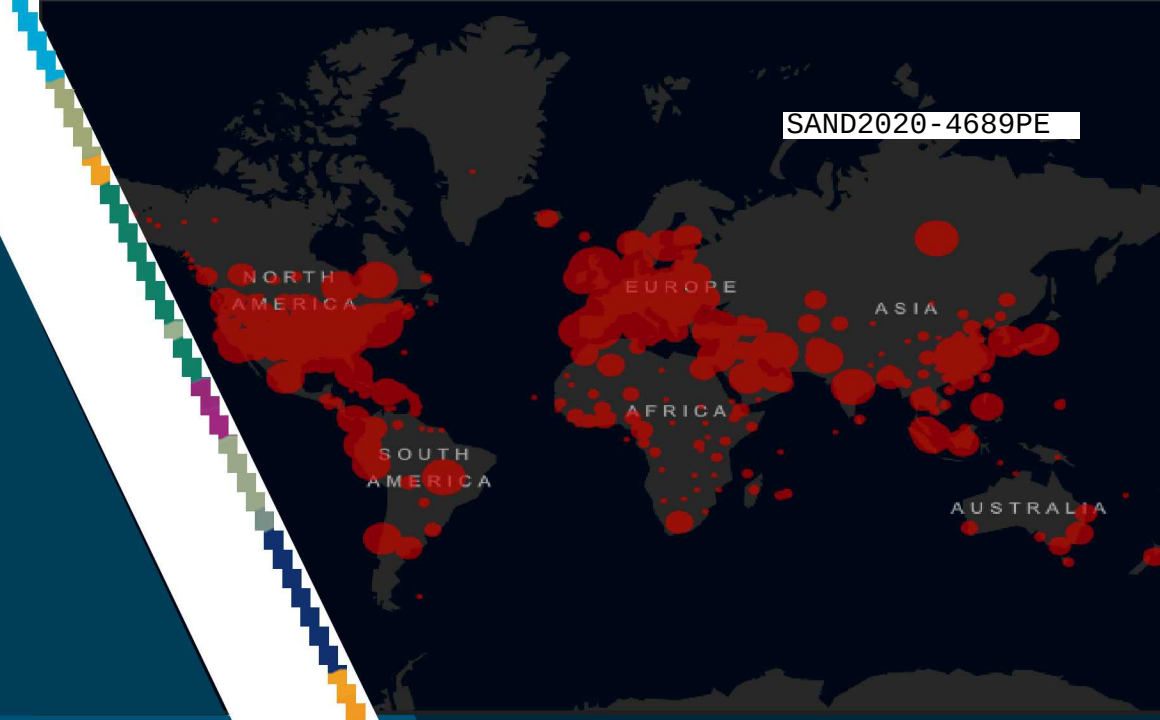

SAND2020-4689PE

COVID19 PANDEMIC ECONOMIC IMPACTS STUDY: CURRENT STATUS

Lead: Vanessa Vargas

APRIL 24,2020

Sandia: Taylor McKenzie, Lawrence Trost, Desmond Harmon, Julia Potter, and Michael Ford
Argonne: Braeton Smith
Collaborator/Reviewer: Steve Streetman

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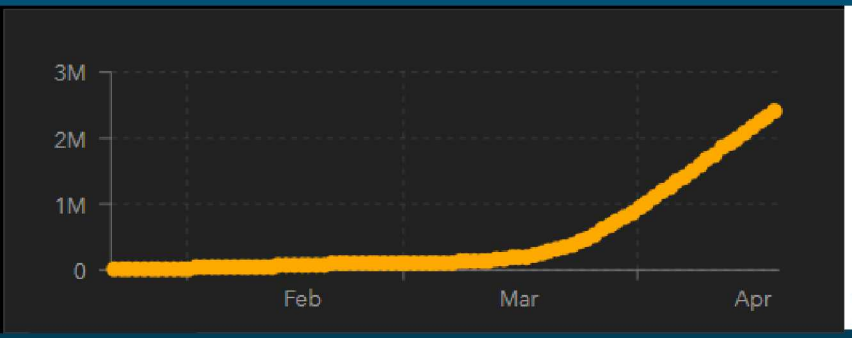
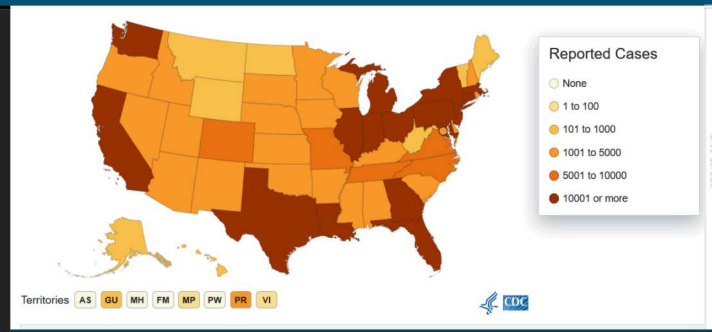
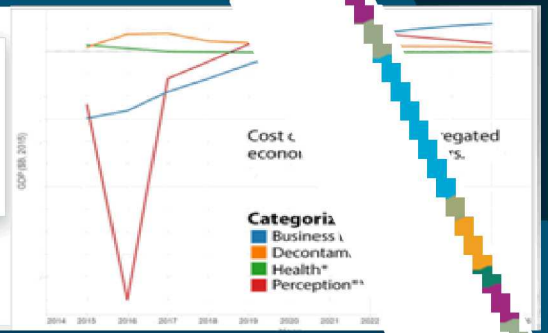
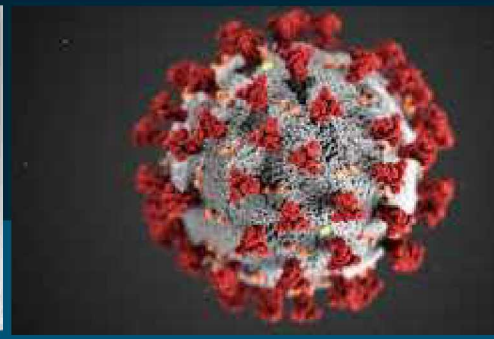








What is the cumulative economic impact of COVID-19 and different recovery strategies?

- **Introduction**
- **Goal**
- **Past Work**
- **How This Differs**
- **High-Level Analysis Process**
- **Layers and Scenarios**
- **Creating a New Baseline**
- **Current Status**

Previous studies performed for DOE/Office of Radiological Security and Department of Homeland Security have shown that large-scale disruptive events can have large economic impacts.

Previous studies have demonstrated that ad hoc policy response can exacerbate economic loss.

The purpose of this study is to:

1. Examine the effects of COVID-19 pandemic
2. Determine the cumulative economic impact and the loss drivers
3. Test recovery strategies

There is a high potential for the COVID-19 pandemic to have a large impact upon every industry and every American.

The impact is sizeable.

- 2020 GDP is estimated to be 10.3% lower than pre-COVID
- Previous runs with early data yielded decreases ranging from 1.7% to 4.3%, illustrating how quickly the data is evolving
- The US GDP impact could extend years, depending on policy
- Daily morbidity and mortality is shifting
- Stay-at-home orders are equivalent to shelter in place

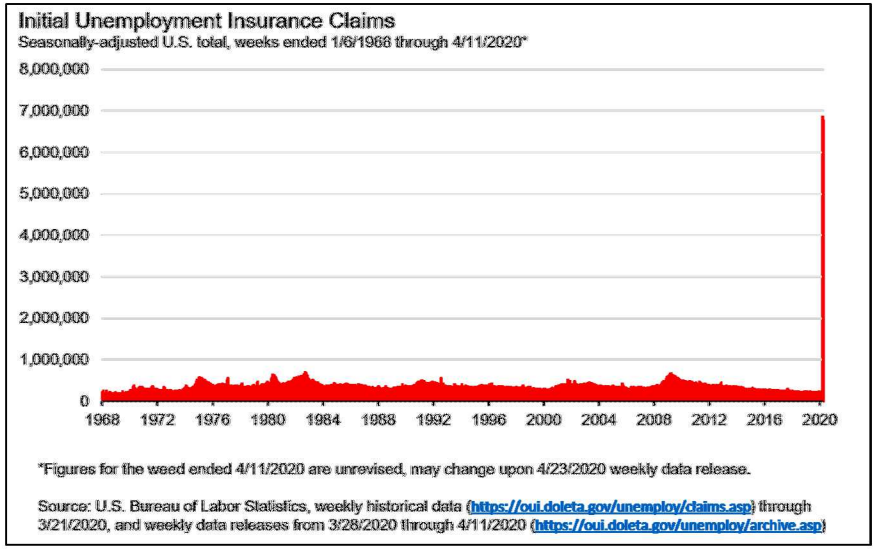
Densely populated states could have significantly larger impacts

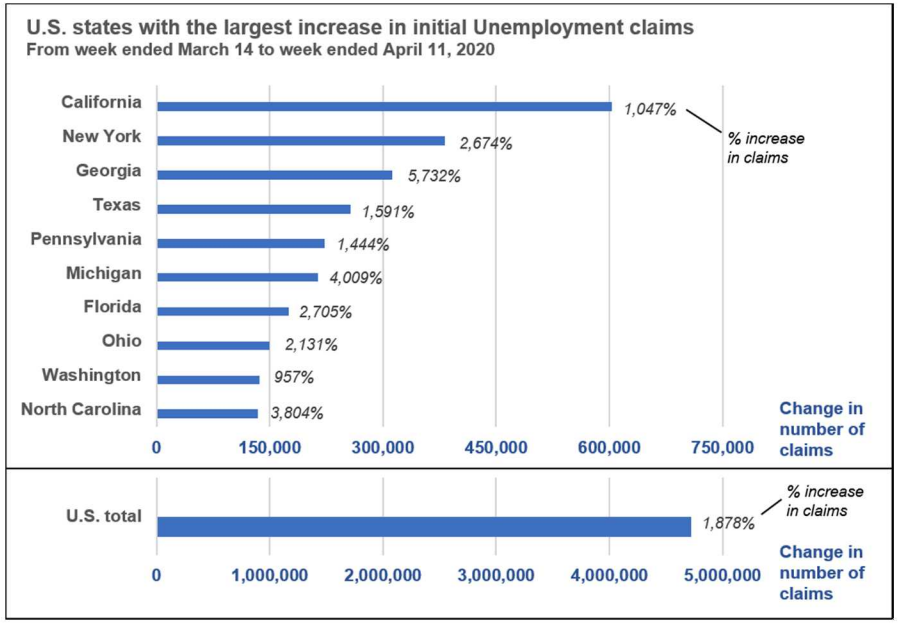
- Fear drives action thresholds to protect human health and safety.
- Some industries more amenable to work from home orders than others.

