The Economic Impacts of COVID-19: Evidence from a New Public Database Built Using Private Sector Data

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Motivation: Measuring the Impacts of COVID-19

- How has COVID-19 affected the American economy and what policies can best mitigate its adverse impacts going forward?

- Since Kuznets (1941), macroeconomic policy decisions have been based on data from surveys of households and businesses.

- These data provide vital aggregate information (GDP, unemployment rates), but have two key limitations:
  1. Available only at low frequencies, often with significant lags
  2. Cannot be disaggregated to examine variation across areas or subgroups
We build a publicly available economic tracker using transaction data from several private companies to measure daily economic activity by ZIP code, income group, and industry.

Use these new data to analyze economic impacts of COVID-19 pandemic:


2. [Policy Responses] Causal effects of fiscal stabilization policies enacted to date

Here, we construct and analyze public statistics based on private sector data rather than directly analyzing confidential sources of microdata

- Benefit: no need to write contracts with specific companies → more scalable and timely analysis
- Challenge: tension between research value (disaggregation+precision preferable) and privacy protection (aggregation+masking preferable)
- Goal: construct public statistics that are sufficiently granular for research yet sufficiently aggregated and masked to protect privacy

This Project
Outline

1. Data

2. Impacts of COVID-19

3. Impacts of Stabilization Policies

4. Policy Implications
Data

Impacts of COVID-19
Impacts of Stabilization Policies
Policy Implications
Data Partners

- Consumer Spending
  - affinity solutions
  - COINOUT

- Small Business Revenues
  - WOMPLY

- Employment
  - PAYCHEX
  - Intuit
  - earnin
  - KRONOS

- Job Postings
  - burningglass

- Education
  - zEARN
Constructing Publicly Available Economic Indices Based on Private-Sector Data

- Starting from raw data, construct series suitable for economic analysis as follows:

1. **Clean** series to remove artifacts that arise in transaction data

2. **Smooth** seasonal fluctuations using data from 2019

3. **Protect privacy**: index to January 2020 values, exclude small cells, combine data from multiple companies

4. **Benchmark** to national statistics to characterize group each dataset represents to mitigate bias from non-representative selection
Consumer Spending: National Accounts vs. Credit/Debit Card Data
Retail and Food Services in Affinity Solutions and Mastercard Data vs. Monthly Retail Trade Survey

Food and Accommodation Services RMSE: 0.04  
Retail RMSE: 0.03
Changes in Employment: Current Employment Statistics vs. Payroll Data

Apr 15  Aug 15
RMSE CES: 3.66
RMSE CPS: 1.88

Percent Change in Employment Since January 2020

Paychex-Intuit-Earnin
CES
CPS

RMSE CES: 3.66
RMSE CPS: 1.88
Constructing Publicly Available Economic Indices Based on Private-Sector Data

- Produce daily/weekly series by industry (two-digit NAICS), geography (county/ZIP code), and income quartile
  - Automated pipeline that ingests data from companies and reports statistics typically within one week of relevant transactions

- All series are freely downloadable (eliminating need for further contracts) and can be visualized at [www.tracktherecovery.org](http://www.tracktherecovery.org)
  - All results that follow are constructed from these publicly available statistics
National Accounts Data: Changes in GDP and its Components

Contribution to the change in real GDP in trillions of chained (2012) dollars from Q1 2020 to Q2 2020

- $1.73T (-31.7%)
National Accounts Data: Changes in GDP and its Components

Contribution to the change in real GDP in trillions of chained (2012) dollars from Q1 2020 to Q2 2020

- Gross Domestic Product: -$1.73T (-31.7%)
- Private Domestic Investment: -$0.47T
- Government Expenditure: $0.04T
- Net Exports: $0.05T
- Personal Consumption Expenditure (PCE): -$1.35T
National Accounts Data: Changes in GDP and its Components

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- Private Domestic Investment: -$0.47T
- Government Expenditure: $0.04T
- Net Exports: $0.05T
- Personal Consumption Expenditure (PCE): -$1.35T
- Card Spending in PCE: -$1.03T
Impacts of COVID-19 on Consumer Spending

- Begin by disaggregating spending changes by household income
  - Who cut spending more – the rich or the poor?

