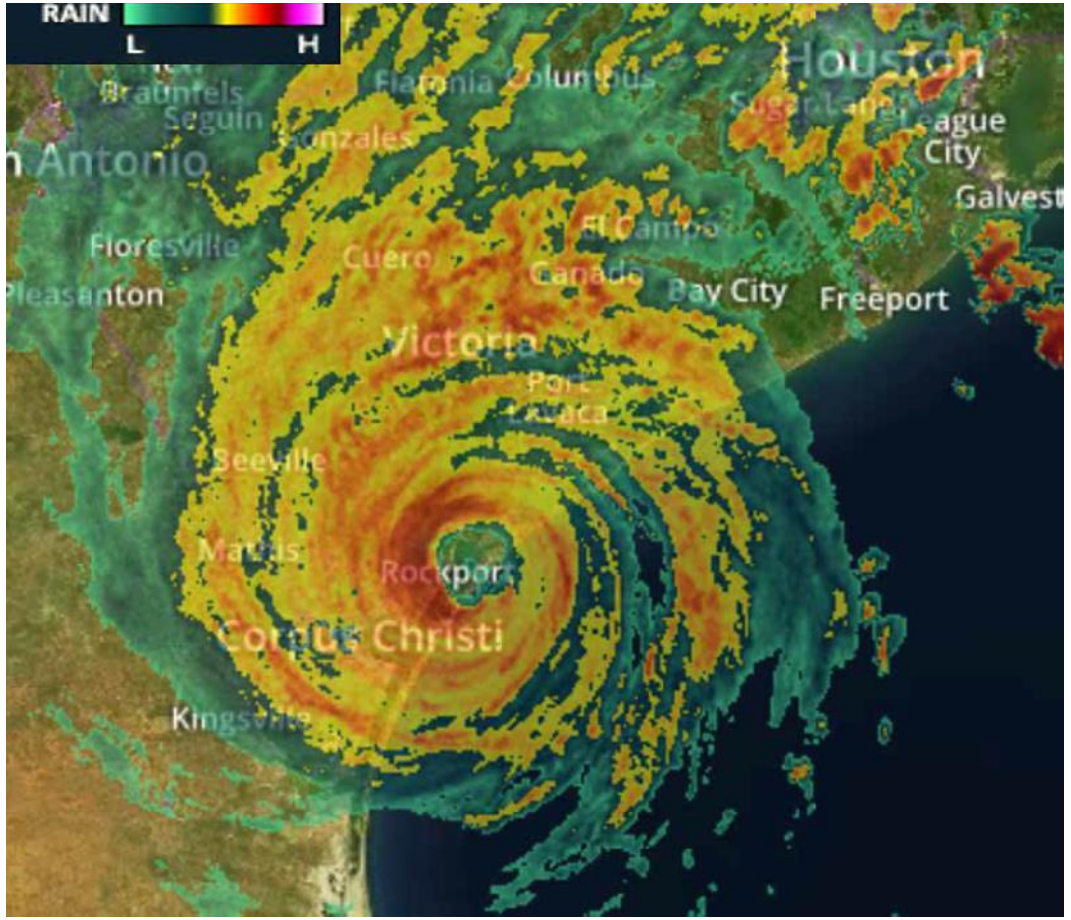
A Storm to Remember

The Economic Impact of Hurricane Harvey



Joyce E. Jauer

REMI Users Conference

San Diego

October 2018

The Economic Impact of Hurricane Harvey

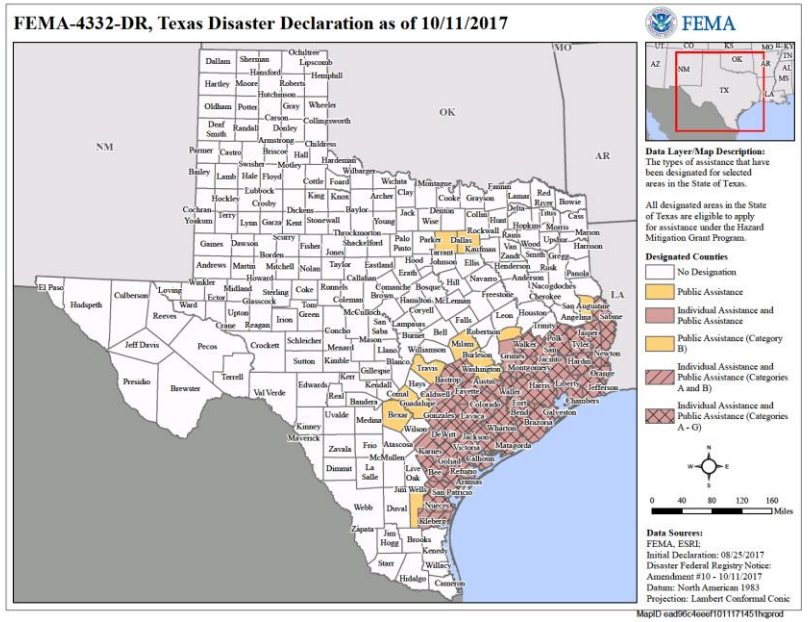
- Assumptions
- Productivity Loss
- Rebuilding Gains
- Model
- Results
- Takeaways

Harvey by the Numbers

- 178,400 Texas homes damaged
- estimated $669 million in damage to public property
- 400,000-600,000 cars damaged
- $200 million in Texas crop and livestock losses
- Winter tourism decreased 50% in coastal areas
- Total costs estimated $125-133 billion

Assumptions

- What geographical areas were affected?
- How long was business disrupted?
- What industries were affected?
- How are supply chains affected?
- How much damage was done?



- How much money is coming in?
- When is it coming?
- On what will it be spent?
- When will it be spent?
- Where will it be spent?