Multiple federal guidance and state decisions lead to "ad hoc" situation.

- Policies can vary state by state
- Recovery will likely vary by state
- State objectives differ

There may be other ways to protect human health and safety.





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Our goal is to estimate the cumulative economic impacts of COVID-19 and recovery strategies

State-by-state impacts
- Essential vs non-essential
- Staged return to work
- Other mitigation or intervention policies

Temporal adjustments
- Scaling of short-term to annual adjustments
- Continuous data mining

Integrate other modeling efforts
- Output from epidemiological (epi) models
- Health resource models

Psychosocial effects
- Consumption switching
- Avoidance behavior
- WFH policies
- Demand elasticities

Percent change of gross domestic product (GDP) by state

We aim to achieve not only a useful product for policymakers, but also improve our capability

We have several modeling objectives

Simple

- Facilitate Quick-turn analysis

Flexible

- Easily modified from baseline to various scenarios

"What-ifs?"

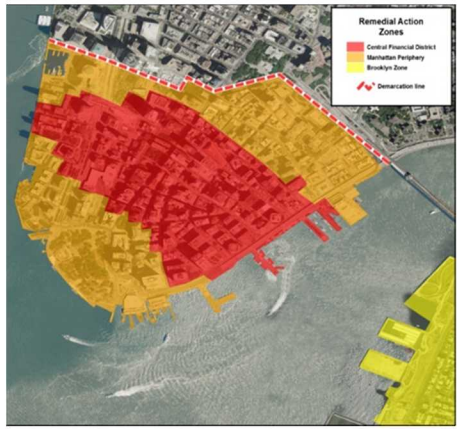
- Allows for analysis of various shocks, policies, and other model output

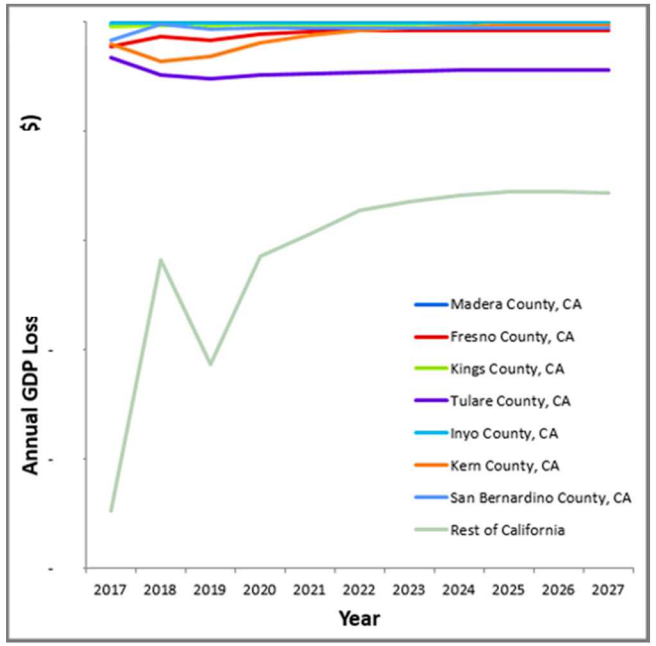
Lessons

- Applying similar techniques from similar projects
- Ongoing peer review (Streetman)

Deliverables

- Deliver a product including national and state GDP losses, employment impacts, and other useful information





The current work builds off previous disruption studies and expertise

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We have performed pandemic modeling before
These are 2009 Pandemic Study results

Key epidemiological parameters drive workplace absenteeism and mortality for 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

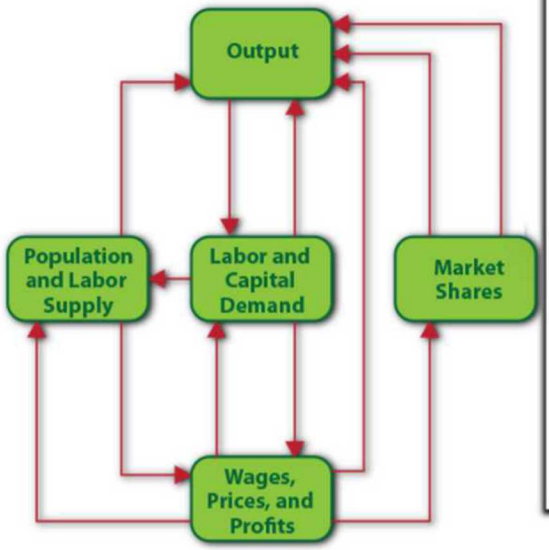
Sponsor: Department of Homeland Security

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**.

Between FY16-20 SNL performed considerable work on radiological dispersion device (RDD) events:

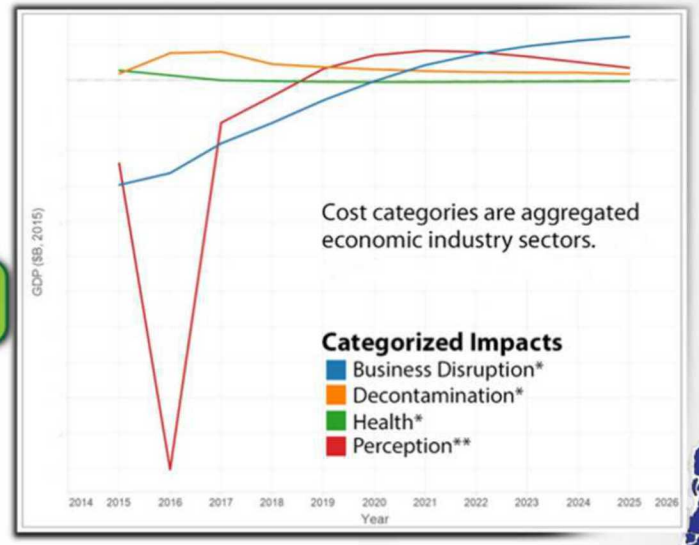
Results showed net 10's of $Billions GDP Loss over 10 Years from a significant event

The economy: circular and dynamic



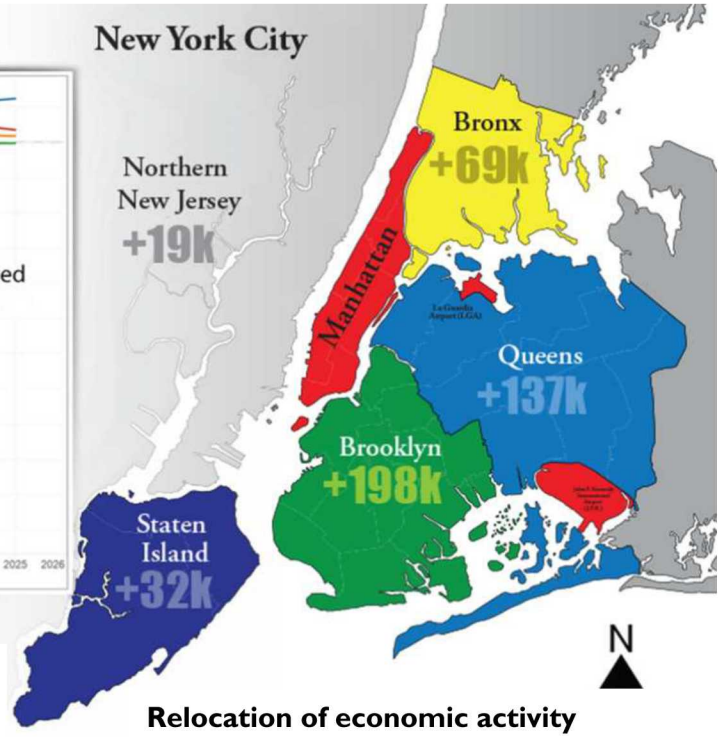
Output generates employment, employment generates income, income generates demand for and spending on new output, new output generates new employment, *and so on*.

Output (GDP) contributed by activity



***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 to observed post 9/11 relocation patterns.

Sponsor: Department of Energy, Office of Radiological Security

GDP impacts are not intuitive. Regions of analysis include urban and rural. Impacts can be negative or positive, but all represent economic disruption.

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How does the present work differ from past Sandia studies?

	Past	Present
Event	Completed scenario Known virus	On-going Unknown virus
Driving factors	National response Changes to labor	Ad hoc response policies State responses Constricted supply
Industry changes	Absenteeism Productivity	Essential vs. non-essential Avoidance behaviors
Scale of the event	Spread was seasonal Assumed levels of herd immunity Vaccine availability Familiarity with virus	Unknowns dominate this environment Waves of infection are indeterminate Policies are driven by best intentions Psychosocial factor could be crippling

Hypothetical scenarios vs playing catchup to real-world event

How our study differs from others outside Sandia?

As of April 24, 2020 GDP Forecasts

- UCLA Anderson
  - -0.4% (Q2 -6.5%, Q3 -1.9%)
- IHS Markit
  - -0.2%
- Moody's
  - Q1 -1.6%, Q2 -2.5%
- Morgan Stanley
  - Q2 -4%
- Deutsche Bank
  - -1% (Q2 -13%)
- Pantheon
  - Q2 -10%

As of May 1, 2020 GDP Forecasts

- UCLA Anderson
  - -0.4% (Q2 -6.5%, Q3 -1.9%)
- IHS Markit
  - -13% Q2
  - -1.7% 2020 (year over year)
- Moody's
  - Q1 1.6%, Q2 -4.2%
- Morgan Stanley
  - Q2 -38%
  - -5.5% (annualized)
- Deutsche Bank
  - -4.2%% (Q2 -13%)
- Pantheon
  - Q2 -30% (annualized)

What our sources are saying?

- Declines of 53% in sales tax revenue
- City and County budgets bankrupt by May and June
- Businesses refusing to hand over tax revenue
- More layoffs coming
- Increased suicides
- Agriculture and food & beverage supply chains are holding
  - Depends on worker protection

Regional analysis path

- Use new GDP growth forecasts from Moody's (others)
- Using prescribed forecasts
- This serves as the new driver for estimating regional forecast differences
- Additional modifications for "What-if" scenarios for regions

Forecasts ranging from -0.4% to -13% are informing regional "best guess" forecasts and "what-if" scenarios.
Little information on what informs other forecasts.
Anecdotal evidence is interesting but it remains hard to quantify

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What is our methodology?