- Impute income based on median household income in cardholder ZIP code
  - Matches estimates in JPMorgan Chase individual-level income data [Farrell, Greig, Cox, Ganong, Noel 2020]
Consumer Spending by Income Quartile

- $3.2 Billion (-37.5%)
- $1.23 Billion (-13.7%)
Consumer Spending by Income Quartile

- **2019 Top Income Quartile**
  - Feb 1: -$1.23 Billion (-13.7%)
  - Aug 1: -$0.23 Billion

- **2020 Top Income Quartile**
  - Feb 1: -$1.0 Billion (-26.7%)
  - Aug 1: -$0.18 Billion (-0.3%)

- **2019 Bottom Income Quartile**
  - Feb 1: -$3.2 Billion (-37.5%)
  - Aug 1: -$0.18 Billion (-0.3%)

- **2020 Bottom Income Quartile**
  - Feb 1: -$0.18 Billion (-0.3%)
  - Aug 1: -$0.18 Billion (-0.3%)
Impacts of COVID-19 on Consumer Spending

- Next, disaggregate by sector

- Why did spending fall? Because of a reduction in purchasing power/expected income or health concerns about COVID-19?
Changes in Consumer Spending by Sector

Share of Decline (Jan to Mar 25-Apr 14)

- Durable Goods
- Non-Durable Goods
- Remote Services
- Other in-person services
- Recreation
- Health Care
- Transportation
- Hotels & Food

In-person services (67%)
Changes in Consumer Spending by Sector

Share of Decline (Jan to Mar 25-Apr 14)

- Durable Goods
- Non-Durable Goods
- Remote Services
- Other in-person services
- Recreation
- Health Care
- Transportation
- Hotels & Food

In-person services (67%)

Share of Pre-COVID Spending

- Durable Goods
- Non-Durable Goods
- Remote Services
- Other in-person services
- Recreation
- Health Care
- Transportation
- Hotels & Food

In-person services (33%)
Changes in Consumer Spending by Sector
COVID vs Great Recession

Share of the decline in personal consumption expenditures from peak to trough

- **Durables**: Great Recession, 58.6%; COVID-19, 19.5%
- **Non-Durables**: Great Recession, 44.3%; COVID-19, 13.3%
- **Services**: Great Recession, -2.9%; COVID-19, 67.2%
Business Revenues
How did the fall in consumer spending and business revenue affect business decisions: decision to remain open, employment, job postings, etc.?

To answer this question, use variation in size of spending shocks across ZIP codes

- Spending fell primarily among high-income households for in-person services such as restaurants
- Such services are mostly produced by small businesses that serve customers in their local area
- Differences across ZIP codes in average household income $\rightarrow$ variation in size of spending shock that local businesses face

Begin by analyzing impacts on small business revenue
Changes in Small Business Revenues vs. Rent, by ZIP Code
From January to April 2020

Slope = -13%/$1000 (s.e. = 0.38)
Changes in Small Business Revenues vs. Rent, by ZIP Code
From January to April vs. July 2020

-60
-40
-20
0
Change (%) in Small Business Revenue

500 1000 1500 2000
Median Two Bedroom Monthly Rent in 2018 ($)

Change to April: Slope = -13.00%/1000 (s.e. = 0.38)
Change to July: Slope = -11.27%/1000 (s.e. = 0.56)
Changes in Small Business Revenues vs. Rent, by ZIP Code

Finance and Professional Services

Food and Accommodation Services and Retail Trade
Slope = -12.82%/̅$1000 (s.e. = 0.53)

Finance and Professional Services
Slope = 0.02%/̅$1000 (s.e. = 1.26)
Employment
Impacts of COVID-19 on Employment

- How did businesses react to loss in revenues?