Assumptions

Devastating effects for communities:

- Significant damage and replacement costs
- Utilities interrupted
- Businesses offline for a period of time
- Hourly workers unpaid
- Cars and equipment flooded
- Businesses and families displaced
- Infrastructure damaged (roads, ports)

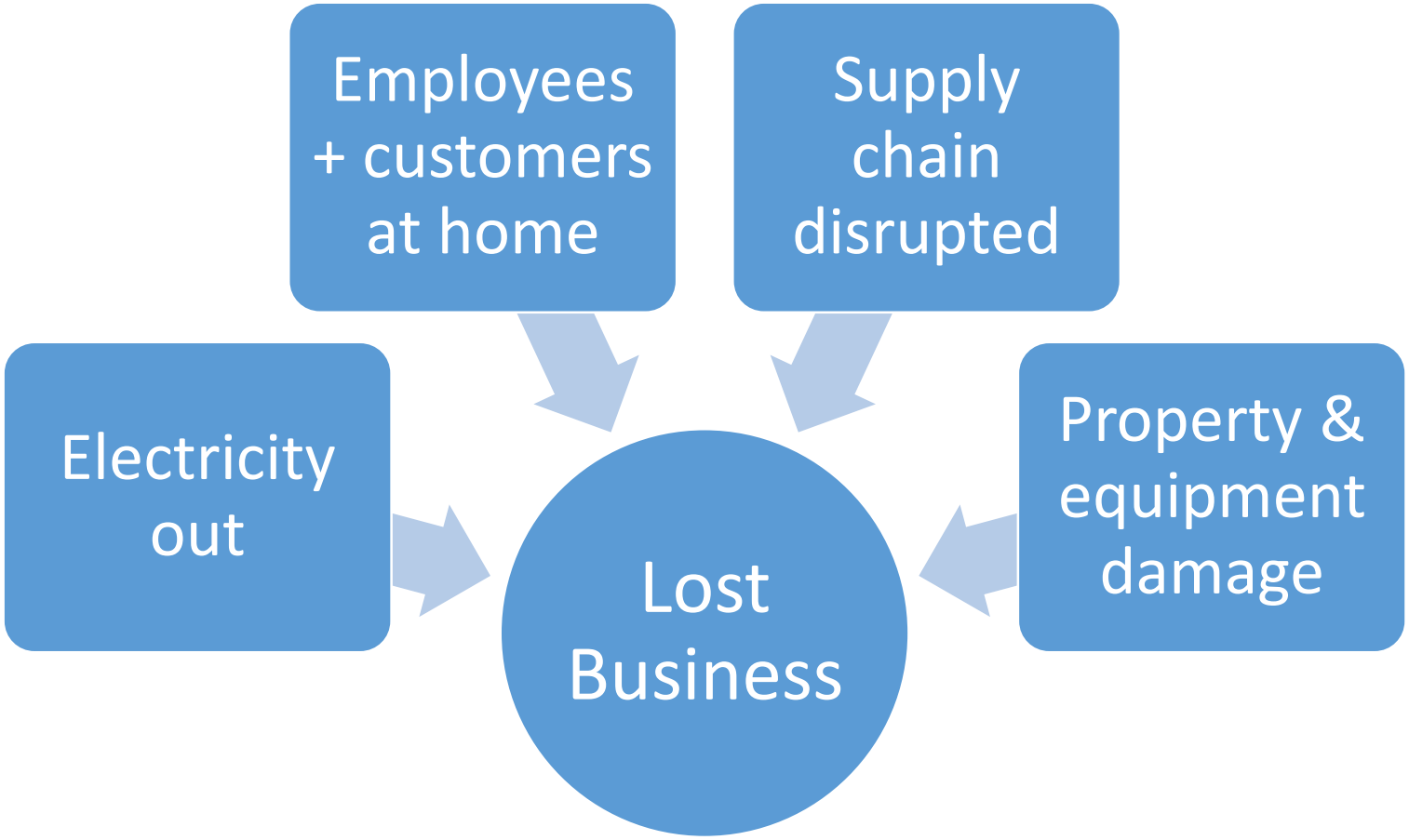
Productivity Loss

Economic activity generating effects for the region:

- Increased spending from rebuilding and replacement
- Influx of insurance payments, federal aid
- Increased employment for construction and debris removal
- Increased building materials and replacement equipment purchases
- Increased intermediate effects due to supply for construction
- Increased consumer spending on household items, health care and induced effects

Rebuilding Gains

Productivity Loss



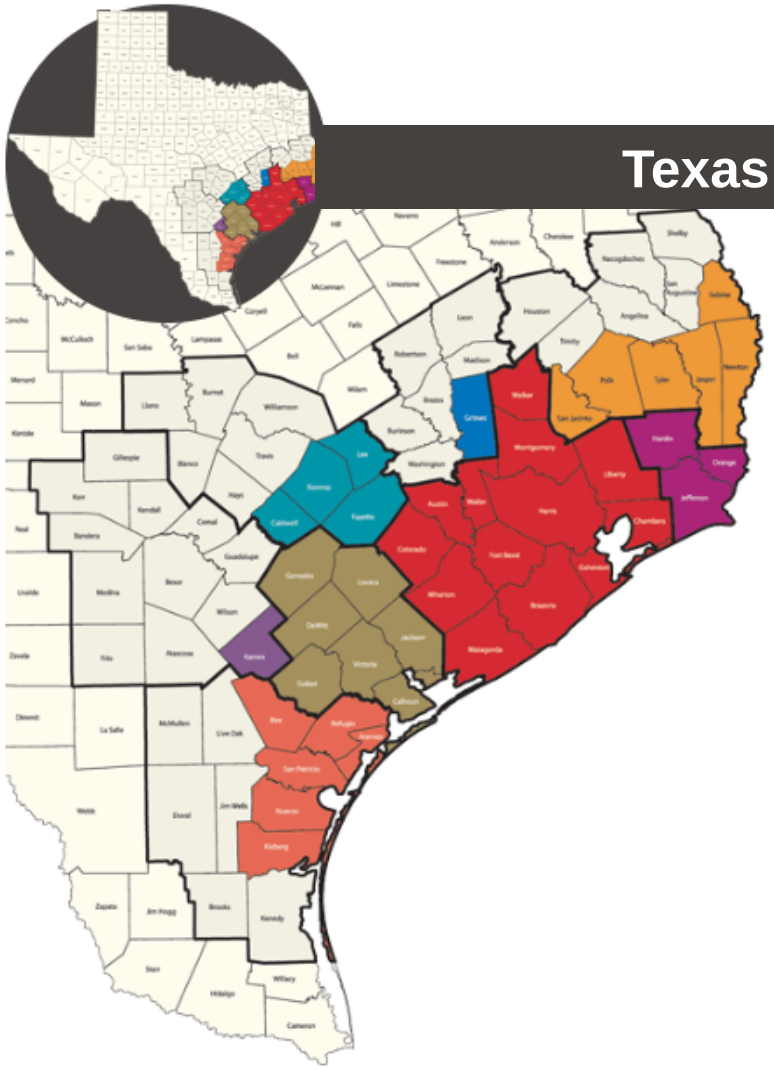
Productivity Loss

Industries are discounted differently depending on:

- the amount of time they were estimated to be offline
- their level of competition
- their place in the supply chain

Regions are discounted differently based on disaster area declaration

Texas Counties Affected by Hurricane Harvey



Source: Federal Emergency Management Agency

Counties declared by FEMA as disaster areas and boundaries showing the eight councils of governments (COGs) affected.

