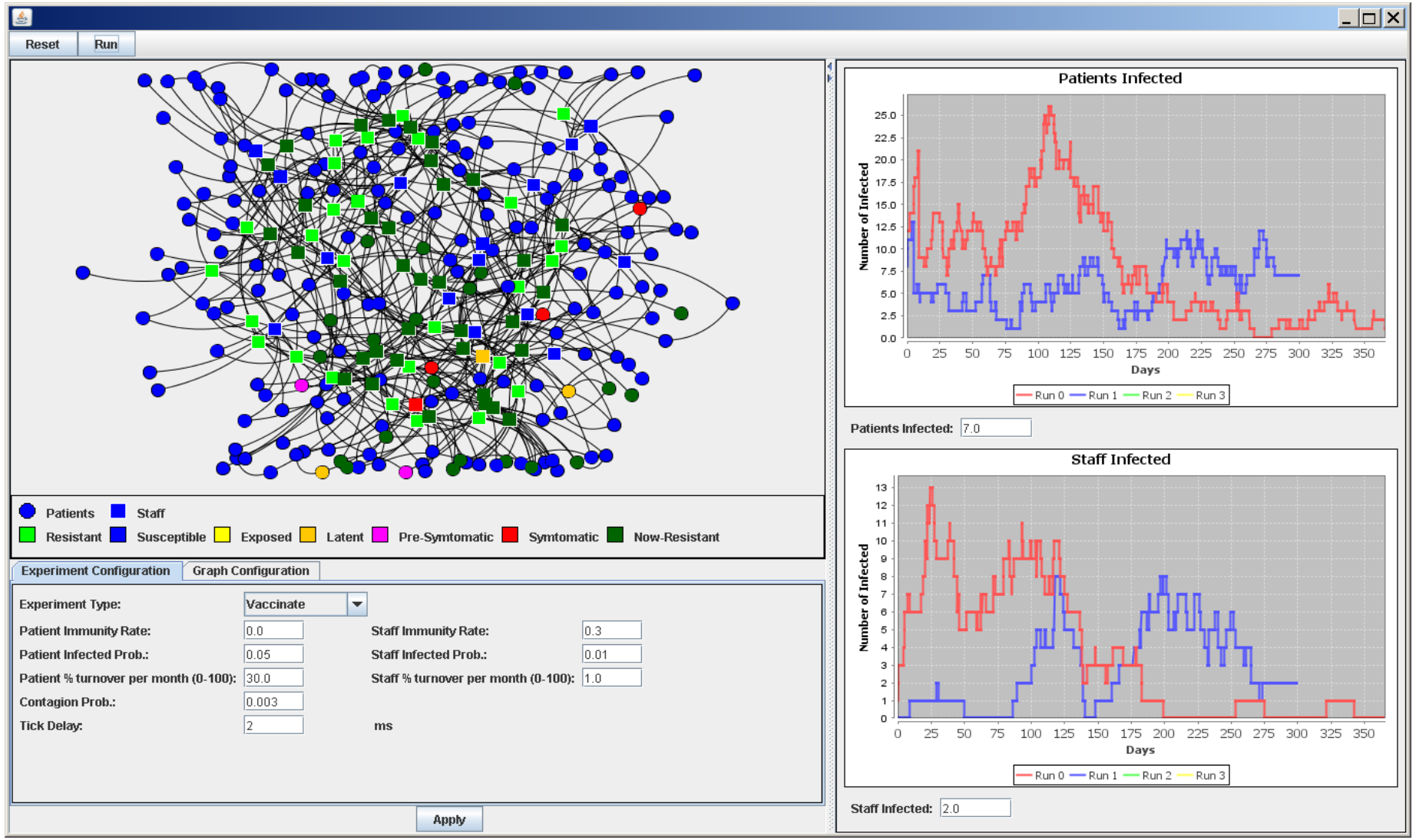
Modeling for better decisions

- **Quantitative guidance for decision makers:**
  - Best use of resources
  - Minimizing risk
- **When are models useful:**
  - Insufficient data
  - Partial understanding of system
  - Need to examine alternatives
- **Payoff:**
  - Which interventions work best

