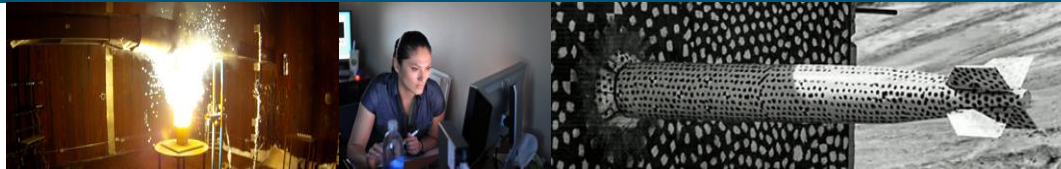# Sandia National Laboratories Economic Impact Methodology for Pandemic Scenarios

Mathematical Sciences Research Institute
Mathematical Models for Prediction and Control of Epidemics (Virtual Workshop)
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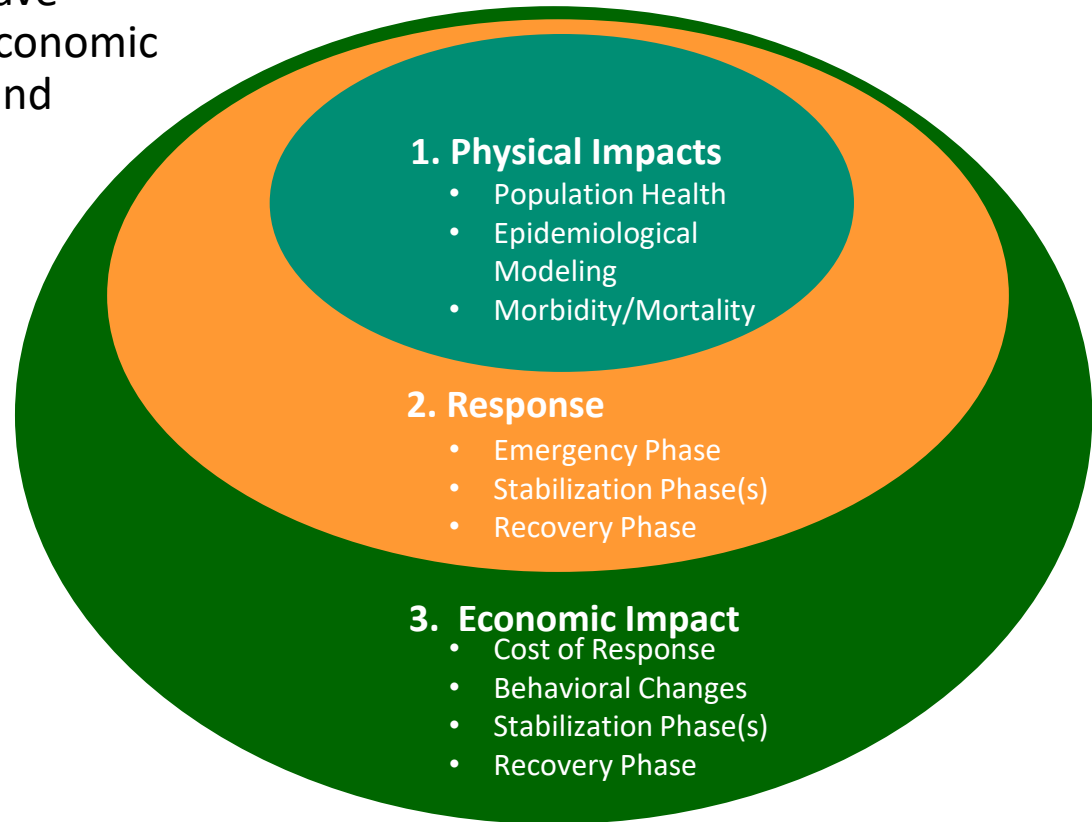*Sandia National Laboratories*

What are the cumulative economic impacts of major disruptive events?

Previous studies performed for DHS and DOE/Office of Radiological Security have shown that pandemics have a large economic impacts but vary with adopted local and national response procedures.