DETCOG — **Deep East Texas Council of Governments**

Jasper, Newton, Polk, Tyler, Sabine, San Jacinto

SETRPC — **South East Texas Regional Planning Commission**

Hardin, Jefferson, Orange

H-GAC — **Houston-Galveston Area Council**

Austin, Brazoria, Chambers, Colorado, Fort Bend, Galveston, Harris, Liberty, Matagorda, Montgomery, Walker, Waller, Wharton

BVCOG — **Brazos Valley Council of Governments**

Grimes

CAPCOG — **Capital Area Council of Governments**

Bastrop, Caldwell, Fayette, Lee

GCRPC — **Golden Crescent Regional Planning Commission**

Calhoun, DeWitt, Goliad, Gonzales, Jackson, Lavaca, Victoria

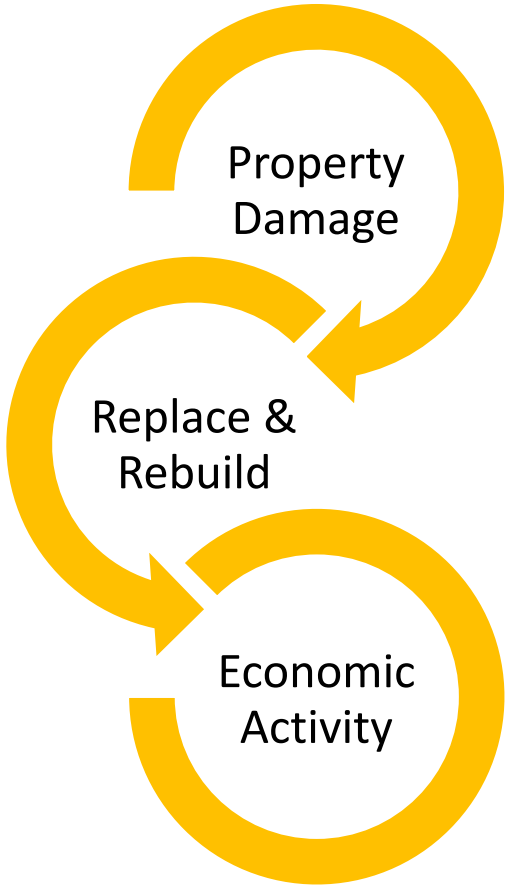
AACOG — **Alamo Area Council of Governments**

Karnes

CBCOG — **Coastal Bend Council of Governments**

Aransas, Bee, Kleberg, Nueces, Refugio, San Patricio

Rebuilding Gains



FEMA

+

Nonprofit

+

Insurance

$

- Construction
  - Debris removal
  - Rebuilding
- Equipment
  - Trucks
  - Machines
- Consumer goods
  - Clothes
  - Food

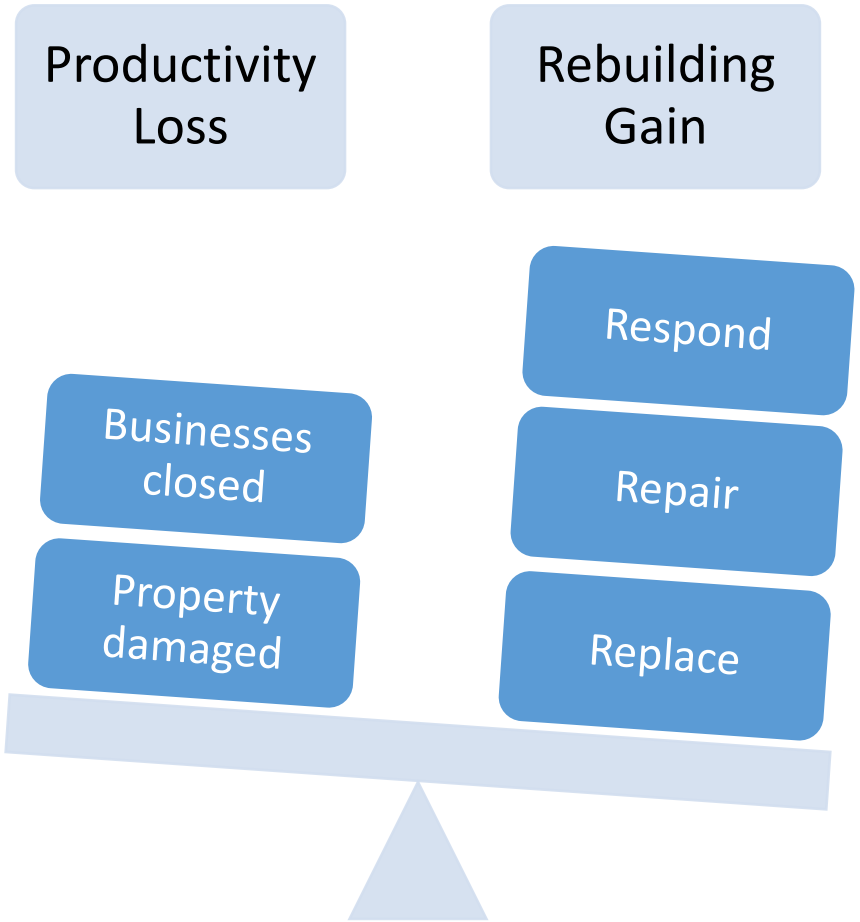
Rebuilding gains

Funds came into the market from different places and were divided into inputs depending on how they were expected to be spent
(involved a lot of spreadsheet tabs)

- **Federal Emergency Management Agency**
  - National Flood Insurance Program: payments for flood claims
  - Individual assistance: payments to individuals and households
  - Public assistance: reimbursements to state and local governments and certain nonprofits
- **Small Business Administration**
  - Home loans
  - Business loans
- **U.S. Department of Housing and Urban Development – Community Development Block Grants**
- **State and Local Funds**
- **Private Insurance Companies**
- **Nonprofit Organizations**

- Construction
- Housing
- Consumer goods
- Equipment
- Investment
- Health care & social services