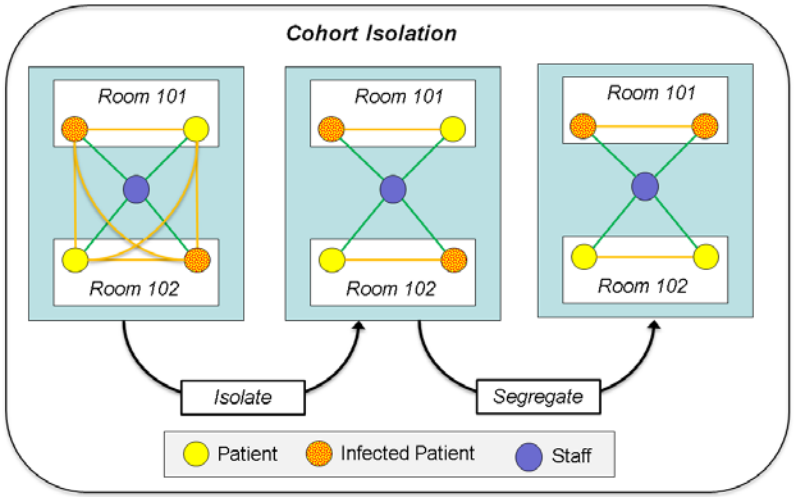


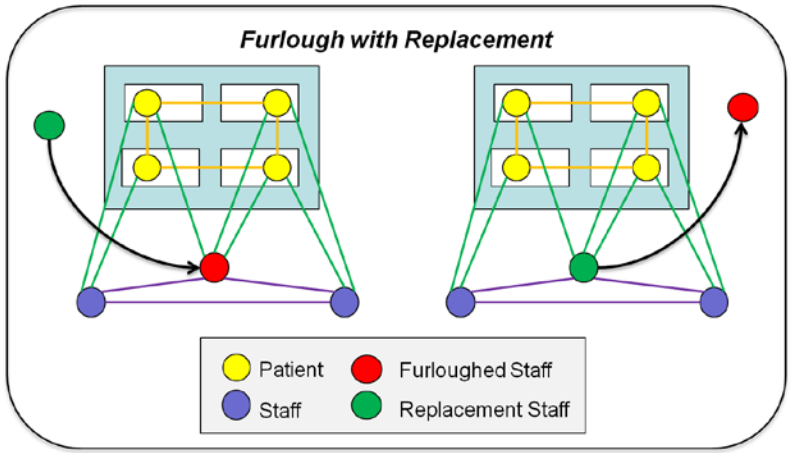


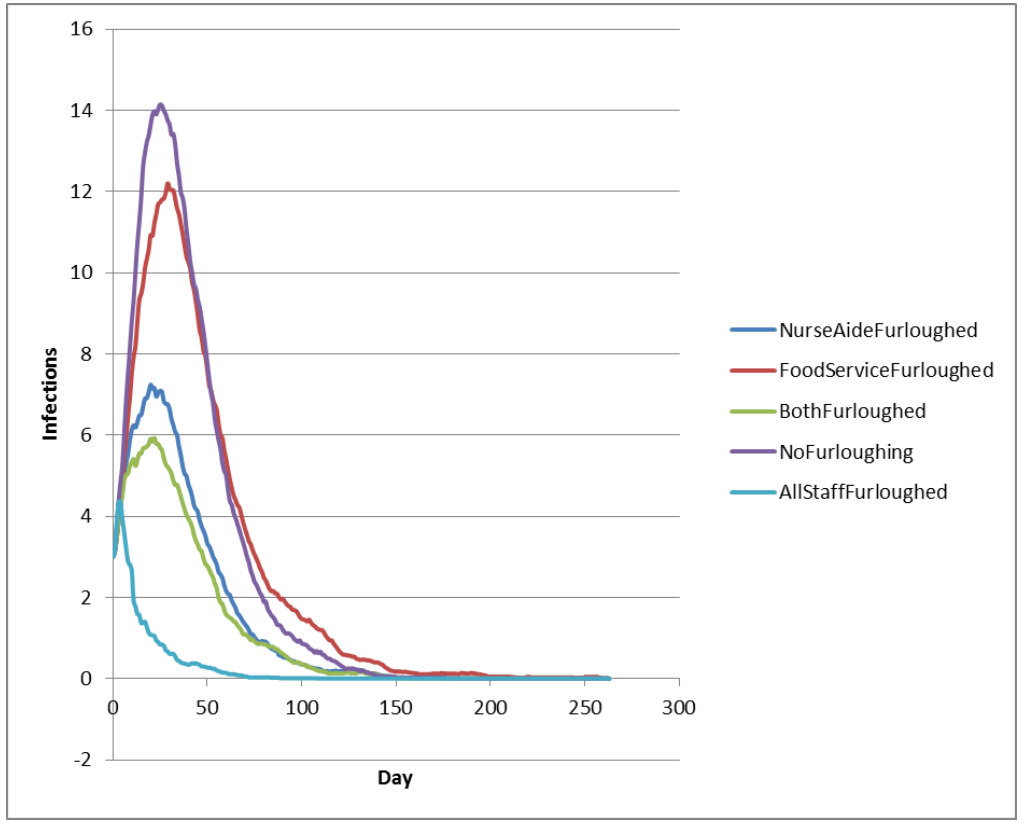
Example of Modeling social distancing workplace policies