Modify baseline national forecast to reflect national COVID-19 impacts

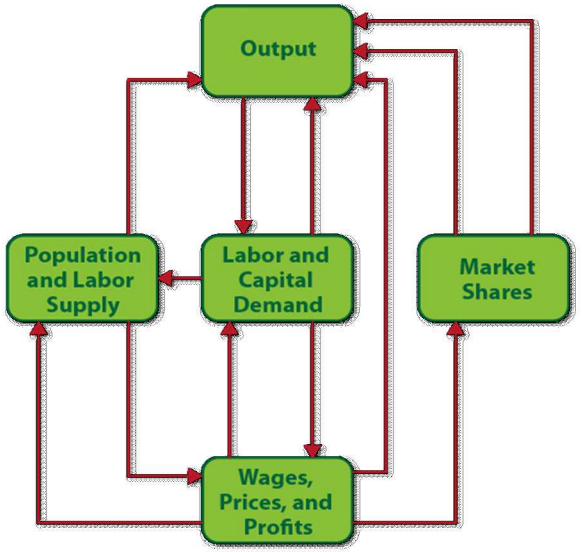
- Supply and demand shocks
- Results in new national COVID baseline forecast
- Slowdown or recession scenario

Test mitigation strategies

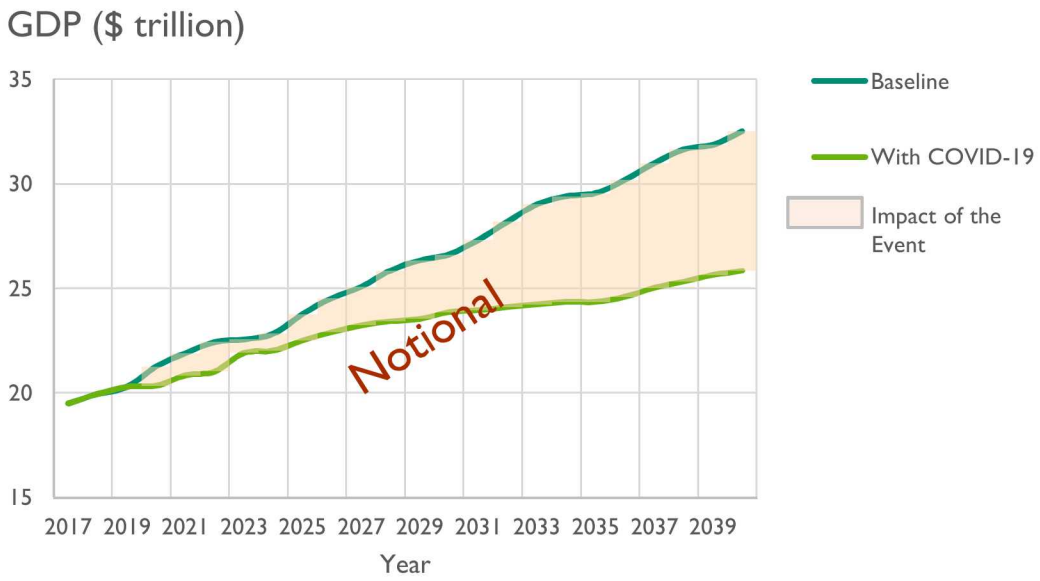
- Epidemiological
- Economic
- Resource model
- State and federal

Overall

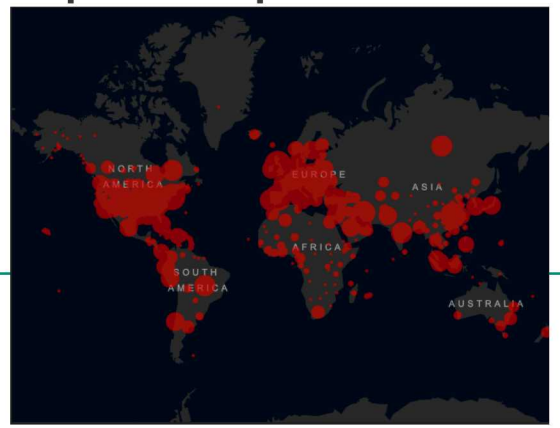
- All weekly, monthly, or quarterly data is scaled to annual
- Stimuli +/- will occur over the year at differing time intervals
- Base year in model for inflation is 2017
- Output will be reported in 2020 dollars
- Perform sensitivity analysis on principal parameter estimates or UQ analysis to assess uncertainty (work w/DAKOTA team)



Example Output

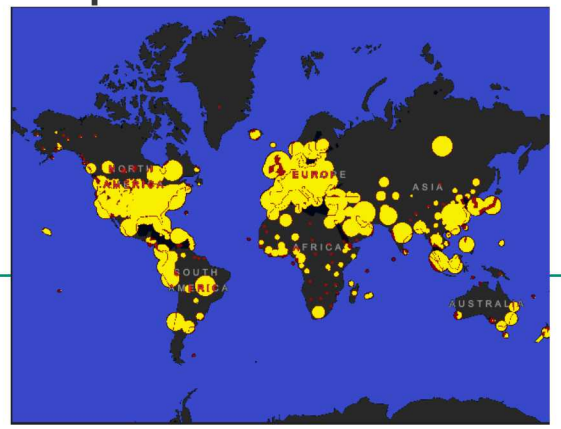


Response phases inform the temporal breakdown of the course of events



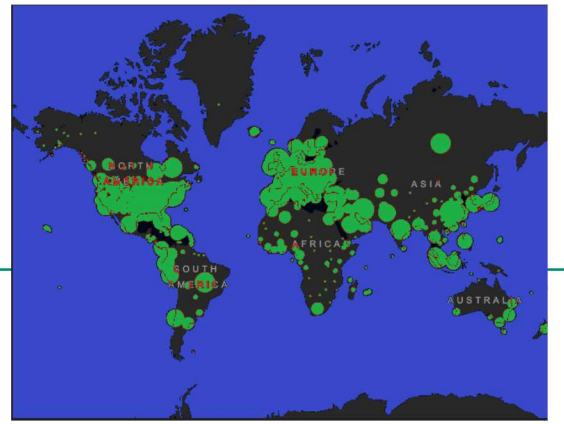
Emergency Phase

- March 1, 2020 to June 1, 2020
- Characterized by stay-at-home orders
- Essential VS. non-essential
- Psychosocial responses
- Tracking weekly, quarterly, or monthly changes
- Informed by real-world observation and estimates



Stabilization Phase

- June 2, 2020 to December 31, 2020
- Characterized as a loosening of stay-at-home orders
- Reduced restrictions on essential or non-essential businesses
- Reduced avoidance behaviors
- Primarily informed by scenario assumptions or real-world policies



Recovery Phase

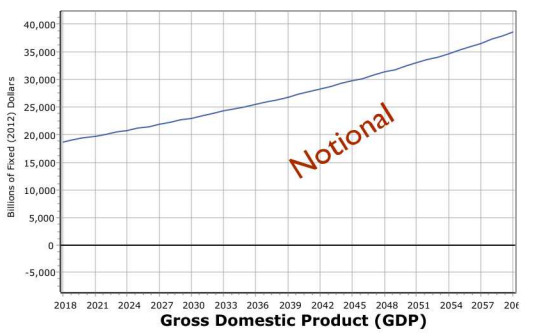
- January 1, 2021 to TBD
- Return to normal operations or new normal
- Ongoing stimulus and health mitigation strategies
- Health and economic policies

Epidemiological progression remains unknown but it will factor in and could change the response phases.

How the model is used:

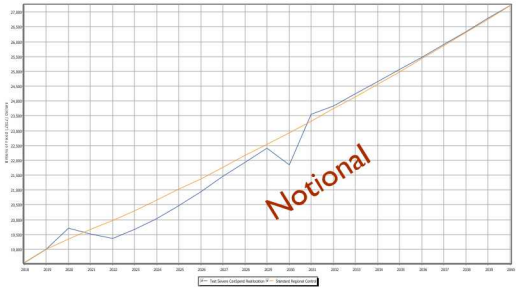
1. Pre-loaded Regional Control "Baseline"

Model is the I/O, econometric, CGE representation of interactions



2. COVID-19 Shock ("New COVID Baseline")

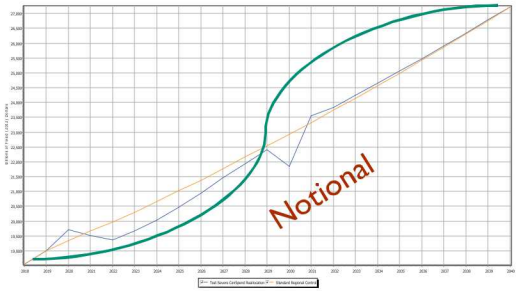
Translation of physical event to dollars



2018 → 2019 → 2020 → 2021 → 2022 → .....