Net result of economic shock

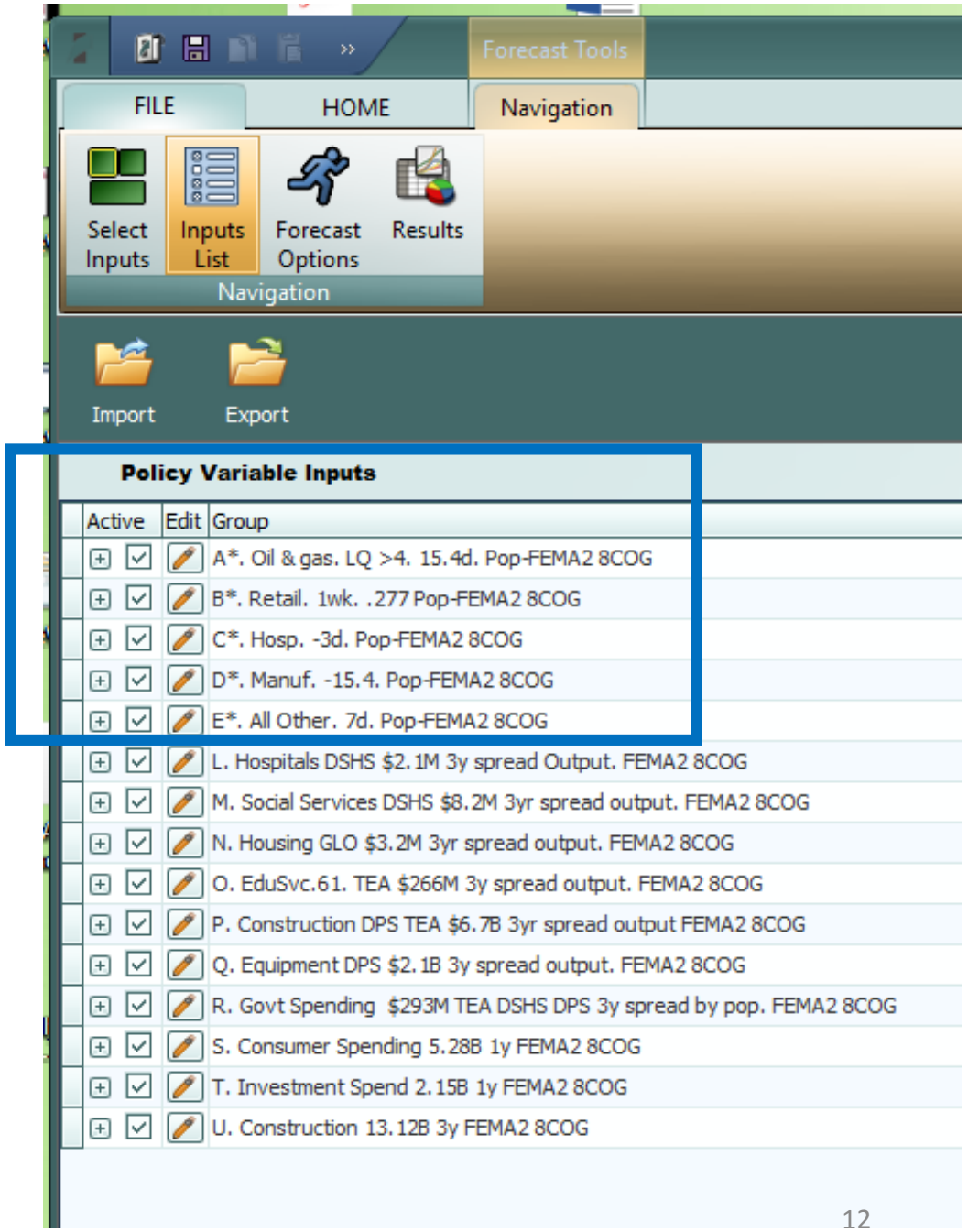


What is the net impact of these two forces interacting?

Not included:
capital stock loss to prevent double counting,
production cost change difficult to estimate

Remi Inputs list

- Productivity Loss (A-E)
  - Oil & Gas
  - Retail
  - Health Care
  - Manufacturing
  - All Other
- Rebuilding gains (L-U)



Productivity Loss

- Each of the 5 categories of industry had specific discounts:
  - Time discount – reduced by number of days offline
  - Geography discount – reduced by percentage of the COG affected
  - Industry discount – Retail reduced and Oil&Gas considered exogenous

Policy Variable Inputs

Active | Edit | Group

A*. Oil & gas. LQ >4. 15.4d. Pop-FEMA2 8COG

Active	View	Category	Detail	Region	Units	2015	2016	2017
☑	🔍	Output	Industry (Exogenous Production): Details (3)	Capital Area	Percent	0	0	-0.33
☑	🔍	Output	Industry (Exogenous Production): Details (3)	Brazos Valley	Percent	0	0	-0.33
☑	🔍	Output	Industry (Exogenous Production): Details (3)	Deep East Texas	Percent	0	0	-1.72
☑	🔍	Output	Industry (Exogenous Production): Details (3)	Houston-Galveston	Percent	0	0	-4.2
☑	🔍	Output	Industry (Exogenous Production): Details (3)	Golden Crescent	Percent	0	0	-4.2
☑	🔍	Output	Industry (Exogenous Production): Details (3)	Alamo Area	Percent	0	0	-0.3
☑	🔍	Output	Industry (Exogenous Production): Details (3)	Coastal Bend	Percent	0	0	-3.69
☑	🔍	Output	Industry (Exogenous Production): Details (3)	South East Texas	Percent	0	0	-4.2

Productivity Loss (fine print…TL;DR)