- Begin by analyzing national trends in employment by wage group (as in Cajner et al. 2020) and then turn to geographic variation
Employment Changes by Income Quartile

Percent Change in Employment Rates Since January 2020

- Top Quartile (>$60K)
- Third Quartile (<$60)
- Second Quartile (<$37K)
- Bottom Wage Quartile (<$27K)

Key dates:
- April 15: -36% (11.6m jobs lost)
- May 6: -20% (6.2m)
- June 17: -17% (5.6m)
- July 8: -8% (2.4m)
- Aug 19: -4% (1.2m)
- Sept 9: -1% (0.4m)

Dates:
- Jan 1
- Jan 22
- Feb 12
- Mar 4
- Mar 25
- Apr 15
- May 6
- May 27
- Jun 17
- Jul 8
- Jul 29
- Aug 19
- Sep 9
- Sep 30
Employment Changes by Income Quartile

- **Top Quartile (>$60K)**
  - Apr 15: -14% (4.4m jobs lost)
  - Aug 21: -4% (1.2m)
  - Sep 25: 0% (0.0m)

- **Third Quartile (<$60)**
  - Apr 15: -20% (6.2m)
  - Aug 21: -8% (2.4m)
  - Sep 25: -17% (5.6m)

- **Second Quartile (<$37K)**
  - Apr 15: -26% (8.4m)
  - Aug 21: -1% (0.4m)
  - Sep 25: -19% (5.9m)

- **Bottom Wage Quartile (<$27K)**
  - Apr 15: -36% (11.6m)
  - Aug 21: -3% (0.9m)
  - Sep 25: -6% (1.9m)

Note: Dashed lines are forecasts based on Kronos time sheet data and Paychex employment data for workers on weekly pay cycles.
National Trends in Consumer Spending vs. Employment Rates
Bottom Wage Quartile Reweighted to Match Top Quartile by Industry and County

![Graph showing trends in consumer spending and employment rates.](image-url)
National Trends in Consumer Spending vs. Employment Rates
Retail Trade


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<th>Employment: Bottom Wage Quartile</th>
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<td>60%</td>
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<td>Aug 12</td>
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Date: Feb 12, Feb 26, Mar 11, Mar 25, Apr 8, Apr 22, May 6, May 20, Jun 3, Jun 17, Jul 1, Jul 15, Jul 29, Aug 12
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<th>Employment: Bottom Wage Quartile</th>
<th>Total Consumer Spending</th>
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<td>10%</td>
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<td>Feb 26</td>
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<tr>
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<td>-40%</td>
<td>-16.2%</td>
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<tr>
<td>Mar 15</td>
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<td>-40%</td>
<td>-16.2%</td>
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<td>Mar 25</td>
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<td>-40%</td>
<td>-16.2%</td>
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<td>Apr 8</td>
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<td>May 20</td>
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<td>-16.2%</td>
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<tr>
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<td>-40%</td>
<td>-16.2%</td>
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<td>-16.2%</td>
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</tr>
<tr>
<td>Aug 12</td>
<td>-110%</td>
<td>-40%</td>
<td>-16.2%</td>
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-16.2% = 9.8% + 0.3%
Changes in Wage and Employment Rates
Chained Estimates Using Wage Growth for Job Stayers from Week t to t+1

Changes vs. January Level (%)

-60%  -40%  -20%  0%  20%

Feb 15  Feb 29  Mar 14  Mar 28  Apr 11  Apr 25  May 9  May 23  Jun 6  Jun 20  Jul 4  Jul 18

Wage Rates
Employment Rates
Changes in Low-Wage (Bottom Quartile) Employment Rates by ZIP Code
San Francisco
Changes in Bottom-Wage-Quartile Employment Rates vs. Rent, by ZIP Code
From January to April 2020

Percentage Change in Employment

Median Two Bedroom Monthly Rent in 2018 ($)