3. COVID-19 Strategies

Reopening/recovery strategies

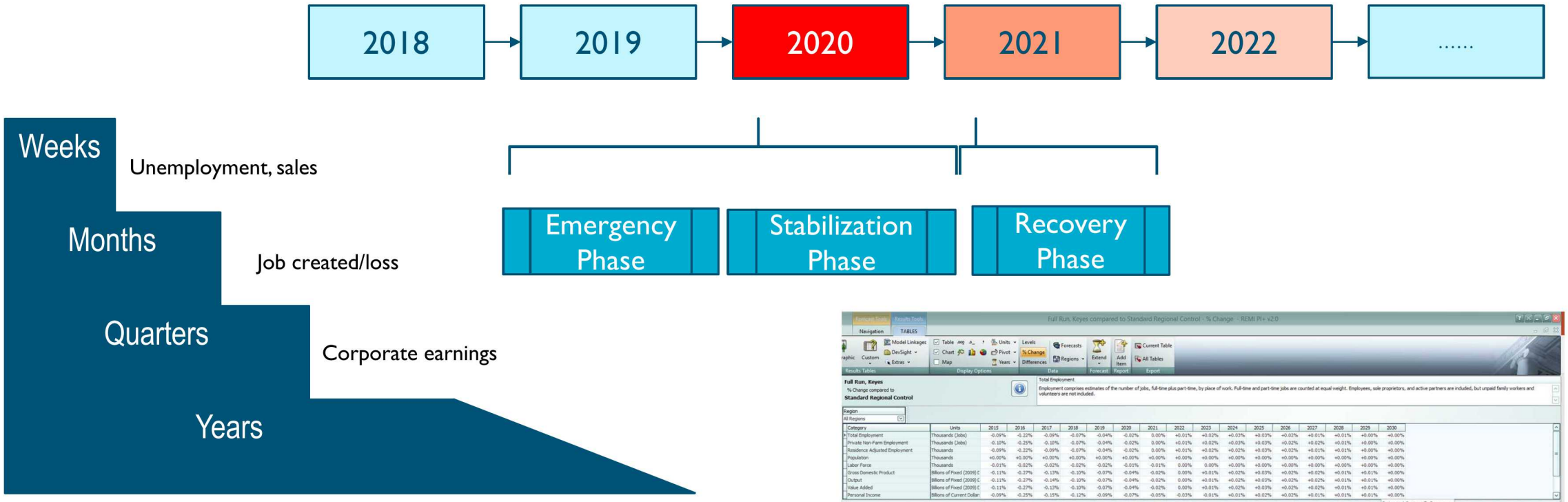


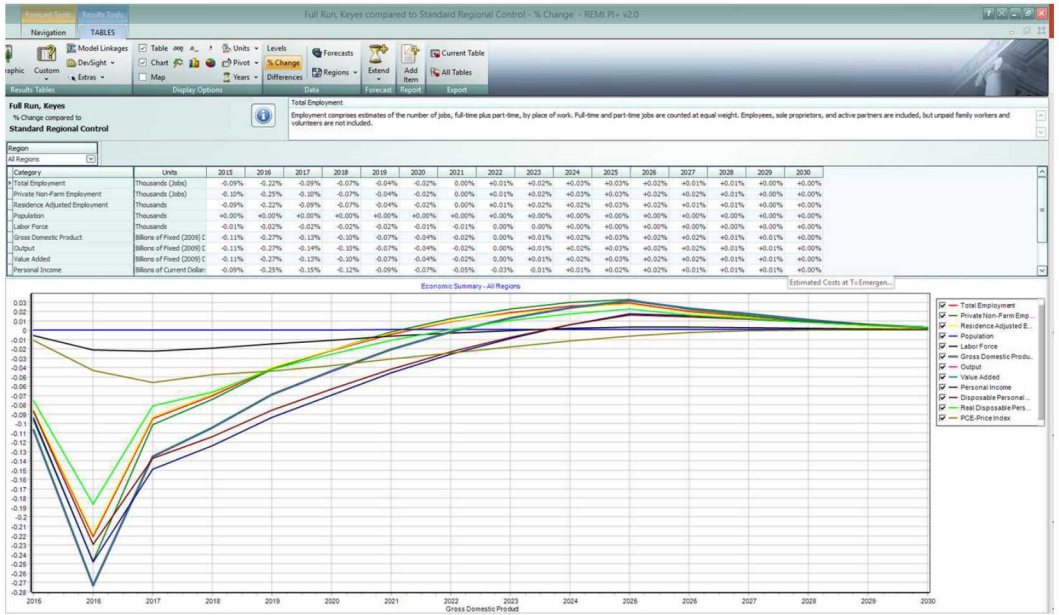
2018 → 2019 → 2020 → 2021 → 2022 → .....

Emergency Phase | Stabilization Phase | Recovery Phase

Temporal adjustments scale from weekly impact to annual

Notional Timelines (Not to Scale)





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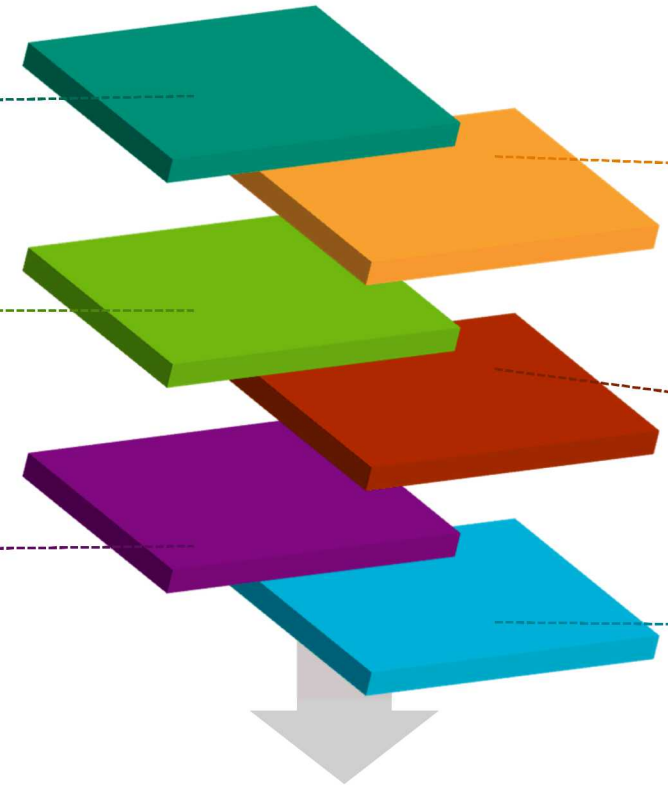
How we are building the modeling input for parameter changes

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

Layer 1
Supply and Demand Shocks

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

Layer 5
Healthcare Costs
Treatment costs



Layer 2
Changes in Spending Behavior
- Reallocation of consumption
- Reallocation of sales

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

Layer 6
Morbidity and Mortality
- Survival rates

The combination of all layers provides a representation in the model of multiple types of shocks.

What is modeled in each phase depends upon a scenario

Development is iterative, model based, and/or reflective of real-world

Severe

- Emergency Phase
  - No change
- Stabilization Phase
  - Mitigations, little to no effect
    - High savings rate; low demand
    - Continued stay-at-home orders
- Recovery Phase is still to be determined
  - +/- 10 years

	Year 1 - Severe	
Category	Time Period 1	Time Period 2
Tourism	-100%	-75%
Non-essential	-100%	-75%
Essential	-75%	-50%
Medical Services	100%	75%

Cautious

- Emergency Phase
  - No change
- Stabilization Phase
  - Mitigations, have a mild effect
    - Savings rate slowly eases
    - Consumption approaches normal
- Recovery Phase is still to be determined
  - +/- 5 years

	Year 1 - Cautious	
Category	Time Period 1	Time Period 2
Tourism	-50%	-25%
Non-essential	-50%	-25%
Essential	-50%	-25%
Medical Services	50%	-25%

Exuberant

- Emergency Phase
  - No change
- Stabilization Phase
  - Mitigations, are fully effective
    - Marginal propensity to consume returns to normal or exceeds for every income group
- Recovery Phase is still to be determined
  - +/- 2 years

	Year 1 - Exuberant	
Category	Time Period 1	Time Period 2
Tourism	-25%	-10%
Non-essential	-25%	-10%
Essential	-25%	-10%
Medical Services	25%	-10%

What is not considered? Full scale economic deterioration.

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We are collecting data and the process is challenging

Continuously updating and refining

This is an ongoing, evolving event

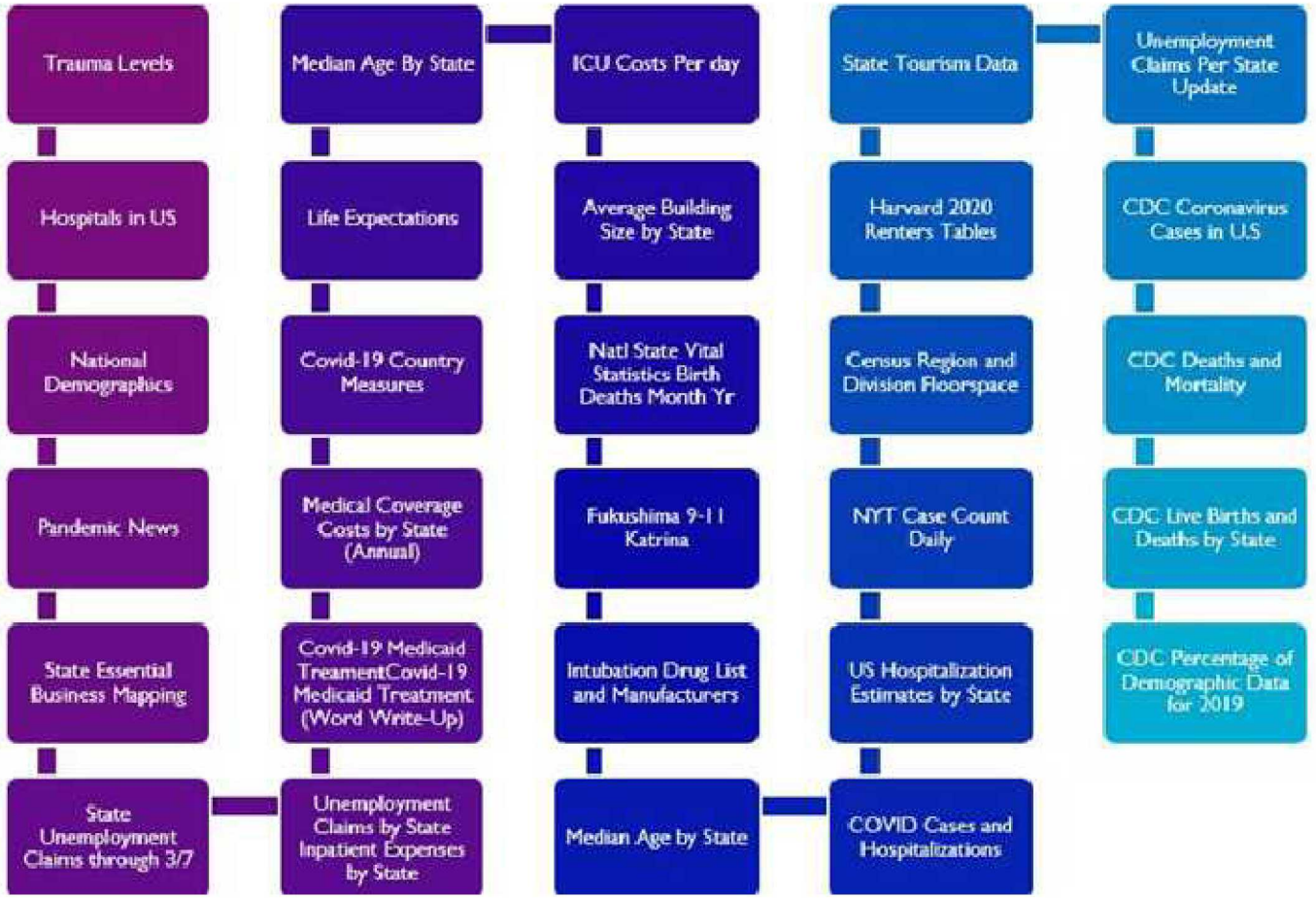
- A team is pulling data around the clock to continually update the model

Sources

- Peer reviewed and non-peer reviewed
- State/local government
- Industry reports
- Network of peers
- Professional associations
- Lobbying groups

Challenges

- Unreliable data
- Economic data runs on a lag
- Differences in reporting
- "True" will be too late



Creating a new economic baseline

Informed by changing spending patterns

- Combine consumer spending data from the Bureau of Economic Analysis (BEA) and Census Bureau
- Spending on goods and services propagates upstream through the PCE-Bridge matrix
- Relates goods and services to retail and manufacturing sectors
- Changes in spending on goods and services change demand in retail and manufacturing sectors and impact inter-industry relationships