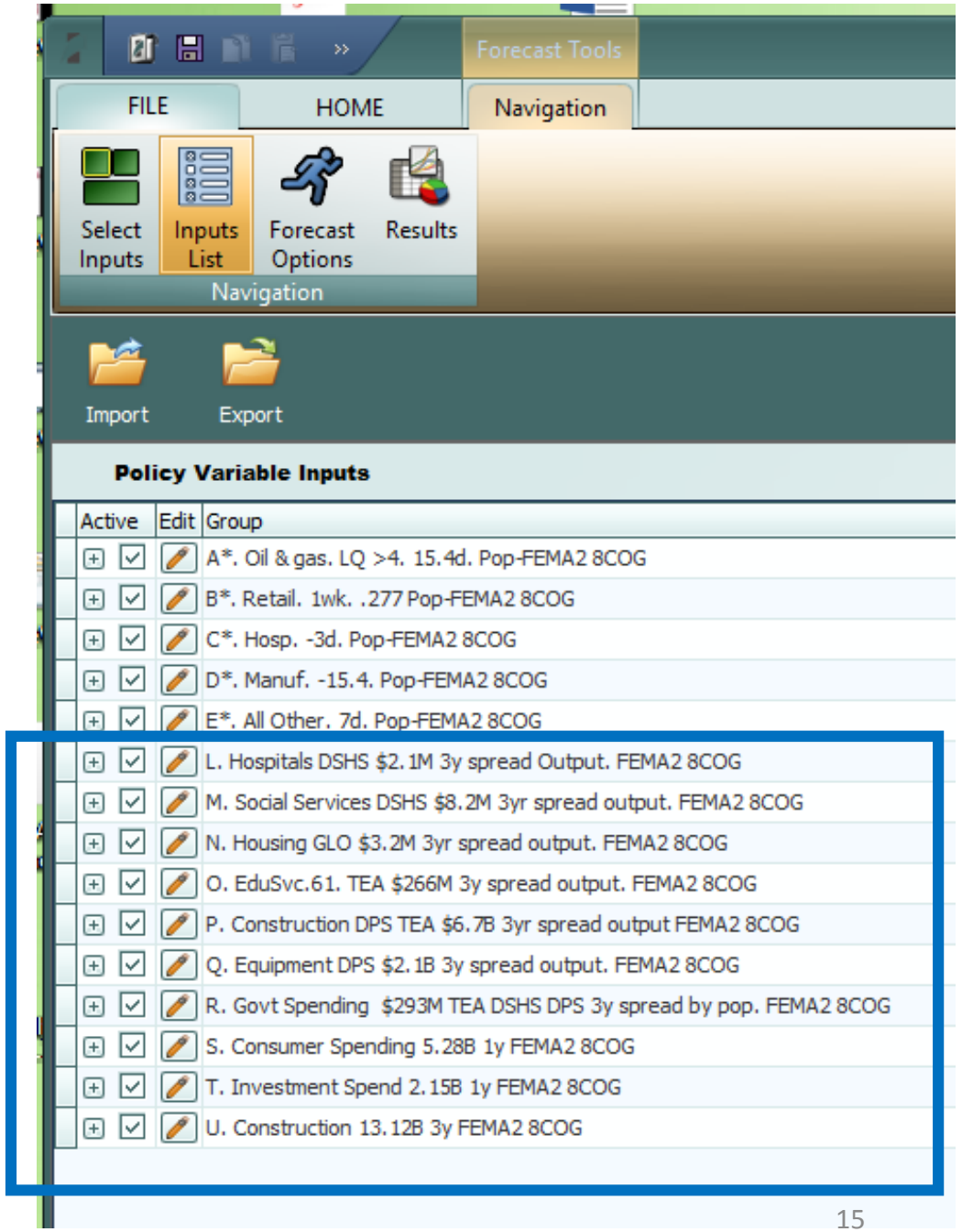
- manufacturing and mining were assumed to be offline or experiencing reduced revenue for 15.4 days (Manufacturing Outlook Survey).49
- hospitals were assumed to be offline or experiencing reduced revenue for four days.50
- firm-level competition is assumed for all industries except those with a high location quotient (LQ >4) such as oil and gas extraction, which are considered exogenous.51
- retail and wholesale trade are further discounted to account only for the markup of cost of goods sold, to avoid double-counting.52
- accommodation is assumed to be unaffected by productivity losses as the decrease in tourism from the storm could be counterbalanced by the increase in hotel occupancy by evacuees.

Remi Inputs list

- Productivity Loss (A-E)

- Rebuilding gains (L-U)
- Total expected spending divided by category:

  - Hospitals
  - Social Services
  - Housing
  - Education Services
  - Construction (Debris removal)
  - Government Spending
  - Equipment
  - Consumer Spending
  - Investment Spending
  - Construction (Rebuilding)



Rebuilding Gains

- Consider all funding sources entering the market
  - FEMA funding
  - National Flood Insurance Program
  - Private insurance
  - SBA loans
  - State/local governments
  - Nonprofits
  - Personal savings
- How will the funds be spent?
- When will the purchases be made?

	A	B	C	D	E	F
1	U. Payout from flood and private insurance (manna)					
2						
3	**Influx of funding**					
4	$11B FEMA Flood Insurance Program					
5	$8B private insurance					
6	$1B SBA loans. Not counterbalanced bc assumed pay off over 30yrs					
7	20.543	Billions	spread by consumption			
8						
9	**Spending over time**					
10	most people rebuild in 18-24 mos					
11	80% accounts closed after year 3 in katrina					
12	2017	2018	2019	out years beyond scope		
13	0.65	0.15	0.1	0.1		
14						
15	**Spending categories**					
16	proportions of SBA loans for Sandy					
17		Total Approved Loan Amount	Approved Amount Real Estate	Approved Amount Content	Approved Amount EIDL	Total by type
18	Biz	20.69%	10.22%	6.84%	3.60%	20.66%
19	Home	79.31%	53.66%	25.68%	0.00%	79.34%
20	Both	100.00%	63.88%	32.53%	3.60%	100.00%

Rebuilding gains calculation

- Total influx of funding
- Divided by the categories in which we expect people to spend
- Spread over the year we expect them to spend it
- Spread by output, population, and consumption

I	J	K	L	M	N	O	P	Q	R	S
Variables ($B)	Percentag	Inputs		2017	2018	2019				
Construction	0.64	13.12	real estate: business and home	**$ 8.53**	**$ 1.97**	**$1.31**		spread by output		
Investment	0.10	2.15	content and EIDL	**$ 2.15**	assume replace immediately			spread by population		
Consumer spend	0.26	5.28	home content	**$ 5.28**	assume replace immediately			spread by consumption		