Sandia's modeling approach answers questions about:
- Unintended consequences
- Recovery strategies
- Economic Impacts
  - GDP
  - Unemployment
  - Industry Impacts
  - Supply Chains

1. Physical Impacts
- Population Health
- Epidemiological Modeling
- Morbidity/Mortality

2. Response
- Emergency Phase
- Stabilization Phase(s)
- Recovery Phase

3. Economic Impact
- Cost of Response
- Behavioral Changes
- Stabilization Phase(s)
- Recovery Phase

Approach:
## *Estimate Economic Impact from Physical and Infrastructure Impacts*

Objective

- Estimate cumulative economic impacts

Challenges

- Parameter specification, and modeling assumptions
  - Unknowns dominate event
  - Risk of double counting
  - Detailed data needs
  - Response sequence
  - Lack of real-time data
  - Stimuli +/- will occur over the year at differing time intervals

Solutions

- Outreach to experts
- Leverage epidemiological models
- Early peer review
- New/non-traditional data sources
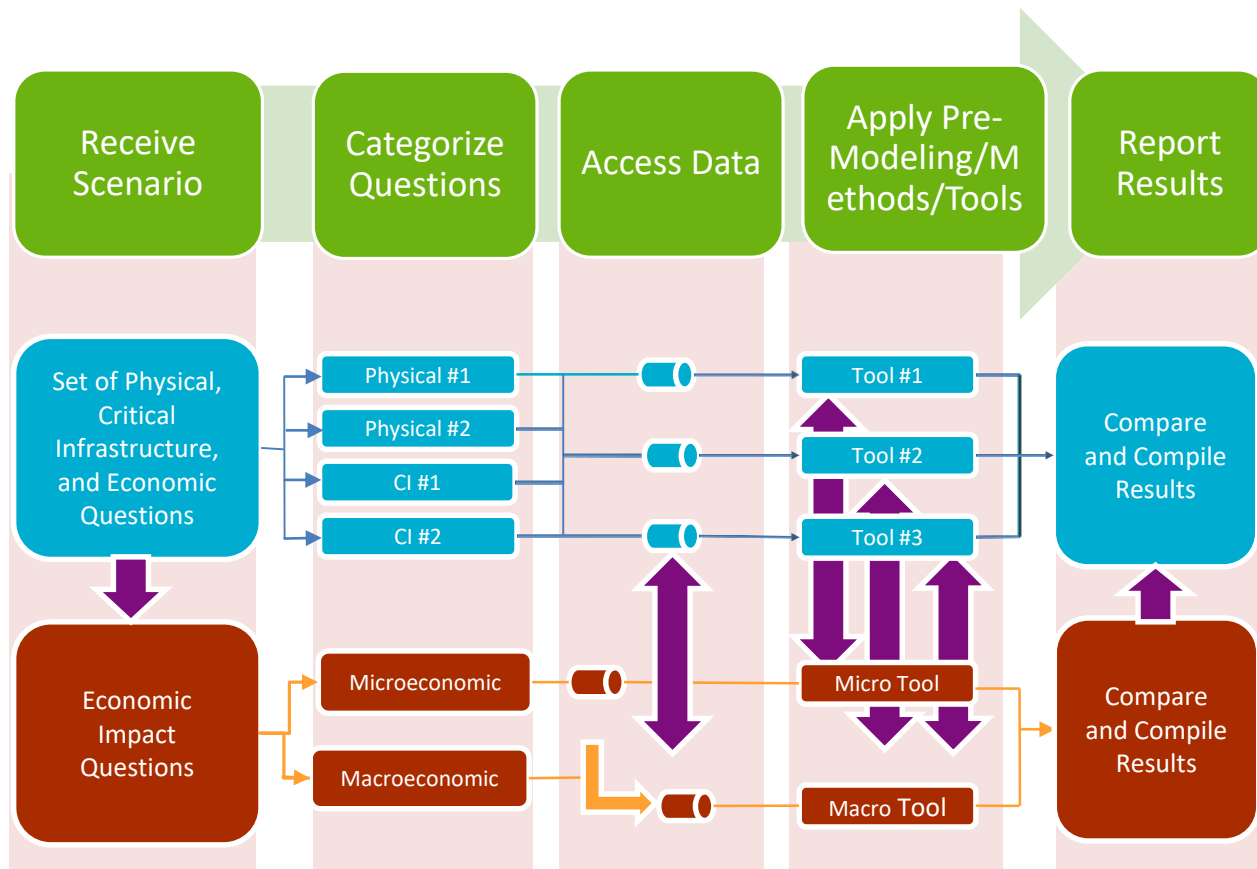
Representative not worst case scenarios. Leveraging of existing research of similar scale events