Consumer spending data is representation of new market equilibrium

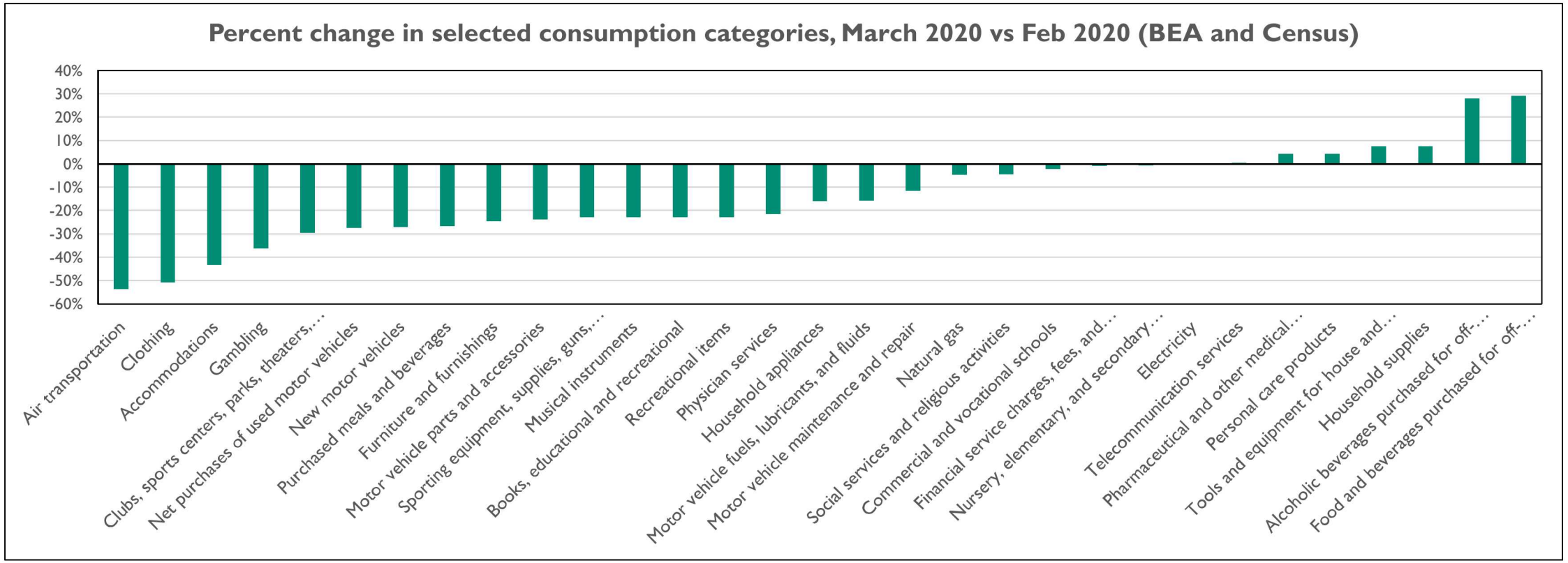
- Changes in demand due to
  - Psycho-social effect
  - Income effect (job loss, furlough, savings under uncertainty)

Changes in supply due to forced and voluntary closures

Personal consumption expenditures have changed

Total personal consumption expenditures (PCE) down 7.5% in March 2020 from Feb 2020, larger impact expected for April

- Examples: Purchases of new autos (-26%), clothing (-51%), food services and drinking places (-27%), food from grocery stores (+29%)



There are potential supply-side impacts

Consumer spending variables change baseline demand…

- Do not capture potential supply-side effect of shuttered manufacturing facilities (voluntary or by mandate)
- Attempt to incorporate while minimizing double counting

Further reduced output from certain industries captured by changes in Industry Sales

- Informed by business Essential and Non-Essential designations at state level
- Informed by reporting of permanent and temporary business closures subject to the Worker Adjustment and Retraining Notification Act of 1988 (WARN Act)

Impacts to each industry determined to be:

- Exogenous supply shock (reduced output due to facility closure)
- Indirect (changes in consumer spending or closures of businesses in other industries)
  - Indirect effects are not modeled, effects are outputs from simulations

Even "essential" industries face exogenous supply shocks

The essential vs. non-essential business situation is not simple

States and local governments designated certain industries as being "essential" and "non-essential"

- Categories poorly defined and ad-hoc (do not correspond to any classification system)
- Designations gleaned from state-level policies and the press
- Created list of common industries and worker categories designated as essential or explicitly non-essential
- Each industry evaluated for each state
- Each industry assigned to REMI industries (based on NAICS codes)

Not all essential businesses are operating

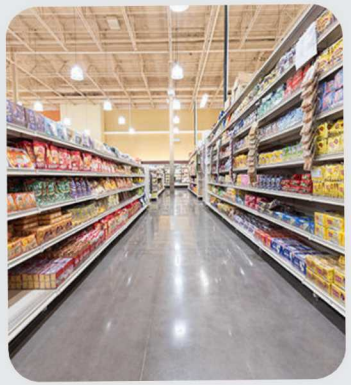
- Low demand, difficulty implementing social distancing measures (air transportation)

Not all non-essential businesses ceased operation

- Able to operate under social distancing measures (telecommuting, some retail)

Categorizing industries is not always straightforward

Essential and non-essential industries vs. supply and demand shocks



Essential

Increased output due to high demand

Essential

Reduced output due to low demand

Non-Essential

No output due to no supply

Non-Essential

Reduced output due to lower supply *and* demand

Non-Essential

Ambiguous change in output due to WFH; indirect changes in supply and demand

Varies

Direct and indirect changes in output due to exogenous changes in supply and demand

We use this notional binning system

A	Share of industry that is essential
B	Share of essential activity that shuts down
C	Share of non-essential activity that operates
D	Share of industry that operates during social distancing

$$D_i = A_i(1 - B_i) + C_i(1 - A_i)$$

Category	A	B	C	D	Example
E4	1.00	0	0	1.00	*Grocery stores*
E3	1.00	0.25	0	0.75	*Banks, construction*
E2	0.75	0	0.25	0.81	*Public transportation, ride sharing*
E1	0.75	0.50	0	0.38	*Air transportation*
E0	1.00	1.00	0	0	*N/A*
N4	0	0	1.00	1.00	*Office jobs*
N3	0	0	0.75	0.75	*Educational services (private)*
N2	0	0	0.50	0.50	*Retail*
N1	0	0	0.25	0.25	*Restaurants*
N0	0	0	0	0	*Personal care industries*

Binning system

- Each industry (99) is assigned to both Essential (E) and Non-essential (N) categories
- If industry is essential or not defined in a state order, receives E score; otherwise, receives N score
- For each state, output is reduced for each industry by $1 - D_i$ and scaled for a single quarter
- Example of values in binning system in table on the left

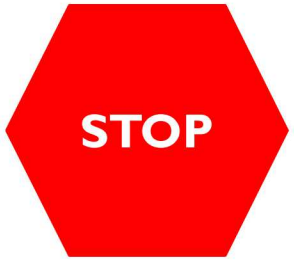
How this briefing will progress

- Introduction
- Goal
- Past Work
- How This Differs
- High-Level Analysis Process
- Layers and Scenarios
- Creating a New Baseline
- **Current Status**

These key economic modeling assumptions are used in the analysis.

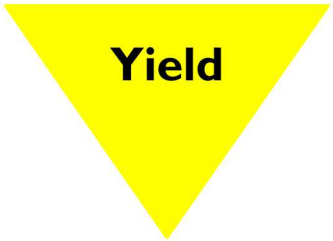
Type	Number	Duration	Region	Pedigree	Event/Scenario
Business Disruption: essential	See binning; supply/demand	Partial Q1 and Q2 w/decay Q3 and Q4	~6 states not fully participating	No	
Business Disruption: non-essential	See binning; supply demand	Partial Q1 and Q2 w/decay Q3 and Q4	~6 states not fully participating	No	
Industry NAICS	3-digit and 4 digit	10 year w/decay	All 51 regions	Yes	Standard federal system
Perception: Tourism	-30% to -90%	Partial Q1 and Q2 w/decay Q3 and Q4	All 51 regions Every class of traveler	Yes	9/11, Hurricane Katrina, SARS, Fukushima
Perception: Worried-well	10%	Partial Q1 and Q2 w/decay Q3 and Q4	All population	Yes	SARS, Goionia, Fukushima
Remediation Services	~5%	1 year	All 51 regions	Yes	Anthrax, radiological accidents; 9/11
Healthcare: prompt illness	$ per doctor visit; hospital; ICU; COVID test	Partial Q1 and Q2	All 51 regions	Yes	9/11, SARS, RDD, pandemic scenarios
Healthcare: latent illness; not yet applied, not yet estimated	$ rehabilitation; nursing home; hospice; home healthcare; other med practitioners	Lifetime of individuals	All 51 regions	No	9/11, Fukushima, RDD scenarios
U.S. survival rate	Change in avg. survival by cohort	Study duration	All 51 regions	Yes	RDD scenarios; pandemic scenarios
Transfer payments	Avg $ State UIC; federal additional $600 UIC	Partial Q1 and Q2	All 51 regions	No	

This is the data situation as of April 24, 2020



"Froze" data as of April 24 for current runs

- Economic data, newly released week ending 4/24
- Reporting of cases and deaths
- State level and National; quarterly
- Other relevant data



We are continuing to collect data for future runs

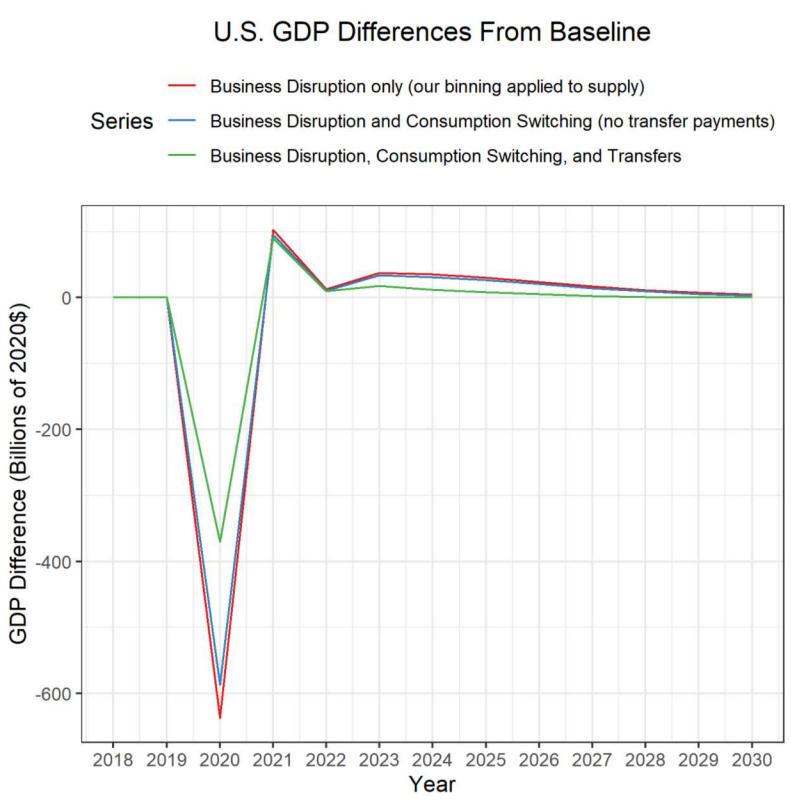
- All updated on rolling basis
- Additions to include Epidemiological and resource model outputs
- Expecting consumer spending data in April to be far lower than in March