Rebuilding Gains

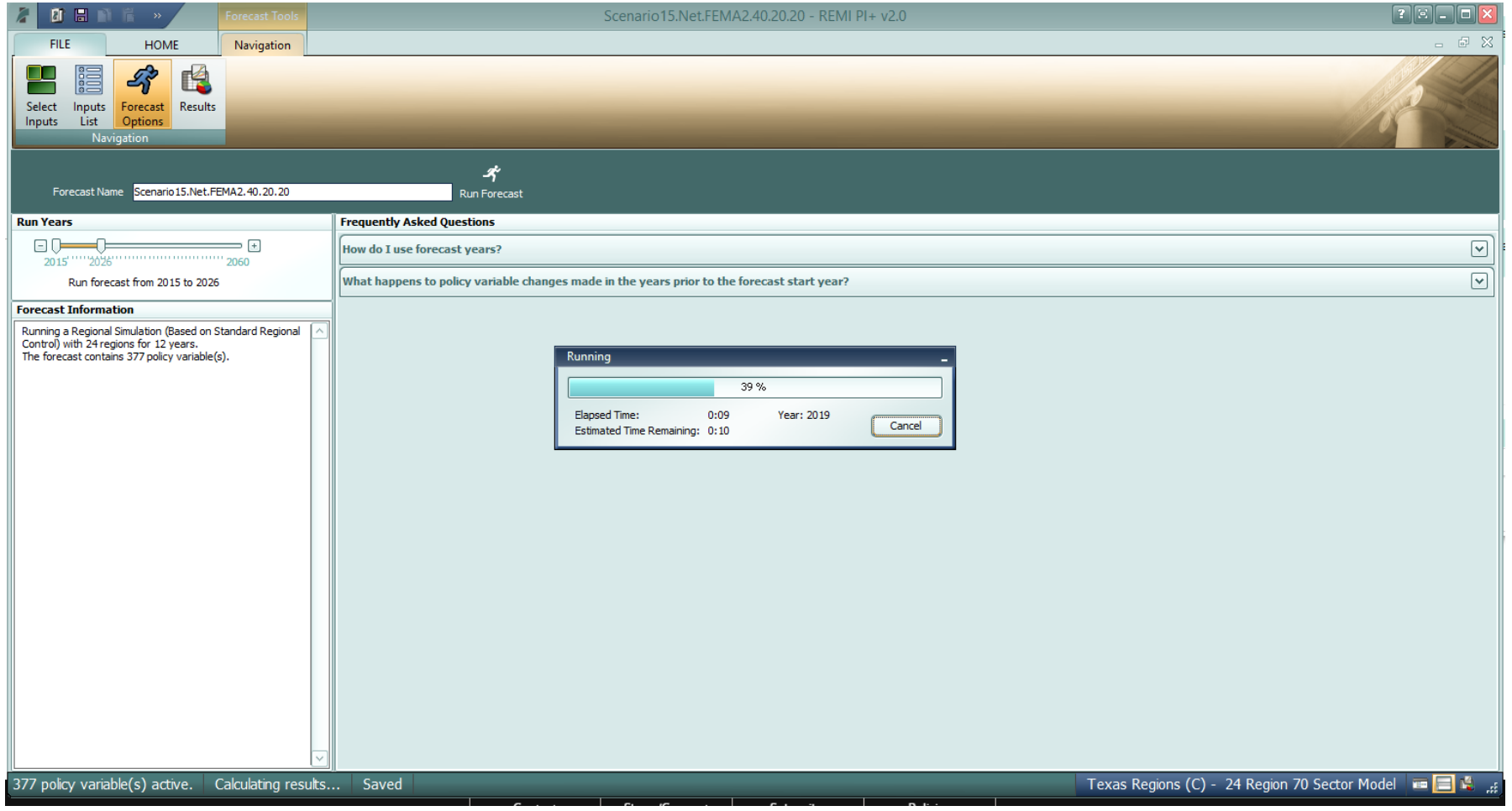
- Time factor – year money spent
- Geography factor – spent in the COGs affected
- Industry factor – spread by output, consumption, or population as appropriate

T. Investment Spend 2.15B 1y FEMA2 8COG

U. Construction 13.12B 3y FEMA2 8COG

Active	View	Category	Detail	Region	Units	2015	2016	2017	2018	2019	2020	
☑	🔍	Firm Sales (competes locally)	23 - Construction	Capital Area	Nominal $ (B)	0	0	1.2296	0.2883	0.1939	0	0
☑	🔍	Firm Sales (competes locally)	23 - Construction	Brazos Valley	Nominal $ (B)	0	0	0.1645	0.038	0.0254	0	0
☑	🔍	Firm Sales (competes locally)	23 - Construction	Deep East Texas	Nominal $ (B)	0	0	0.1269	0.0291	0.0194	0	0
☑	🔍	Firm Sales (competes locally)	23 - Construction	South East Texas	Nominal $ (B)	0	0	0.3651	0.0841	0.0561	0	0
☑	🔍	Firm Sales (competes locally)	23 - Construction	Houston-Galveston	Nominal $ (B)	0	0	4.8431	1.113	0.7398	0	0
☑	🔍	Firm Sales (competes locally)	23 - Construction	Golden Crescent	Nominal $ (B)	0	0	0.1245	0.0284	0.0188	0	0
☑	🔍	Firm Sales (competes locally)	23 - Construction	Alamo Area	Nominal $ (B)	0	0	1.2518	0.29	0.1939	0	0
☑	🔍	Firm Sales (competes locally)	23 - Construction	Coastal Bend	Nominal $ (B)	0	0	0.4237	0.0974	0.0649	0	0