Slope = -10.34%/$/1000 (s.e. = 0.34)
Changes in Bottom-Wage-Quartile Employment Rates vs. Rent, by ZIP Code
From January to April vs. July 2020

-40
-30
-20
-10

Percentage Change in Employment

500
1000
1500
2000

Median Two Bedroom Monthly Rent in 2018 ($)

Change to April: Slope = -10.34%/§1000 (s.e. = 0.34)

Change to July: Slope = -9.31%/§1000 (s.e. = 0.42)
Changes in Employment and Job Postings vs. Rent
Job Postings for Low-Education Workers vs. County Median Rent (Burning Glass)

Slope = -27.44%/$1000 (s.e. = 1.26)
Reduction in spending by the rich led to loss of jobs for low-income individuals, especially those working in affluent areas.

Will employment of low-wage workers revert to baseline as spending recovers?
Reduction in spending by the rich led to loss of jobs for low-income individuals, especially those working in affluent areas.

Will employment of low-wage workers revert to baseline as spending recovers?

Signs of a potential “jobless recovery” in this recession as well for low-wage workers, perhaps because of technological shifts away from routine occupations [Jaimovich and Su 2018].

Evidence from Great Recession suggests that disparate job losses across regions/sectors could have persistent effects for many years because workers do not move to find jobs [Yagan 2019].

How can we mitigate the employment impacts of the crisis via macroeconomic policy?
Impacts of Stabilization Policies
In rest of talk, examine what policies can mitigate impacts of pandemic, focusing in particular on employment of low-income workers

Focus on three major policies that target chain of events (consumer spending $\rightarrow$ business revenue $\rightarrow$ employment) at different points

1. State-ordered re-openings
2. Stimulus payments to households
3. Loans to small businesses
State-Ordered Reopenings
Can executive orders restore economic activity?

Compare trends in spending and employment in states that reopened earlier vs. later
Causal Effect of Re-Opening on Consumer Spending
Case Study of New Mexico vs. Colorado

Colorado
New Mexico

Closing
Closing
Re-Opening
Re-Opening

-60
-40
-20
0
20

Feb 1
Feb 15
Feb 29
Mar 14
Mar 28
Apr 11
Apr 25
May 9
May 23
Jun 6

Change in Consumer Spending Relative to January 2020 (%)

Colorado
New Mexico

-60
-40
-20
0
20

Feb 1
Feb 15
Feb 29
Mar 14
Mar 28
Apr 11
Apr 25
May 9
May 23
Jun 6

Colorado
New Mexico

-60
-40
-20
0
20

Feb 1
Feb 15
Feb 29
Mar 14
Mar 28
Apr 11
Apr 25
May 9
May 23
Jun 6

Colorado
New Mexico

-60
-40
-20
0
20

Feb 1
Feb 15
Feb 29
Mar 14
Mar 28
Apr 11
Apr 25
May 9
May 23
Jun 6

Colorado
New Mexico

-60
-40
-20
0
20

Feb 1
Feb 15
Feb 29
Mar 14
Mar 28
Apr 11
Apr 25
May 9
May 23
Jun 6

Colorado
New Mexico

-60
-40
-20
0
20

Feb 1
Feb 15
Feb 29
Mar 14
Mar 28
Apr 11
Apr 25
May 9
May 23
Jun 6

Colorado
New Mexico

-60
-40
-20
0
20

Feb 1
Feb 15
Feb 29
Mar 14
Mar 28
Apr 11
Apr 25
May 9
May 23
Jun 6

Colorado
New Mexico

-60
-40
-20
0
20

Feb 1
Feb 15
Feb 29
Mar 14
Mar 28
Apr 11
Apr 25
May 9
May 23
Jun 6

Colorado
New Mexico

-60
-40
-20
0
20

Feb 1
Feb 15
Feb 29
Mar 14
Mar 28
Apr 11
Apr 25
May 9
May 23
Jun 6

Colorado
New Mexico
Causal Effects of Re-Openings on Economic Activity: Event Studies
Re-Opened States vs. Control States: Consumer Spending