Past Scenarios: 2005 H5N1 and 2009 H1N1

Economic Variables	Year 1	Year 2	Year 3	Year 4	Year 5
Gross Domestic Product (Bil Fixed 1996$)					
Less-severe Scenario	-258.2 (-2.70%)	-31.3 (-0.32%)	-26.36 (-0.25%)	-19.51 (-0.18%)	-15.69 (-0.14%)
Most-likely Scenario	-593.2 (-6.21%)	-70.97 (-0.72%)	-59.72 (-0.58%)	-43.56 (-0.40%)	-34.43 (-0.30%)
Severe Scenario	-1190 (-12.46%)	-151.6 (-1.54%)	-131.8 (-1.27%)	-100.5 (-0.92%)	-83.03 (-0.72%)
Employment (thousand)					
Less-severe Scenario	-3,892 (-2.33%)	-486.4 (-0.29%)	-384.4 (-0.23%)	-267.5 (-0.16%)	-203.6 (-0.10%)
Most-likely Scenario	-8882 (-5.33%)	-1095 (-0.66%)	-862.3 (-0.52%)	-587.2 (-0.35%)	-435.9 (-0.21%)
Severe Scenario	-18100 (-10.84%)	-2355 (-1.42%)	-1928 (-1.15%)	-1388 (-0.82%)	-1090 (-0.54%)
Per-Capita Income					
Less-severe Scenario	-0.394 (-1.59%)	0.004 (0.02%)	-0.001 (-0.00%)	0.009 (0.03%)	0.013 (0.05%)
Most-likely Scenario	-.934 (-3.77%)	0.008 (0.03%)	-0.005 (-0.02%)	0.017 (0.07%)	0.028 (0.11%)
Severe Scenario	-1.877 (-7.59%)	0.020 (0.08%)	-0.014 (-0.05%)	0.031 (0.12%)	0.053 (0.20%)

Sponsor: Department of Homeland Security

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**.

What is our methodology?

Regional economic models: modify a baseline national forecast to reflect national impacts
- Supply and demand shocks
- Results in new national baseline forecast

State-by-state impacts
- Essential vs non-essential businesses
- Staged return to work
- Other mitigation or intervention policies
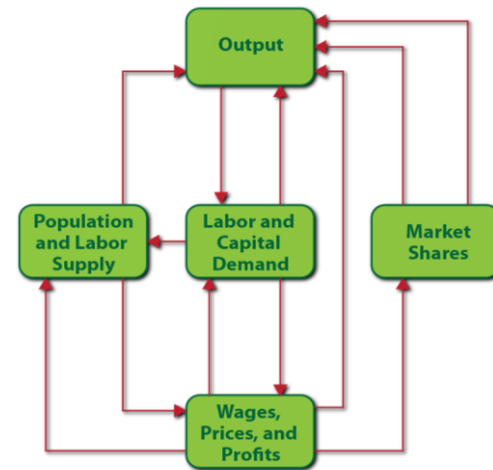
Integrate other modeling efforts
- Epidemiological
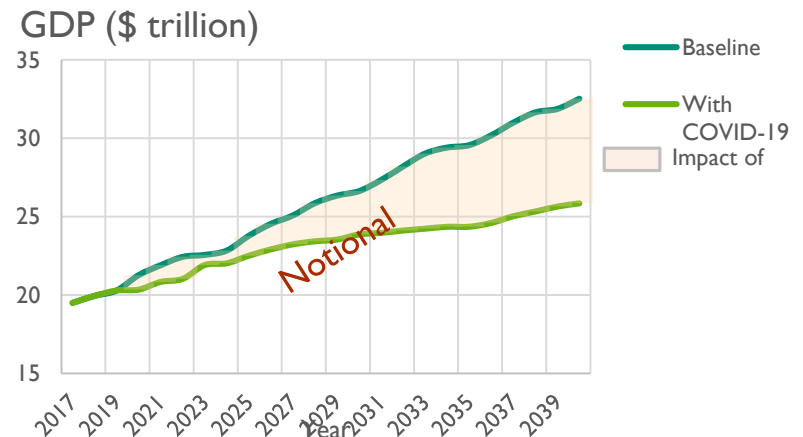- Economic
- Resource model

Temporal adjustments
- Scaling of short-term to med- or long-term
- Continuous data mining