Targeting workplace policies to control disease





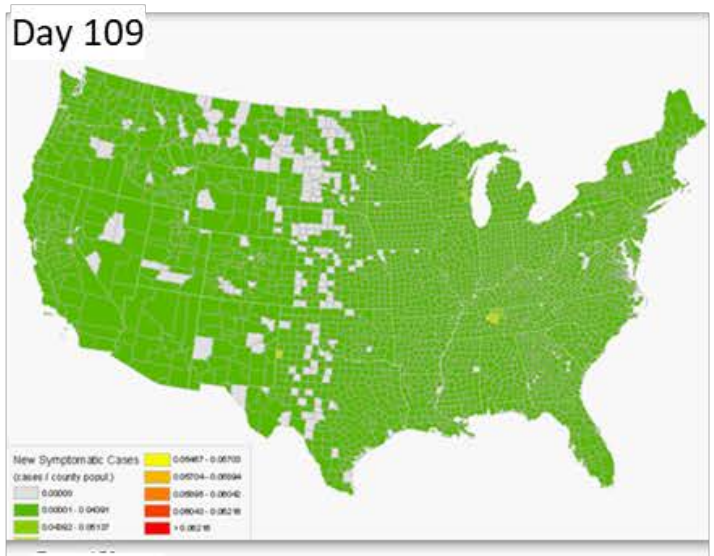


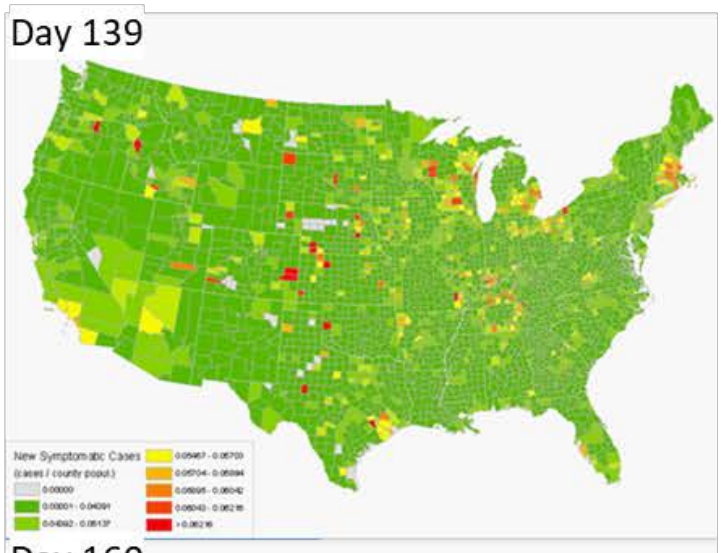
Analysis shows which policies perform best

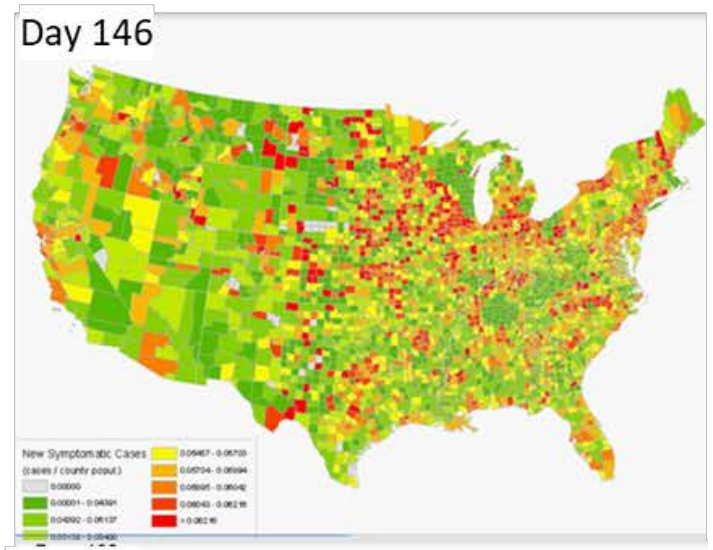
Pandemic Influenza Epidemiology

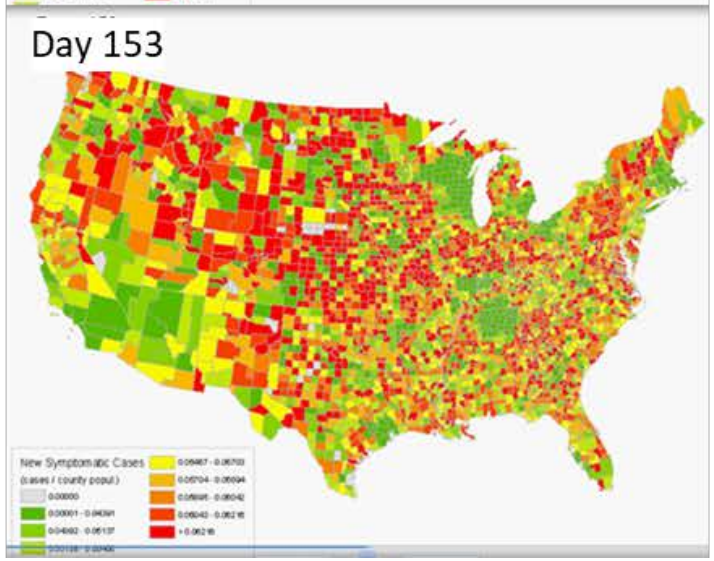
- A pandemic is a worldwide occurrence in which most, if not all, people are at risk for infection and illness
- Past influenza pandemics have spread worldwide in a matter of months
- Human influenza pandemics have occurred 3 times in the 20th century: in 1918, 1957, and 1968
- During the pandemic of 1918–1919, influenza struck between 20 and 40 percent of the world's population, killing on average of 2 percent of the infected cases