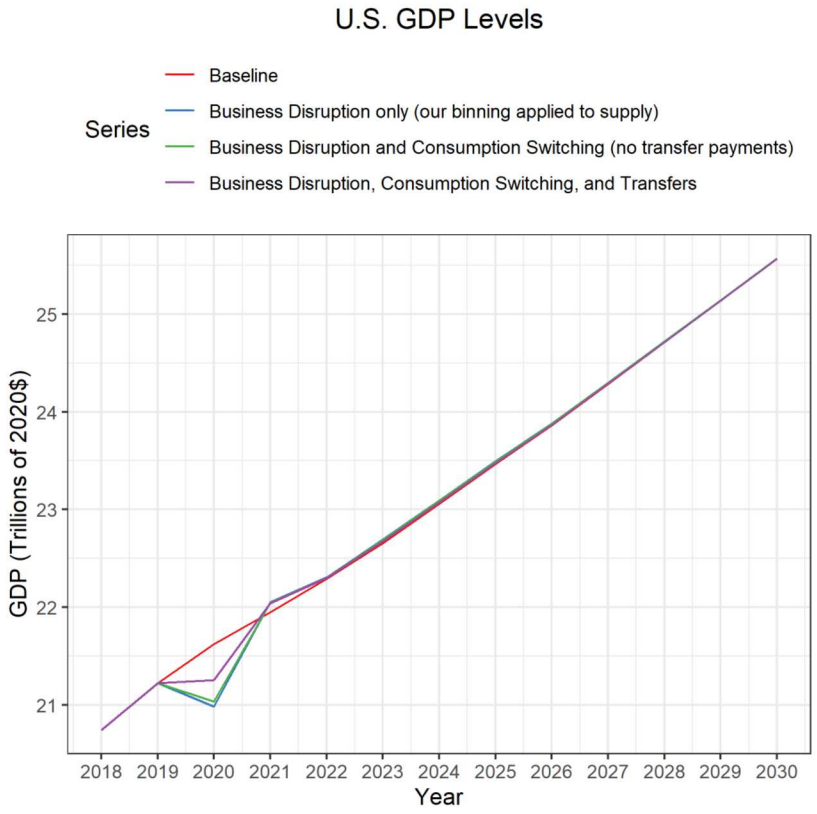
We are moving forward

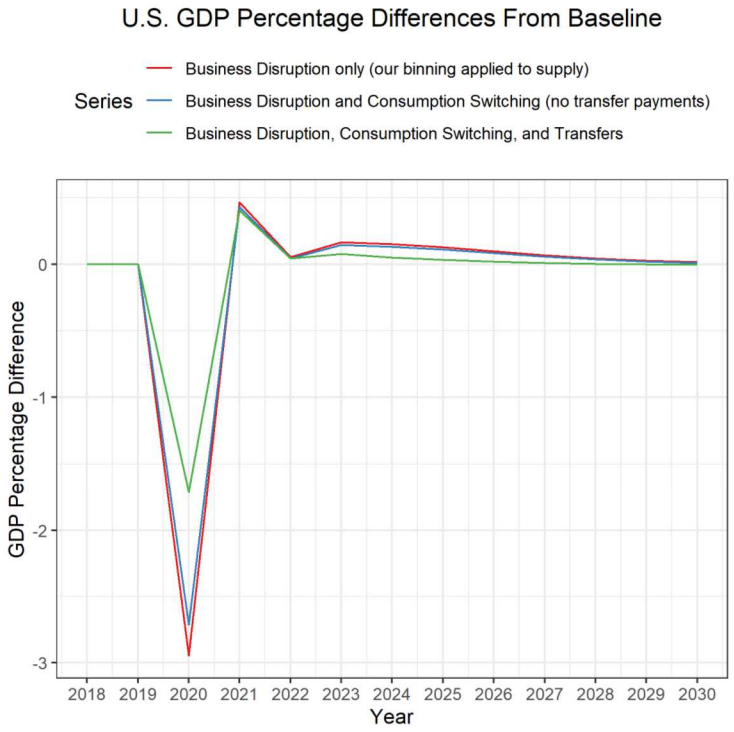
- **Past:** best informed assumptions and daily reporting; essential vs. non-essential binning
- **Current:** publicly available (govt. sourced), peer reviewed, non-peer reviewed
- **Next:** Epidemiological and resource data, newly launched federal data sources

Past: These are our results for a "Best Guess" Baseline

Q3 and Q4 adjustments only, all layers applied



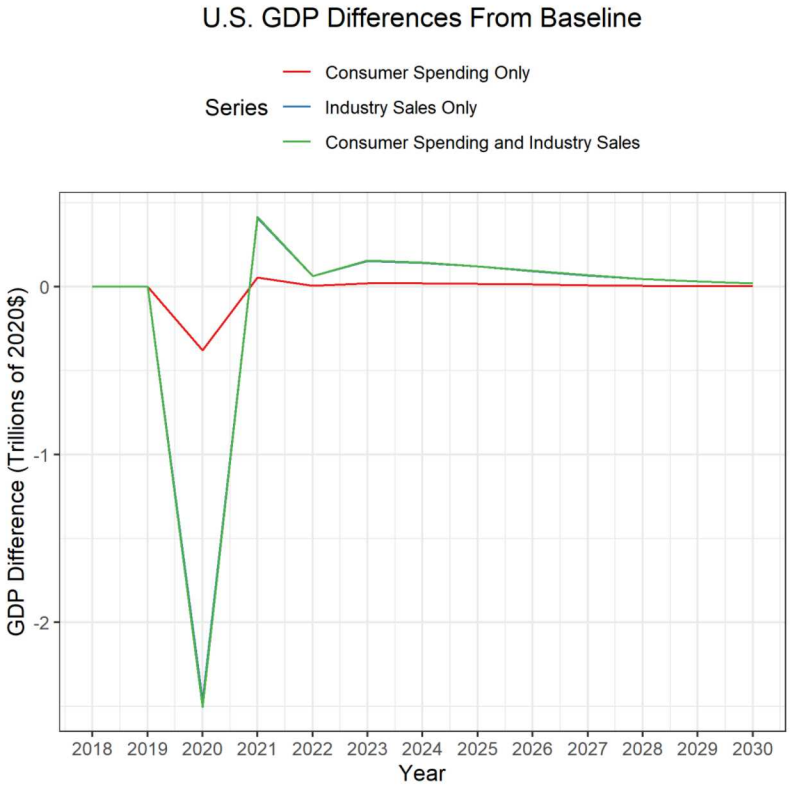


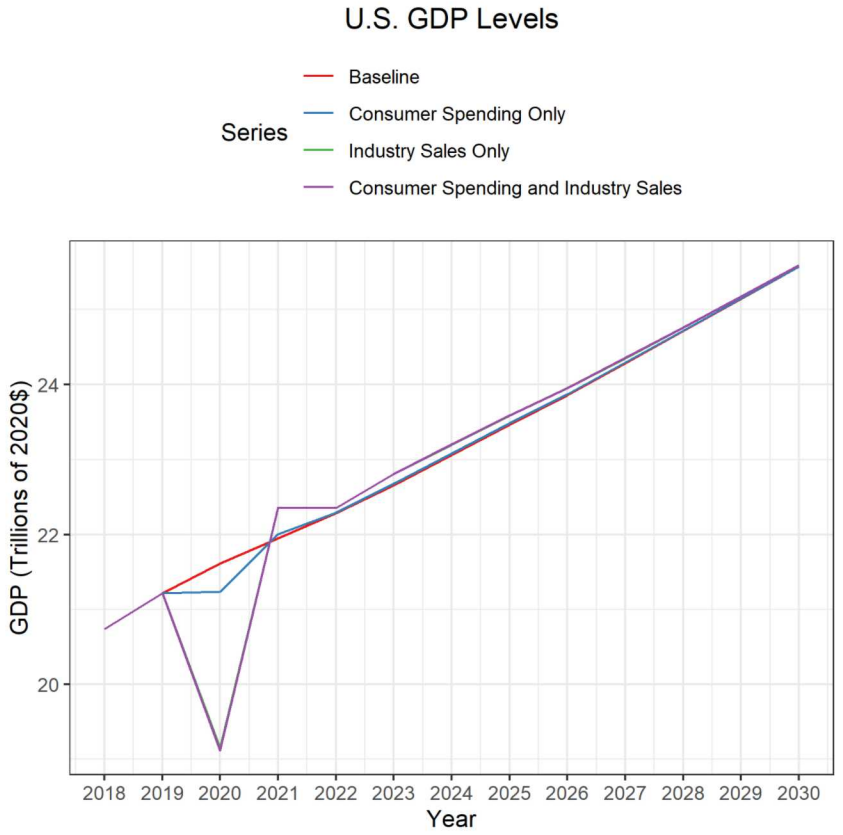


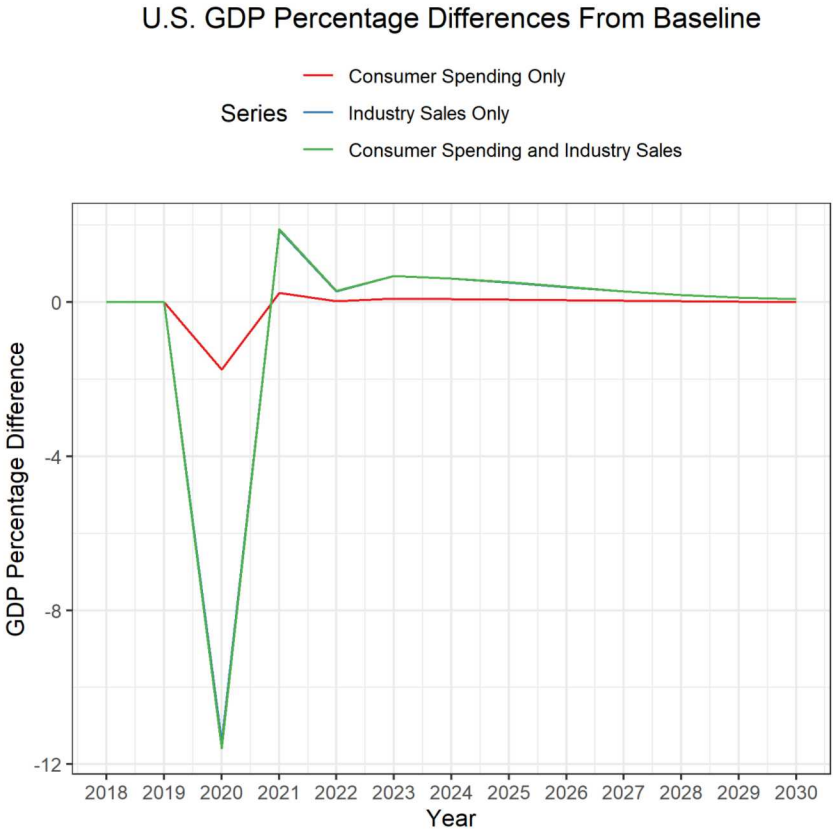
Using data as of 4/24/20

Current: These are our results for a current "Test COVID-19" Baseline

Recently released data (4/24/20) for supply and demand changes only, no other layers