Run REMI, Run

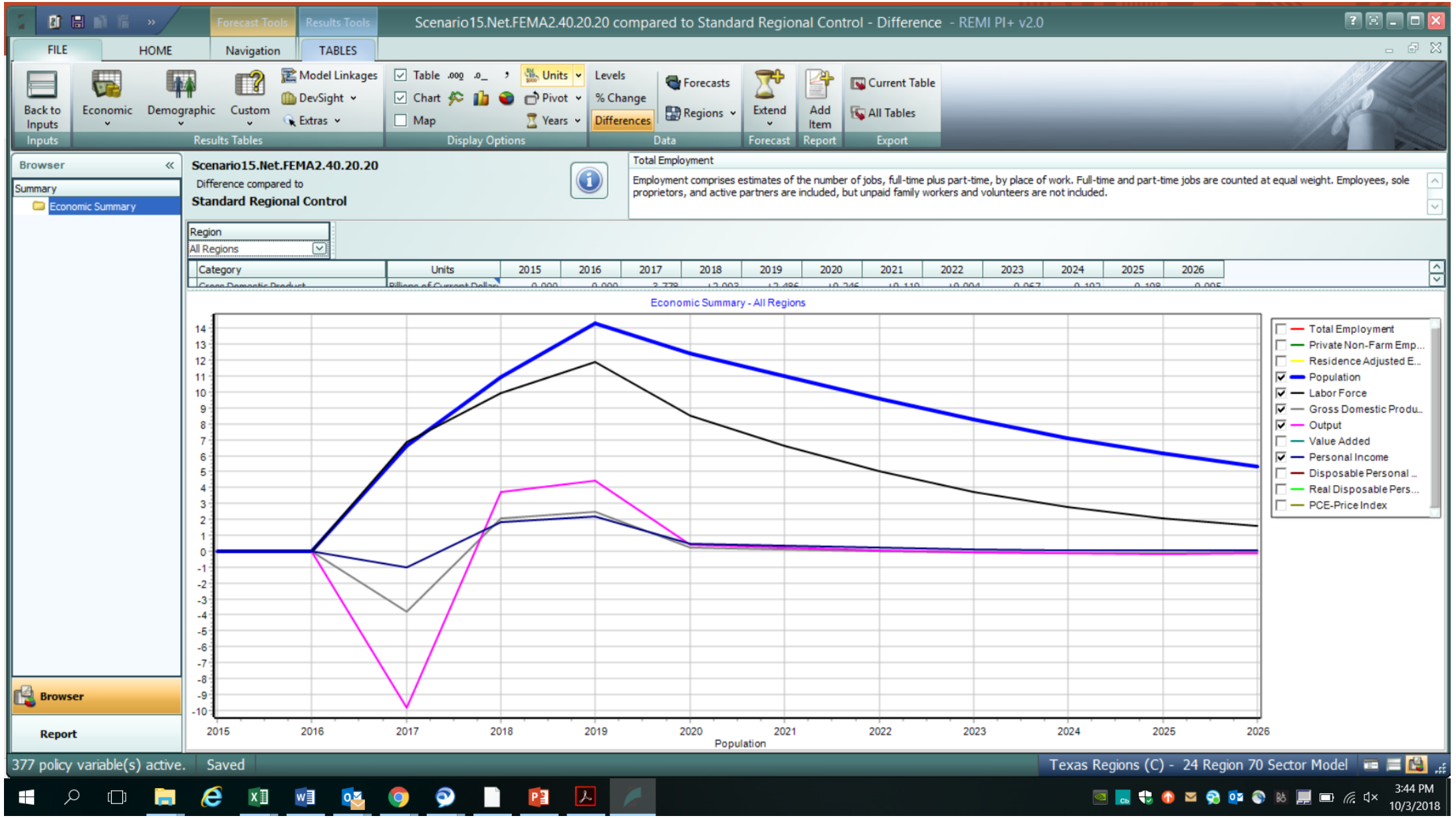

Forecast Tools
Scenario15.Net.FEMA2.40.20.20 - REMI PI+ v2.0
FILE
HOME
Navigation
Select Inputs
Inputs List
Forecast Options
Results
Navigation
Forecast Name
Scenario15.Net.FEMA2.40.20.20
Run Forecast
Run Years
2015
2026
2060
Run forecast from 2015 to 2026
Forecast Information
Running a Regional Simulation (Based on Standard Regional Control) with 24 regions for 12 years.
The forecast contains 377 policy variable(s).
Frequently Asked Questions
How do I use forecast years?
What happens to policy variable changes made in the years prior to the forecast start year?
Running
39 %
Elapsed Time: 0:09
Year: 2019
Estimated Time Remaining: 0:10
Cancel
377 policy variable(s) active.
Calculating results...
Saved
Texas Regions (C) - 24 Region 70 Sector Model

Productivity Loss + Rebuilding Gains = Net Effects

NET ECONOMIC IMPACT OF HURRICANE HARVEY ON TEXAS GSP (in billions)				
Impact	**Year 1**	**Year 2**	**Year 3**	**Years 1-3**
Estimated Losses	($16.8)	($2.0)	($1.0)	($19.8)
Estimated Gains	$13.0	$4.1	$3.5	$20.6
Net Economic Impact	($3.8)	$2.1	$2.5	$0.8

The impact of Harvey is certainly substantial, but the robustness of Texas' economy can sustain the economic shock.

A disaster like Harvey is certainly a blow, but the spending required in its wake can buoy the overall economy while families and communities rebuild their lives and their businesses.


Scenario15.Net.FEMA2.40.20.20 compared to Standard Regional Control - Difference - REMI PI+ v2.0
Forecast Tools
Results Tools
FILE
HOME
Navigation
TABLES
Back to Inputs
Economic
Demographic
Custom
Model Linkages
DevSight
Extras
Table
Chart
Map
Units
Pivot
Years
Levels
% Change
Differences
Forecasts
Regions
Extend
Add Item
Current Table
All Tables
Inputs
Results Tables
Display Options
Data
Forecast
Report
Export
Browser
Summary
Economic Summary
Scenario15.Net.FEMA2.40.20.20
Difference compared to
Standard Regional Control
Total Employment
Employment comprises estimates of the number of jobs, full-time plus part-time, by place of work. Full-time and part-time jobs are counted at equal weight. Employees, sole proprietors, and active partners are included, but unpaid family workers and volunteers are not included.
Region
All Regions
Category
Units
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
Economic Summary - All Regions
Total Employment
Private Non-Farm Emp...
Residence Adjusted E...
Population
Labor Force
Gross Domestic Produ...
Output
Value Added
Personal Income
Disposable Personal ...
Real Disposable Pers...
PCE-Price Index
Population
Browser
Report
377 policy variable(s) active.
Saved
Texas Regions (C) - 24 Region 70 Sector Model
3:44 PM
10/3/2018

Regional & Industry effects

Hit hardest:

- First-year losses for the Coastal Bend, South East Texas, and Golden Crescent COGs were projected at $350 million to $800 million each
- Industries with the most losses include memberships (to clubs, sports centers, parks, theaters and museums), telecommunication services and entertainment

Most growth:

- First-year gains in additional economic activity for the Alamo Area, Capital Area, and North Central Texas regions, were estimated $1 billion to $2 billion
- Industries with the most gains include health services, food and beverages, rental housing, motor vehicles, furniture, and clothing
- The auto industry in particular should see increased demand as consumers seek to replace the cars and trucks damaged or destroyed by flooding

Implications

- Federal Reserve Bank of Dallas data showed that Texas bounced back much like we expected, or better
- Some industries recovered much faster than others—small businesses had a harder time
- The more diverse the economy, the quicker the rebound
- Much of the literature shows that OECD countries rebound very quickly while

Looking forward

Limitations the study did not include (fine print…TL;DR):

- damage to commercial, government or personal property, including real estate, contents, equipment, vehicles, inventory, etc. Instead, it accounts for the funds likely be spent in the next three years to rebuild and replace these items.
- expenditures from smaller nonprofit organizations.
- change in tax burden on Texans at the local and state levels due to increased costs from Harvey recovery or state budgetary actions that may be taken.
- change in government services provided due to resource reallocation.
- income to insurance companies from deductibles or potential changes in insurance premiums.
- productivity loss and gains from agricultural insurance; this study focused on the nonfarm portion of the economy. The REMI model does not include an agriculture sector.
- non-pecuniary losses due to fatalities or decreased desirability of living in an area. The estimate assumes people who do not receive a buyout will rebuild — especially property owners along the coast in hurricane-prone areas, who are likely to understand the risk of property ownership in their location.
- the long-term costs of flooding, including buyout programs, new reservoirs, bayou dredging or seawall construction. These flood mitigation efforts will cost billions of dollars over a number of years and are beyond the scope of this study.