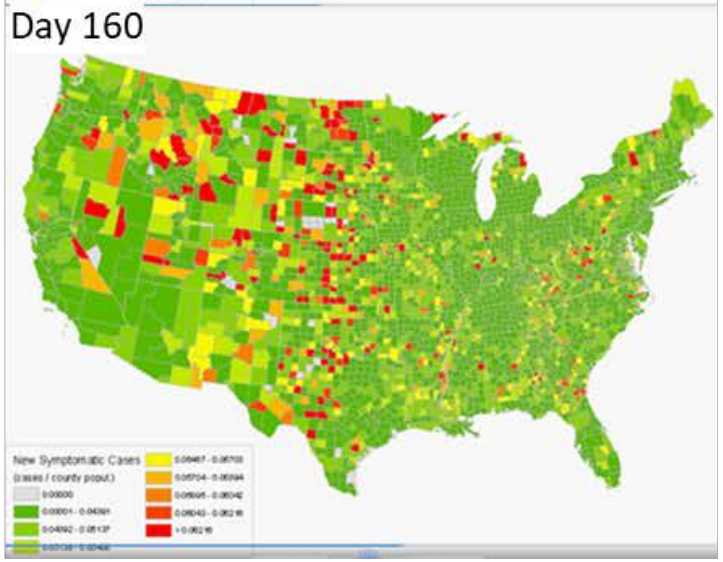
Typical Pandemic Pattern

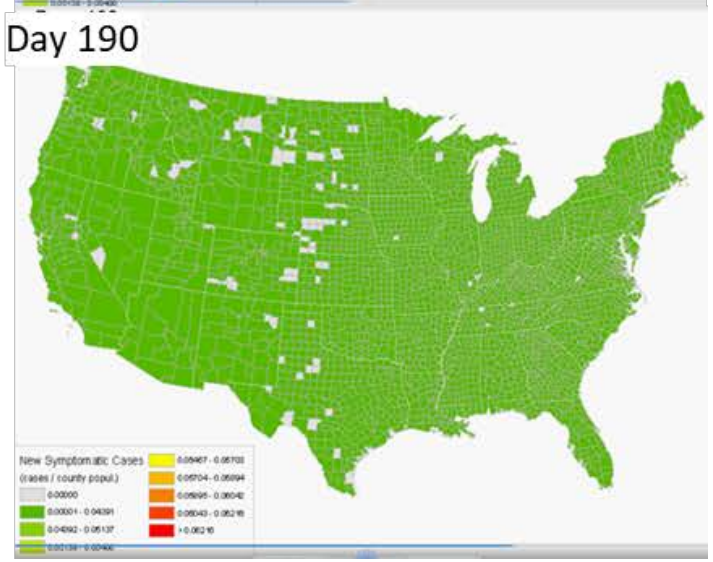








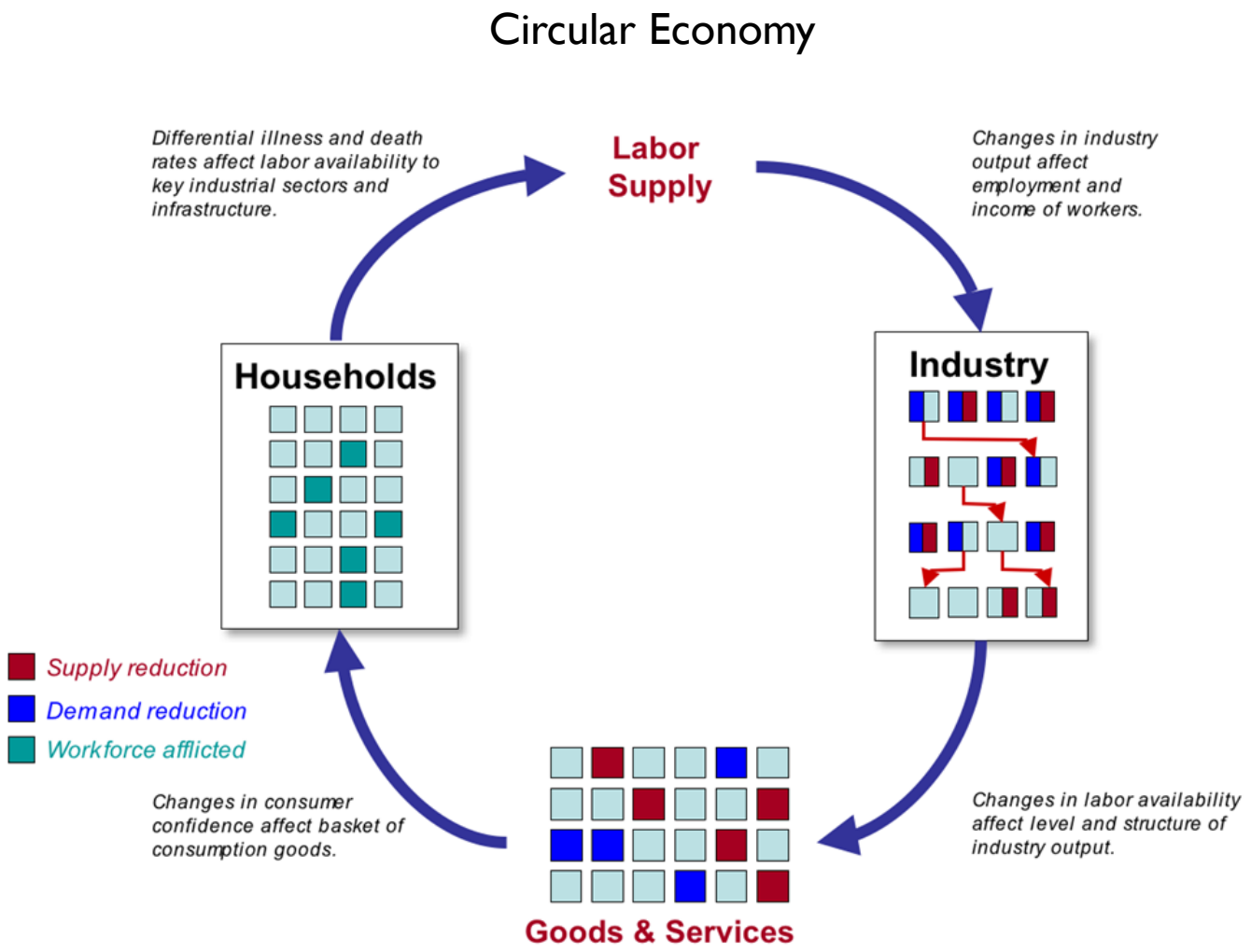




NISAC 2009: National Population and Economic Impacts of 2009 Influenza A (H1N1) NISAC Technical Report. Model based study of advanced data analytics approach to determine most effective combinations of pandemic interventions

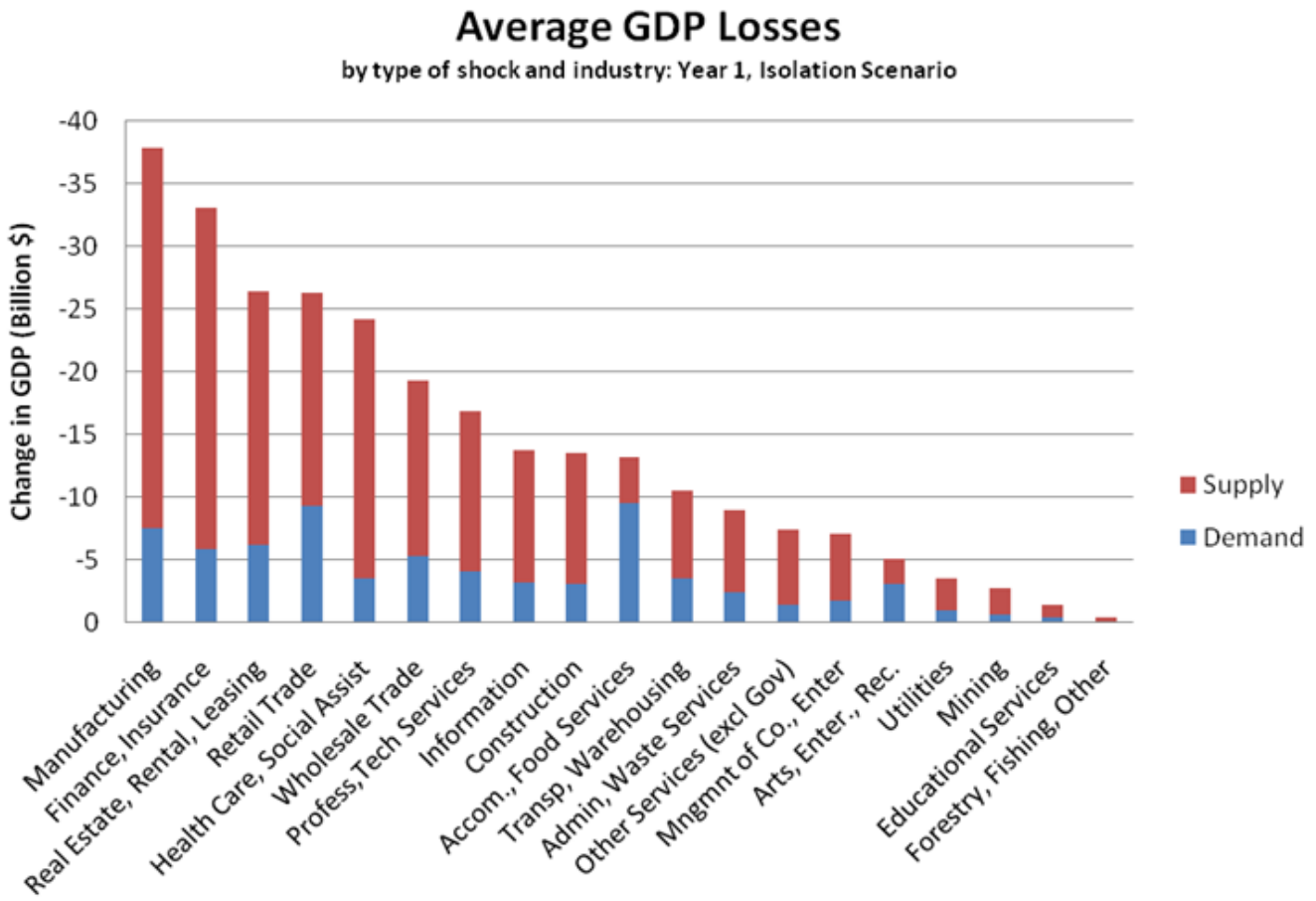
2010 Scenario: Absenteeism, Morbidity, Mortality