Opening -30 -20 -10 0
Change in Consumer Spending Relative to January 2020

Days Relative to Re-opening
Control States Opening States

Diff-in-diff Estimate: +0.86p.p. (s.e. = 1.00)
Causal Effects of Re-Openings on Economic Activity: Event Studies
Re-Opened States vs. Control States: Employment

Diff-in-diff Estimate: +0.57 p.p. (s.e. = 0.54)
Stimulus Payments
Impacts of Stimulus Payments

- Coronavirus Aid, Relief, and Economic Security (CARES) Act made direct payments to nearly 160 million people, totaling $267 billion as of May 31, 2020

  - Larger payments for lower-income households

  - Vast majority of payments made exactly on April 15, 2020

- Was stimulus effective in increasing consumer spending and restoring employment?
Impact of Stimulus Payments on Consumer Spending
Bottom Income Quartile Households


Total Spending Jumps by 26% on April 15
Causal Effects of Stimulus

- Stimulus payments increased aggregate consumer spending, especially among low-income households.

- Key question for determining potential multiplier effects: where was the money spent?
  - If spending went up in sectors where employment didn’t fall, multiplier effects could be muted. [Guerrieri et al. 2020]
Impact of Stimulus Payments on Consumer Spending

Durable Goods


-30%   -20%   -10%   0%   10%   20%   30%

Apr 1  Apr 8  Apr 15  Apr 22  Apr 29

Durable Goods Spending Jumps by 21%
Impact of Stimulus Payments on Consumer Spending

In-Person Services


In-Person Spending Jumps by Only 7%
Impact of Stimulus Payments on Business Revenue and Employment Rates

Revenue and Employment Changes Among Small Businesses, by ZIP Rent Quartile

- Small Bus. Revenue in Bottom Rent Quartile ZIPs
- Small Bus. Revenue in Top Rent Quartile ZIPs
Impact of Stimulus Payments on Business Revenue and Employment Rates

Revenue and Employment Changes Among Small Businesses, by ZIP Rent Quartile

<table>
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<tr>
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<th>Pct. Change Relative to Jan.</th>
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<tbody>
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<td>Feb 22</td>
<td>0%</td>
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<tr>
<td>Mar 7</td>
<td>-20%</td>
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<tr>
<td>Mar 21</td>
<td>-40%</td>
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<tr>
<td>Apr 4</td>
<td>-60%</td>
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<tr>
<td>Apr 18</td>
<td>-20%</td>
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<tr>
<td>May 2</td>
<td>0%</td>
</tr>
<tr>
<td>May 16</td>
<td>20%</td>
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<td>May 30</td>
<td>4.1%</td>
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<td>Jun 13</td>
<td>-12.6%</td>
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<tr>
<td>Jun 27</td>
<td>-15.9%</td>
</tr>
<tr>
<td>Jul 11</td>
<td>-27.1%</td>
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</table>

- Bottom Wage Quartile Employment in Bottom Rent Quartile ZIPs
- Small Bus. Revenue in Bottom Rent Quartile ZIPs
- Bottom Wage Quartile Employment in Top Rent Quartile ZIPs
- Small Bus. Revenue in Top Rent Quartile ZIPs
Loans to Small Businesses
Paycheck Protection Program

- CARES Act also provided $500 billion in loans to small businesses starting on April 3

- Loans were forgivable if payroll was not reduced significantly relative to pre-COVID levels

- Firms with fewer than 500 employees were eligible for these loans (with some exceptions)
Impact of Paycheck Protection Program on Employment

Employment Rates by PPP Eligibility, Reweighted to Match Industries (Excl. Food Services), with NAICS x County x Income Quartile FEs

Change in Employment Since January

IPP Program Begins

Feb 12  Feb 26  Mar 11  Mar 25  Apr 8  Apr 22  May 6  May 20  Jun 3  Jun 17  Jul 1  Jul 15  Jul 29  Aug 12