Psychosocial effects
- Consumption switching
- Avoidance behavior
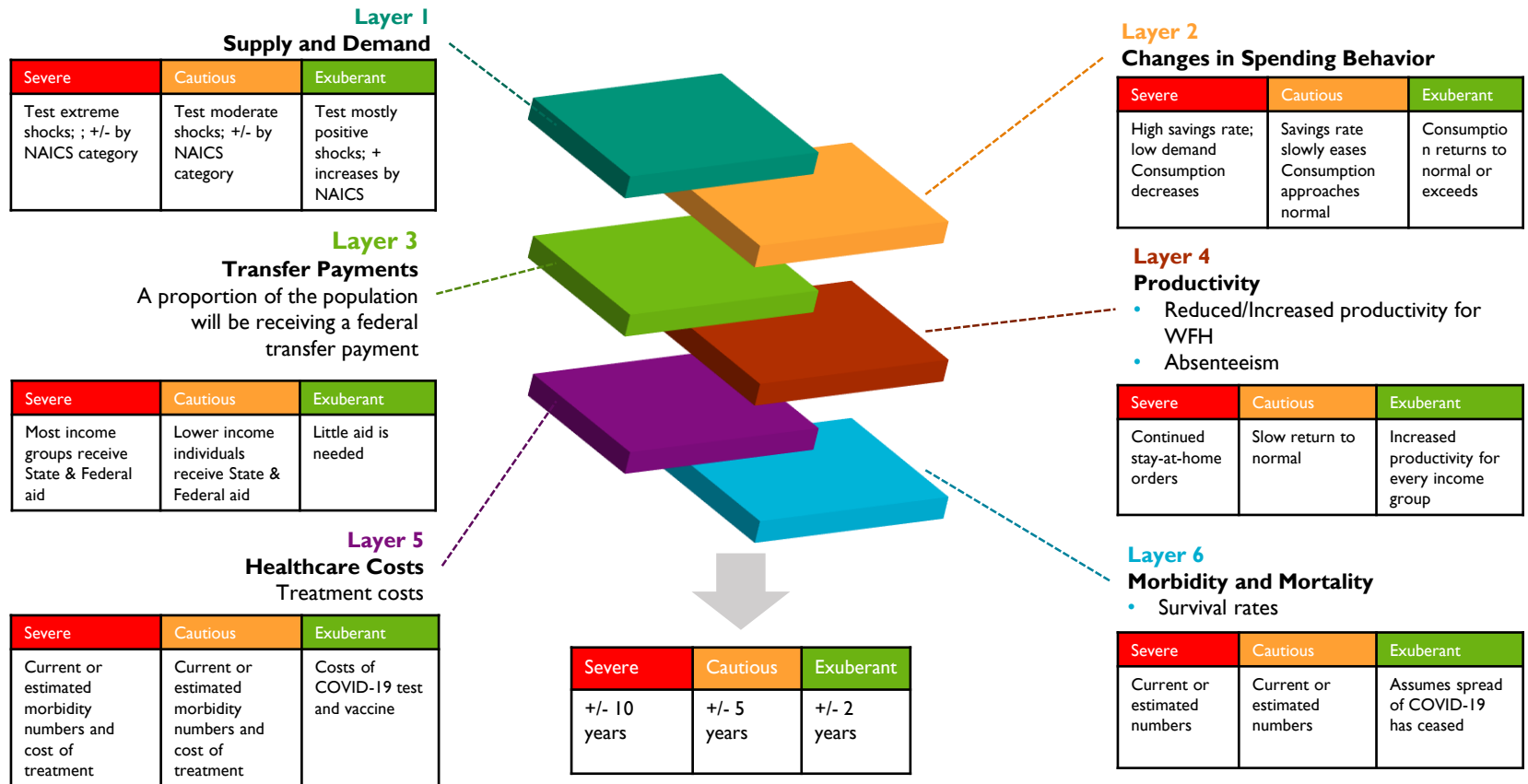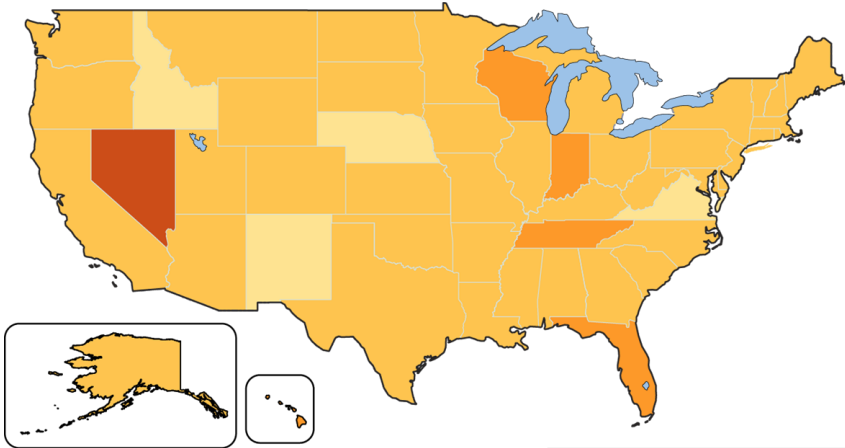- Work from home policies