- The healthcare sector is stressed
  - Increased absenteeism
  - Increased demand
- Work from Home
  - Will vary by industry
  - Likely decreased productivity
- Absenteeism
  - Some sectors more affected
  - May be nullified by WFH orders
- Morbidity
  - Increased demand for healthcare
- Mortality
  - Will change survivability within the model



2010 Scenario: Impact of Pandemic on U.S. Economy

- Two Types of Impact to U.S. Economy
  - Supply Shock
    - Employees absent
    - Lower productivity of working employees
    - Mortality
  - Demand Shock
    - Mortality
    - Consumers adjust spending due to pandemic fears (e.g., not willing to do face-to-face transactions)
    - Decreased consumer confidence
- Mitigating Factors
  - Delayed Purchases
  - Substitution
  - On-line Purchases



SAND2010-1910. V. W. Loose, V. N. Vargas, D. E. Warren, S. J. Starks, T. J. Brown and B. J. Smith. Economic and Policy Implications of Pandemic Influenza.

Epidemiological Impacts to Economic Impacts

- Key epidemiological parameters drive workplace absenteeism and mortality for the seven scenarios
- The clinical attack rate drives the pandemic's absenteeism and is highly positively correlated to the mortality rate
- The range of GDP listed for each scenario reflected variations in the demand response,
  - Assumed a reduction for select goods and services
  - Assumed an increase of healthcare expenditures

Scenario Name	Clinical Attack Rate	Mortality Rate
Baseline	0.26	0.0053
Antiviral	0.25	0.0047
Fear-40	0.21	0.0043
CMG-SE[1]	0.10	0.0055
Anticipated	0.0092	0.000064
CMG	0.0045	0.000027

Pandemic Scenario	Year 1	Years 1-10
Baseline		
Level $Billions	$120 to $350	$810 to $1,100
% GDP[1]	1.1 % to 3.1 %	N/A
Fear-40		
Level $Billions	$140 to $400	$770 to $1,000
% GDP	1.2 % to 3.5 %	N/A
Antiviral		
Level $Billions	$120 to $340	$710 to $960
% GDP	1.0 % to 2.9 %	N/A
Anticipated		
Level $Billions	$140 to $400	$430 to $580
% GDP	1.2 % to 3.5 %	N/A
CMG-SE[2]		
Level $Billions	$93 to $270	$310 to $410
% GDP	0.8 % to 2.3 %	N/A
CMG		
Level $Billions	$95 to $280	$290 to $400
% GDP	0.9 % to 2.6 %	N/A

SAND2010-1910. V. W. Loose, V. N. Vargas, D. E. Warren, S. J. Starks, T. J. Brown and B. J. Smith. **Economic and Policy Implications of Pandemic Influenza**.

Lessons from SARS and Past Pandemic Modeling

- Small number of SARS infections compared to other events
- SARS provides some insight into the potential economic impact
- Demand side:
  - Less demand for goods and services
- Supply side:
  - Increased absenteeism; social distancing
- Population shock
  - Increased mortality in labor force
  - Both a demand and supply shock

IMPACT OF SARS ON SELECTED TOURISM AND RELATED SECTORS [Exhibit 1]

	No. of Establishments*	Employment of Sector*	Per Cent Fall in Sales Due to SARS**
Retail	18,372	85,589	10–50 per cent
Catering Trade	3,356	48,202	Up to 50 per cent
Hotels	196	26,096	Up to 70 per cent
Taxi Drivers	–	34,000	30–40 per cent
Tour operators	648	7,405	70–80 per cent

Source: Economic Survey Series 2000, Singapore Department of Statistics

Table 3.2 Breakdown of Consumer Spending, Selected Economies, 2001

	PRC	Korea, Rep. of	Taipei,China	Thailand	United States
Food	28.1	14.6	20.9	25.1	7.1
Alcohol & tobacco	3.9	2.3	3.7	6.6	2.1
Clothing & footwear	10.1	3.9	4.1	11.0	5.1
Rent, water, fuel & power	10.3	17.5	18.3	9.2	17.2
Household goods & services	8.3	4.4	5.8	6.9	5.0
Health Expenditure	6.5	7.6	8.9	7.1	17.1
Recreation, education, & culture	13.0	13.0	19.2	8.1	11.5
Transport & communications	8.6	16.7	11.9	16.2	13.2
Other goods & services	11.3	20.0	7.2	9.7	21.7
Total Private Consumption	100.0	100.0	100.0	100.0	100.0

Sources: Statistical Yearbook of the Republic of China (web site); *China Statistical Yearbook*; Republic of Korea National Accounts (www.bok.or.kr); Thailand Annual National Accounts (www.nesdb.go.th); OECD National Accounts.