Using data as of 4/24/20

Current: Going from "Best Guess" Baseline to "New COVID-19" Baseline

Changes to consumer spending only
- Uses PCE data from BEA and Census to inform changes in demand
- Plus additional layers

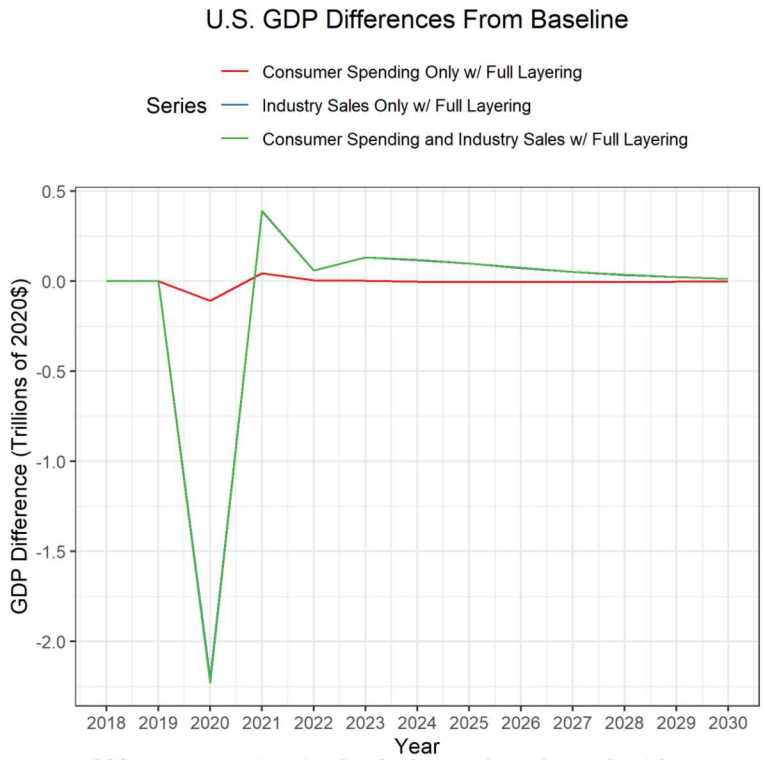
Changes to consumer spending and industry sales
- Uses PCE data as well as notional binning system
- Binning system used for industries with exogenous supply-side impact (mainly manufacturing)
- Plus additional layers

Changes to industry sales only
- Uses notional binning system without PCE data
- Binning system used for industries with exogenous supply-side impact (manufacturing *and* retail)
- Plus additional layers

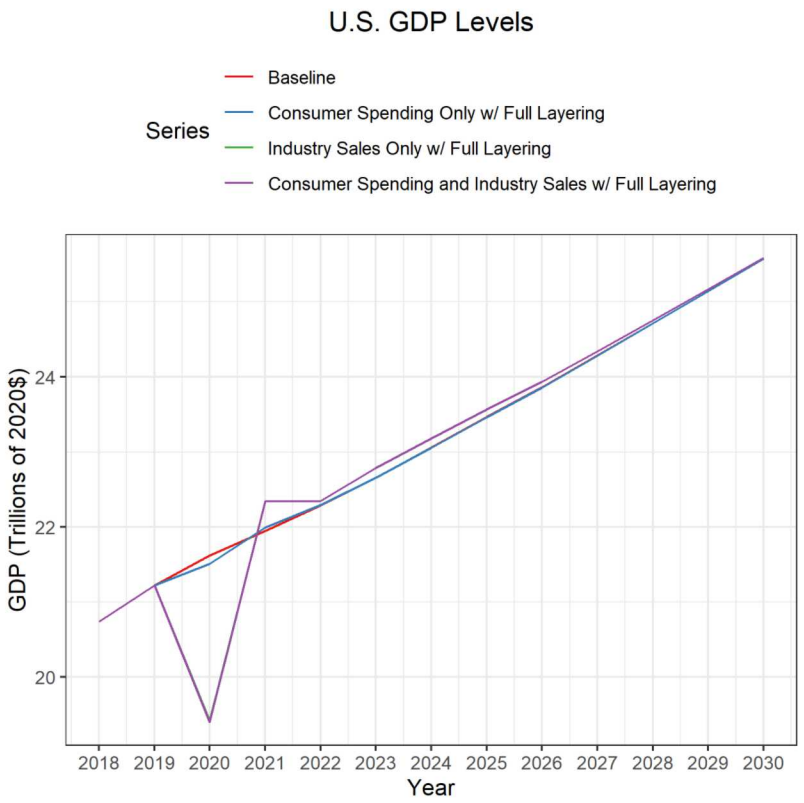
Additional layers (not modeled in baseline business disruption) include
- Tourism spending
- Remediation
- Transfer payments (from CARES Act)
- Healthcare spending

Current: These are our results for a current "New Covid-19" Baseline

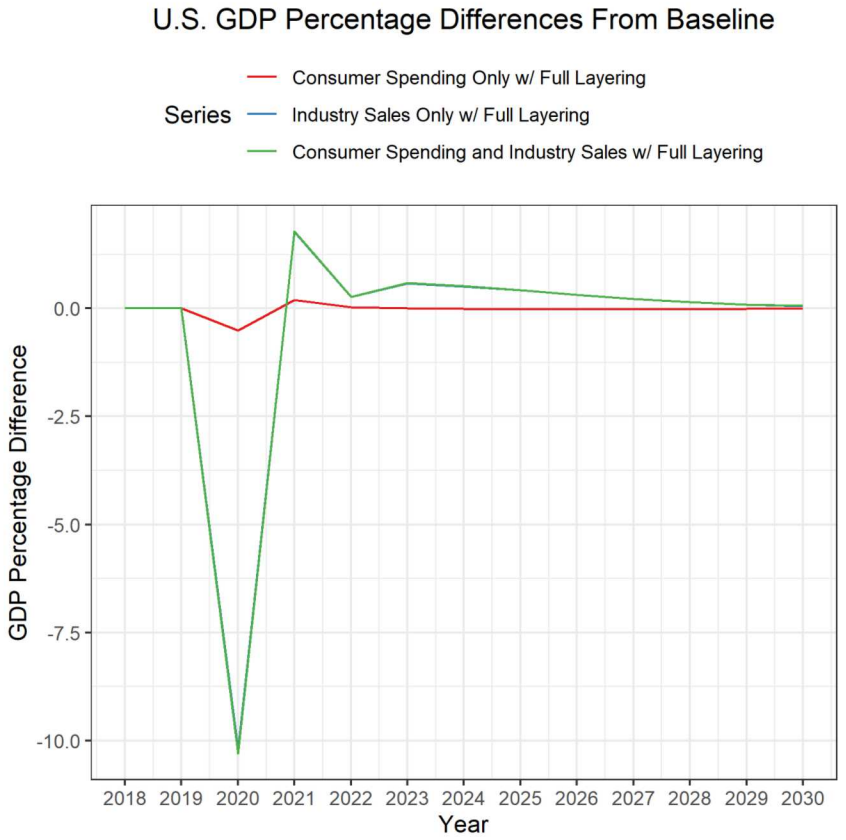
All categories combined, full layering approach applied



We are experiencing both demand and supply side shocks. It is the net of these effects that we are "experiencing" as economic losses. The economic situation will continue to evolve as either the event continues (i.e. healthcare spending) or mitigations (i.e. WFH; CARES Act) take a effect.



The pre-COVID baseline forecast is shown in red. "New COVID" baseline forecast is in purple. The interactions between supply and demand shocks, exogenous changes in economic transactions, and transfer payments are all captured in the purple result.



Depicted is the percent change from baseline. This is equivalent to the dollar change in the graph on the left.

The New COVID-19 scenario results in a 10.3% reduction in 2020 U.S. GDP from the baseline
That is equivalent to ~$2.2 trillion

What we will do next

Layer in epidemiological and resource model output

Continue collecting data

- This will continue until we're told to stop

Perform final runs

- We'll call these the "blessed" runs
- Agreement from COVID Response Team

Define Reopening Strategies for scenario analysis with COVID Response Team

Examine permanent shifts to new behaviors

Perform sensitivity analysis and uncertainty quantification

- Right now the focus is on finishing the modeling runs
- This may occur after our 3-month sprint

Present the results to our sponsors

What is not covered in our analyses?