Example Output

GDP ($ trillion)

How we are building the modeling input for parameter changes

Translation of physical, real-world observations, estimations, and hypotheticals into economic impact is accomplished in a layered approach
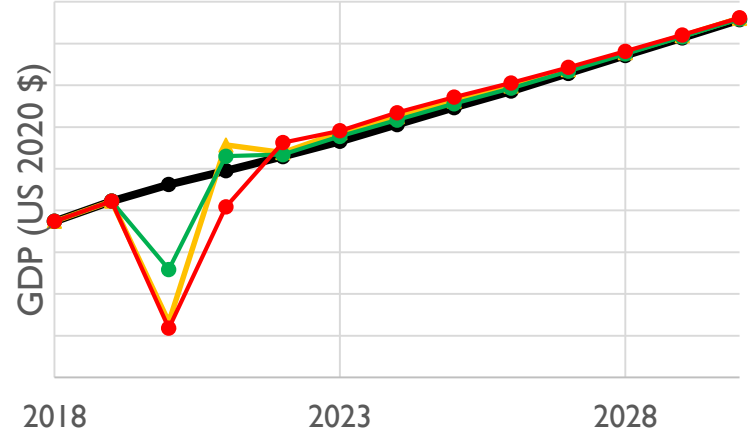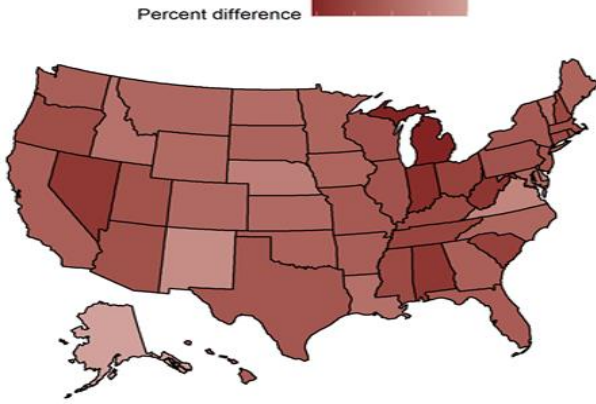
Layer 1
Supply and Demand

Severe	Cautious	Exuberant
Test extreme shocks; ; +/- by NAICS category	Test moderate shocks; +/- by NAICS category	Test mostly positive shocks; + increases by NAICS

Layer 2
Changes in Spending Behavior

Severe	Cautious	Exuberant
High savings rate; low demand Consumption decreases	Savings rate slowly eases Consumption approaches normal	Consumption returns to normal or exceeds

Layer 3
Transfer Payments
A proportion of the population will be receiving a federal transfer payment

Severe	Cautious	Exuberant
Most income groups receive State & Federal aid	Lower income individuals receive State & Federal aid	Little aid is needed

Layer 4
Productivity
- Reduced/Increased productivity for WFH
- Absenteeism

Severe	Cautious	Exuberant
Continued stay-at-home orders	Slow return to normal	Increased productivity for every income group

Layer 5
Healthcare Costs
Treatment costs

Severe	Cautious	Exuberant
Current or estimated morbidity numbers and cost of treatment	Current or estimated morbidity numbers and cost of treatment	Costs of COVID-19 test and vaccine

Layer 6
Morbidity and Mortality
- Survival rates

Severe	Cautious	Exuberant
Current or estimated numbers	Current or estimated numbers	Assumes spread of COVID-19 has ceased

Severe	Cautious	Exuberant
+/- 10 years	+/- 5 years	+/- 2 years

Example Economic Impacts

Change in GDP by State Year 2020

Manufacturing Output by State
Year: 2020

Percent difference

Our methodology aims to capture both demand and supply side shocks. It is the net of local, regional, or national effects that we are "experiencing" as changes to the economy, which evolves depending on the scenario.

Thank you

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