Estimate Cumulative Impacts:
Estimate Impact from Pandemic Event

Objective

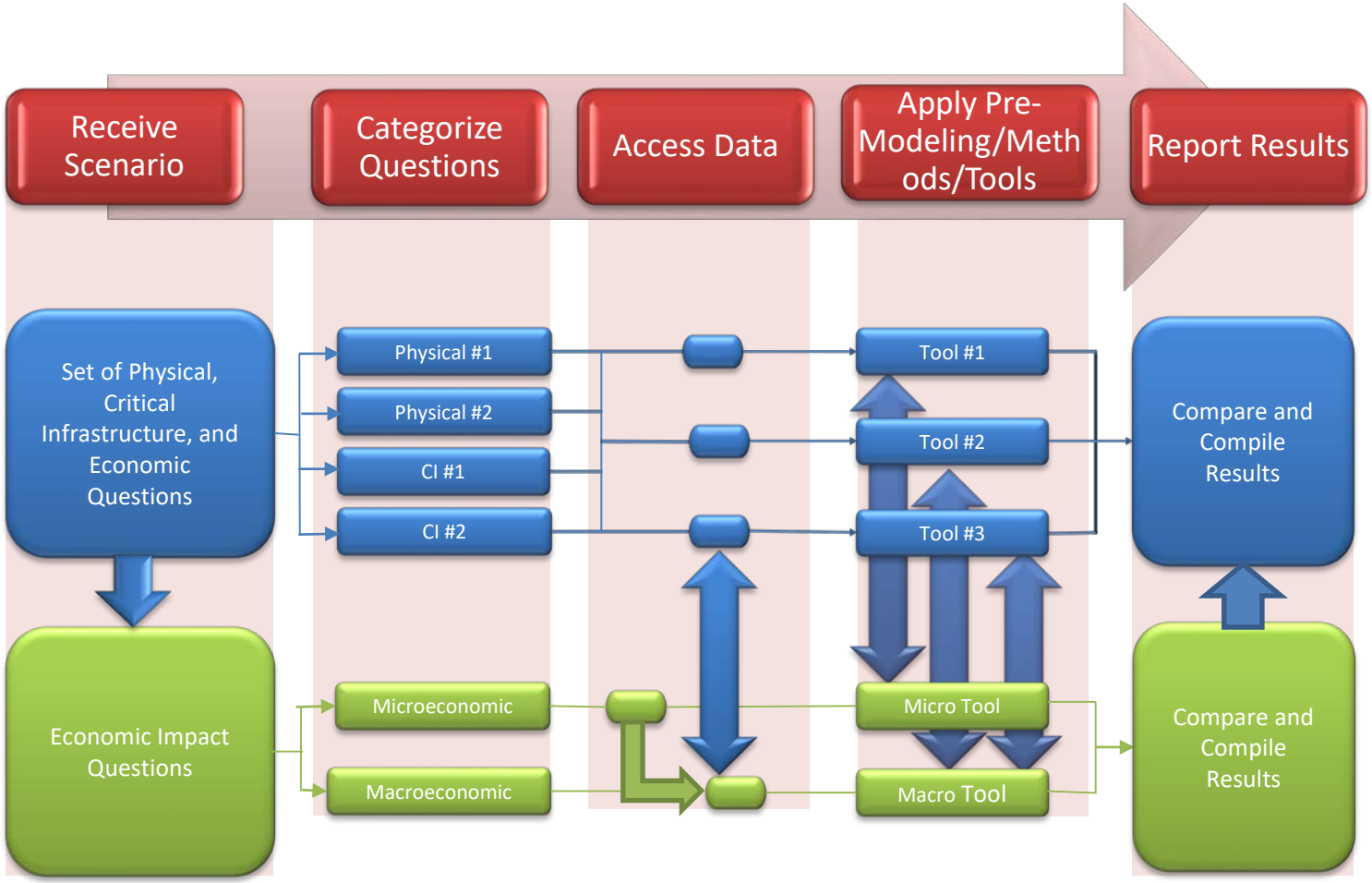
- Estimate cumulative economic impacts

Challenges

- Data acquisition, parameter specification, and modeling assumptions
  - Previous studies not entirely helpful