Unintended consequences of "shut-down"

- Increase in risky behaviors
- Post 2008 financial crash uptick in suicides
- Decreased life-years due to lack of access to medical care
- Increased life-years from lack of exposure to pollution
- The oil surplus

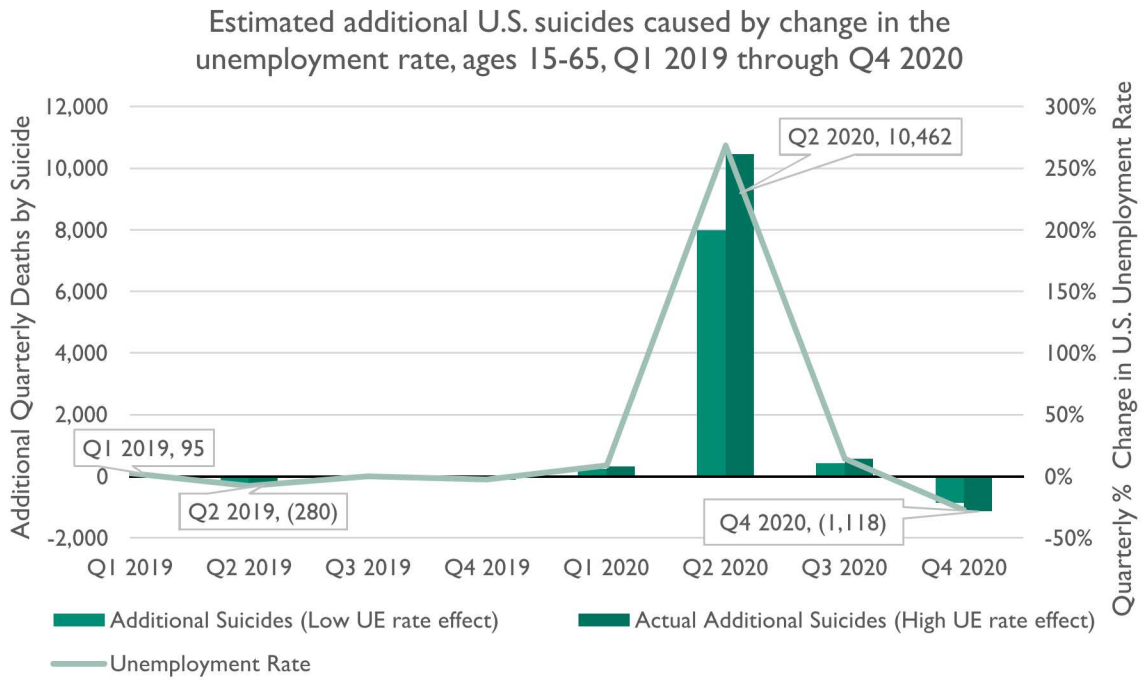
Long-term structural changes to the economy

- Restructuring of labor market?
- Fast-tracking of automated and AI economy?
- Large permanent shifts in consumption?

Future increases to CARES Act

Threats to the National Laboratory System

- Long-term federal tax revenue can be expected to shrink
  - Are the National Laboratories insulated?
  - Are there plans for threats to programs and laboratory closures?



Content Backups

We have learned 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.

Our typical modeling process is being sped up

Objective

- Estimate cumulative economic impacts

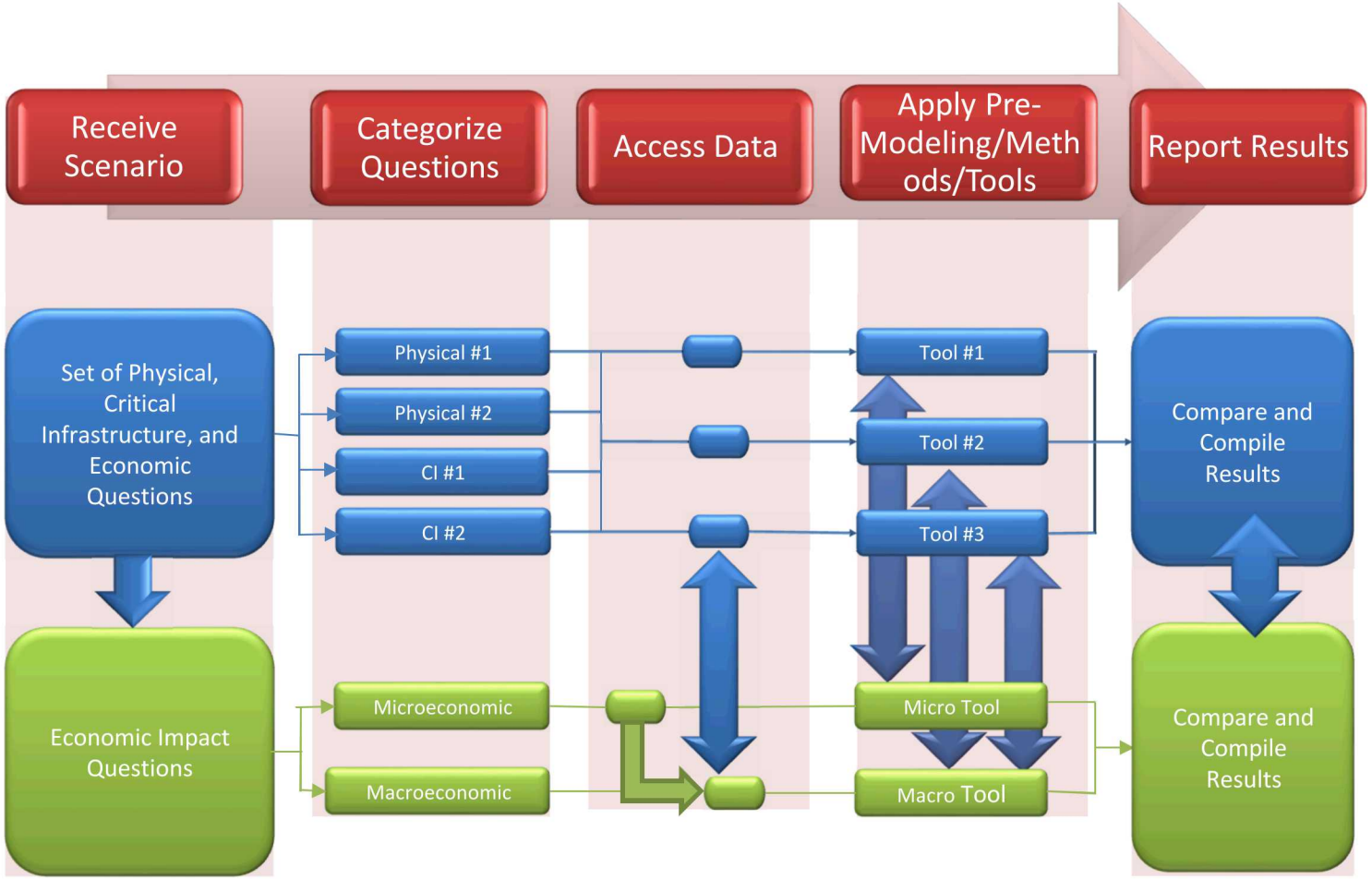
Challenges

- 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
  - Uncertainty quantification and sensitivity analysis

High-level analysis process

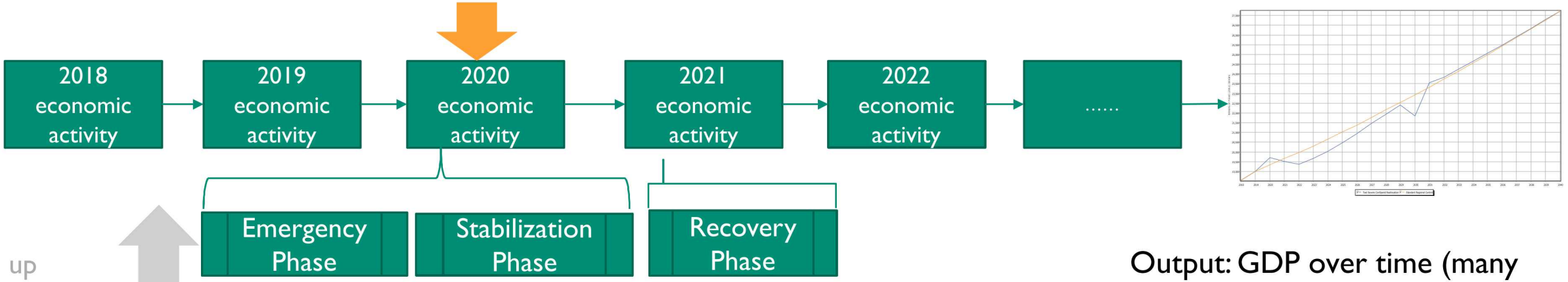


All of this is now occurring simultaneously

How the model is run: 2. Including a COVID-19 event

Model is the I/O, econometric, CGE representation of interactions between sectors and geographic locations

Parameters (I/O values, etc.)



Roll up weekly/monthly behaviors into model parameters that are annual for the model to run

Changes in parameters for March –June (annualized)

Translation of physical observation to economic impact
Translation could be in severe, exuberant, etc.

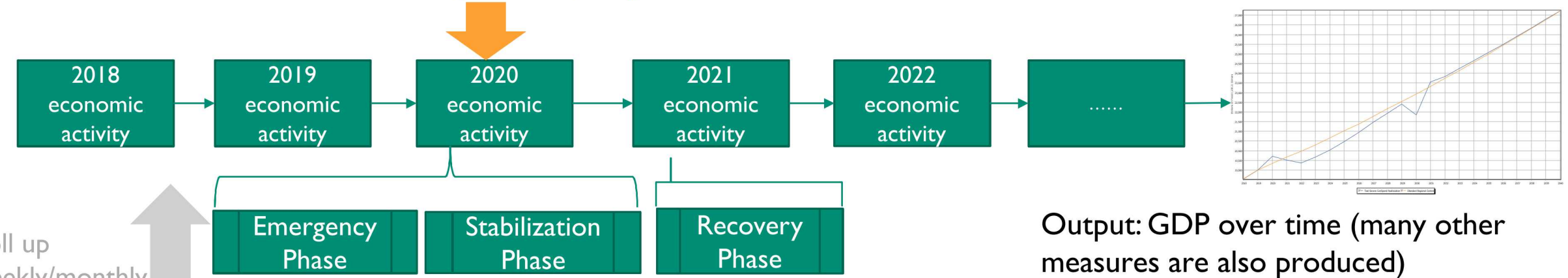
This translation is uncertain in some instances. So is done in three different scenarios that represent ranges in the extent of economic effects

Observations of physical changes in the world. Ex: weekly changes in stay at home orders by state

Output: GDP over time (many other measure are also produced)
Baseline GDP line
Three scenarios – each have their own line

How the model is run: 3. Impact of different reopening/recovery strategies

Parameters (I/O values, etc.)



Roll up weekly/monthly behaviors into model parameters that are annual for the model to run

Changes in parameters for March –June (annualized)

Translation of physical observation to economic impact
Translation could be in severe, exuberant, etc.

Observations of physical changes in the world. Ex: weekly changes in stay at home orders by state

Observations of physical changes in the world. Ex: change the date a stay at home order is lifted

These changes can NOT be done in parameter sweep. Individual scenarios must be run by hand

Output: GDP over time (many other measures are also produced)
Baseline GDP line
Three scenarios – each have their own line
Three scenarios each with one strategy