Next time:

- Include amenity
- Change production cost
- Expand time horizon
- Increase insurance premiums and property taxes
- Account for cost-shifting in government spending such as drawing 2019 Medicare funds to 2018
- Account for mitigation costs

Takeaways

- Texas has a diverse economy such that an economic shock to one area can be softened by the other regions and industries
- With a software like REMI, we can pinpoint specific industries and regions that will be most and least affected from an economic shock like Harvey
- Texas' GSP was $1.6 trillion in 2016 so a $17 billion loss is significant but not crippling

"Harvey devastated much of Southeast Texas in August, earning a page in the history books for its overwhelming winds and flooding. The storm brought unprecedented destruction to parts of our coast; dozens died and many more lost homes, automobiles and livelihoods. Many small communities may require years to recover, and some may not recover completely.

But Texans are resilient, and so is our state. While the initial impact of Harvey was severe, the Texas economy has already absorbed much of the damage from this record-breaking storm and should avoid long-term losses."

--Glenn Hegar,

Texas Comptroller of Public Accounts

Full article in ***Fiscal Notes*** publication:

https://comptroller.texas.gov/economy/fiscal-notes/2018/special-edition/docs/fn.pdf

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- Federal Emergency Management Agency, "Texas Hurricane Harvey (DR-4332)," December 4, 2017. Forty-one counties were declared disaster areas: Aransas, Austin, Bastrop, Bee, Brazoria, Caldwell, Calhoun, Chambers, Colorado, DeWitt, Fayette, Fort Bend, Galveston, Goliad, Gonzales, Grimes, Hardin, Harris, Jackson, Jasper, Jefferson, Karnes, Kleberg, Lavaca, Lee, Liberty, Matagorda, Montgomery, Newton, Nueces, Orange, Polk, Refugio, Sabine, San Jacinto, San Patricio, Tyler, Victoria, Walker, Waller and Wharton.
- Texas Department of Public Safety, Texas Division of Emergency Management, "State Situation Report, Tropical System Harvey," Report Number 3, August 25, 2017, and Report Number 8, August 30, 2017; and "Harvey Timeline: See How the Storm Developed and Marched Across Texas and Louisiana," Corpus Christi Caller-Times (September 7, 2017).
- Federal Reserve Bank of Dallas, "Texas Manufacturing Outlook Survey," September 25, 2017. The average number of days businesses were either completely shut down or experienced a reduction in revenue/production is 15.4. Because 59 percent of firms that experienced a reduction in revenue or production reported ongoing reductions, it is assumed that productivity losses continuing beyond the date of the survey are counterbalanced by the 41 percent of firms that did not experience reduced revenue/production.
- Andrea Hsu and Becky Sullivan, "In Houston, Most Hospitals 'Up And Fully Functional,'" *All Things Considered*, National Public Radio (August 30, 2017). Although some hospitals were evacuated, many remained operational or entered "ride-out" mode in which outpatient services were postposed while inpatient services continued; only four days are assumed for disruption in service.
- Industries are assumed to compete locally because goods and services could be obtained from neighboring counties that were not affected by the storm; this is thus a more conservative estimate. Some industries, however, were disproportionately affected because of the high number of businesses located in Texas relative to the nation. These categories in the North American Industry Classification System with a high location quotient, a measure of industrial concentration, are treated differently: 211 Oil and Gas Extraction, 213 Support Activities for Mining and 486 Pipeline Transportation had an LQ > 4 for Texas and were considered industry-level (exogenous) production.
- A discount rate of .277 was applied to 42 Wholesale Trade and 44-45 Retail Trade as prescribed by experts at REMI, Inc.
- The amount of funds flowing through the state of Texas are being updated as new costs are incurred and new information is received. The figures presented were determined by the best data available as of Nov. 30, 2017.
- David Hunn, "FEMA on Track to Pay $11 Billion in Hurricane Harvey Insurance Claims," *Houston Chronicle* (September 13, 2017).
- "SBA Has Approved $1B-Plus in Harvey-related Disaster Loans," *Houston Chronicle* (October 11, 2017).
- "ICT Pegs Hurricane Harvey Insured Losses at $19B," *Insurance Journal* (September 15, 2017).
- Morgan Smith, "How Much Has Been Raised for Harvey Relief — and How's It Being Spent?" *Texas Tribune* (October 6, 2017).
- Construction is spread by individual industry and output. Equipment is spread by population. Consumer spending is spread by commodity and consumption across these categories: new motor vehicles, net purchase of used motor vehicles, motor vehicle parts and accessories, furniture and furnishings, household appliances, glassware, tableware and household utensils, tools and equipment for house and garden, food and nonalcoholic beverages purchased for off-premises consumption, alcoholic beverages purchased for off-premises consumption, food produced and consumed on farms, men and boys' clothing, women and girls' clothing, children and infants' clothing, other clothing materials and footwear, motor fuels, lubricants and fluids, fuel oil and other fuels, pharmaceutical and other medical products, household supplies, personal care products, rental of tenant-occupied nonfarm housing, group housing, physician services, dental services, paramedical services, hospitals, nursing homes, other motor vehicle services, purchased meals and beverages, accommodations, personal care and clothing services, social services and religious activities and household maintenance.
- For example, on Nov. 17, 2017, the U.S. Department of Housing and Urban Development announced it would award $5.024 billion in community development block grants for hard-hit areas in Texas; the expenditure timeline was unknown at the time of publication, however, and therefore is not included in this study. See "HUD Provides $5 Billion To Help Texas Recover From Harvey," Office of the Texas Governor, November 17, 2017.

Harvey Estimate Table

Sales

Discount Sales by Time to show days offline

Discount Sales by Population to adjust for Affected Counties in the COG

A. Oil & Gas 211, 213, 486

Industry level - LQ >4

15.4 days offline

B. Retail & Wholesale. 42, 44-45

Firm level

7 days offline

Discount by .277 to account for retail markup (doesn't include COGS)

C. Hospitals. 622, 623

Firm level

3 days offline

D. Manufacturing. 300's

Firm level

15.4 days offline

E. All Other. 100-800's less above

Firm level

7 days offline

Excluded

Accommodation, 721 - offset by evacuees

Government Spending
R. Expenses from Harvey, Fed Repayment

Payout (Manna)
S. Consumer Spending
T. Investment Spending
U. Construction

Transfer Payments
Insured Losses provide increase in discretionary income
V. Government
FEMA - National Flood Insurance Program payments
W. Private
Insurance Company payments

Production Cost
Lost inventory results in increase in cost to produce due to replacement cost
X. Estimate for lost inventory
Spread over COGS, industries by output

Capital Stock
Damaged property due to floodwater, wind
Y1. Residential Capital Stock
Discount with percent of damaged single-family homes per COG
Y2. Construction Sales
Increase Construction Sales over 3 years to account for rebuilding
Apply percent of SBA loans used for residential real estate in Sandy to total SBA loan amount reported for Harvey
Z. Non-residential Capital Stock
Deduct reported damage in Current dollars as reported by counties