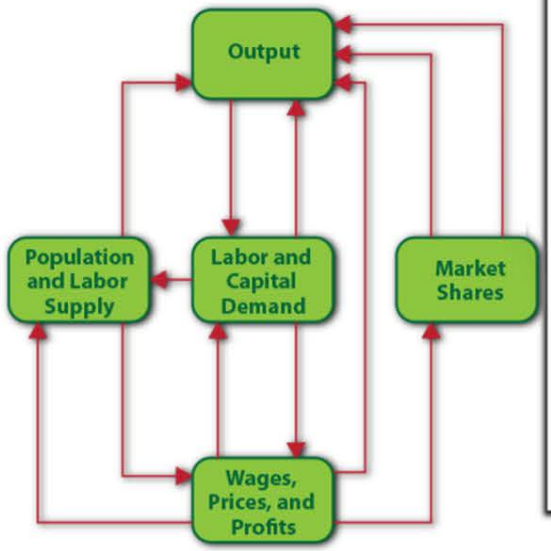
Solutions

- Outreach to stake-holder and subject matter experts
  - **Regional Outreach**
  - Review of methodology and assumptions
  - Identified new or state of the art models or data
  - Uncertainty quantification and sensitivity analysis

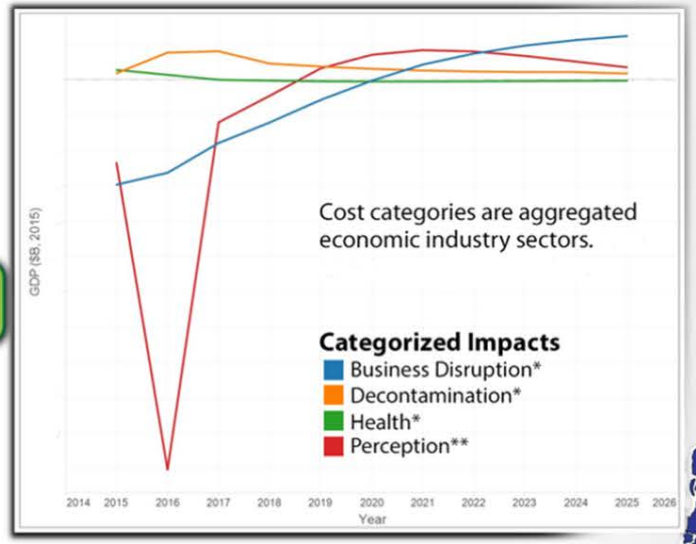


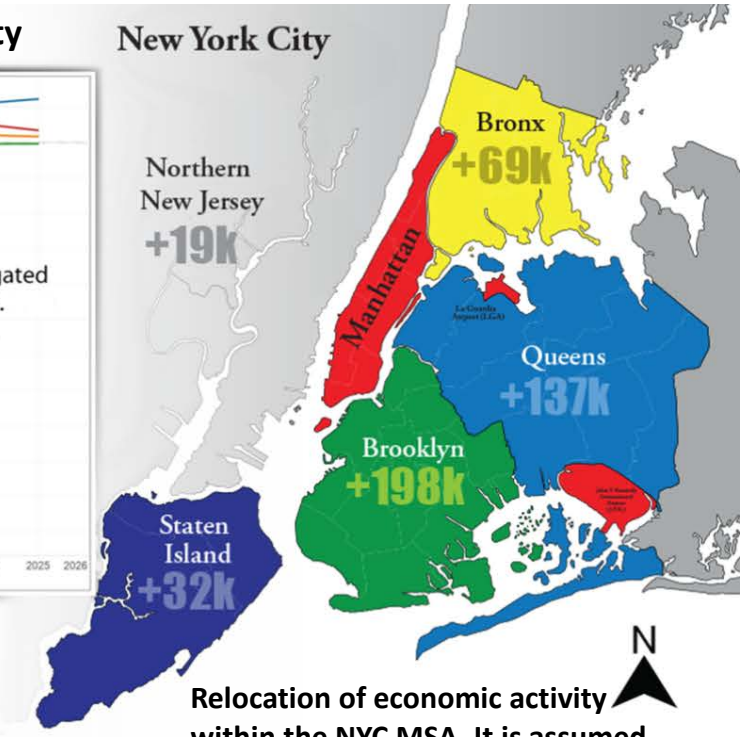
Example of Total U.S. Impact:
GDP Loss Occur Over 10 Years

The economy: circular and dynamic



Output (GDP) contributed by activity





Output generates employment, employment generates income, income generates demand for and spending on new output, new output generates new employment, *and so on*.

*Recovery efforts are likely to be funded by federal government spending, resulting in increases in output.
** Perception is based on tourism patterns observed post-Fukushima.

Relocation of economic activity within the NYC MSA. It is assumed businesses and employees will behave similar observed post 9/11 relocation patterns.

GDP impacts are not intuitive.
They can be negative or positive, but all represent economic disruption.

Regional Economic Models, Inc. Policy Insight+

- **Economic analysis software based on inter-industry commodity flows (IO), dynamic response (general equilibrium theory), and econometrics**

- **Calculates temporal and spatial impacts**
  - Structural relationships (goods and services)
  - Technical relationships (input-output production recipes)
  - Behavioral relationships (demand elasticities)
  - Allows for annual adjustments

- **Appropriate for modeling long-term effects**

Percent change of gross domestic product (GDP) by state

Discussion

Vanessa Vargas, vnvarga@sandia.gov

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