-25%
-20%
-15%
-10%
-5%
0%

100-500 Employees (Eligible for PPP)
501-800 Employees (Ineligible)
Impact of Paycheck Protection Program on Employment

Employment Rates by PPP Eligibility, Reweighted to Match Industries (Excl. Food Services), with NAICS x County x Income Quartile FEs

DD Estimate of PPP Impact:
+1.05% (s.e. = 1.62%)
Impact of Paycheck Protection Program on Employment

Employment Rates by PPP Eligibility, Reweighted to Match Industries (Excl. Food Services), with NAICS x County x Income Quartile FEs

DD Estimate of PPP Impact: → Cost Per Job Saved = $451K
+1.05% (s.e. = 1.62%)
($114K at lower bound of 95% CI)
Why has PPP had limited impact on employment despite substantial expenditure?

- Businesses who took up loans may not have intended to lay off their workers to begin with

- Ex: very high take-up rate among firms providing professional and scientific services despite low job losses in that sector

- Consistent with evidence that loans flowed to areas with smaller employment losses in March [Granja, Makridis, Yannelis, Zwick 2020]
Long-Term Impacts
Long-Term Impacts

- We have focused primarily on short-term impacts of COVID crisis on spending and employment.

- But this shock may have lasting impacts going forward on inequality and social mobility.

- To illustrate, turn to data on educational progress on an online math platform used as part of school curriculum by 800,000 students in the U.S.
Effects of COVID-19 on Educational Progress by Income Group

Students Using Zearn Platform Relative to Jan 2020

- Top Income Quartile
- Middle Income
- Bottom Income Quartile

Jan 8, Jan 15, Jan 22, Jan 29, Feb 5, Feb 12, Feb 19, Feb 26, Mar 4, Mar 11, Mar 18, Mar 25, Apr 1, Apr 8, Apr 15, Apr 22, April 29, Sept 16, Sept 23, Sept 30, Oct 7, Oct 14

-3.9%
-9.1%
-10.3%
Policy Implications

Data

Impacts of COVID-19

Impacts of Stabilization Policies

Policy Implications
Implications for Macroeconomic Policy in COVID-19 Pandemic

- Results suggest that there is limited capacity to restore consumer spending via traditional economic tools in the midst of the pandemic

- Impacts of stimulus and loans to small businesses may be blunted when spending is constrained by health concerns

- Long-term solution lies in addressing virus itself and public health efforts [Allen 2020, Romer 2020]
Implications for Macroeconomic Policy in COVID-19 Pandemic

- In the meantime, may be most fruitful to use economic policy to limit hardship among low-income workers who have lost their jobs
  
  - Extending unemployment benefits and social safety net may be a more impactful use of scarce resources than stimulus checks to all households or loans to all businesses
  
  - May be a role for sectoral training programs and place-based policies targeting hardest hit areas (e.g., low-income workers in affluent counties)
  
  - Important to take potential long-term impacts on children into account, e.g. in decisions on when to re-open schools vs. businesses
Broader Implications and Future Work

- RETINA: Real Time National Accounts
  - Current paper demonstrates that it is feasible to construct public statistics from private sector data that are useful for research and policy analysis but protect privacy
  - Now working with staff at BLS, BEA, and Census to construct a more permanent system of granular, real time national accounts, building on prototype constructed here

- Policy: real-time fine tuning based on observed state of the economy and empirical impacts of policies
  - New measures for state-contingent policies beyond unemployment rates
  - Re-target PPP program based on observed short-run empirical impacts?
More broadly, private sector data can provide a new tool to support economic policy in the age of big data

- Can target aid more effectively
- And diagnose what the root causes of economic failure are rapidly

Tracker constructed here is a prototype for a system of “real time” national accounts, building on the vision of Kuznets (1941) in constructing current national accounts

- All data used to produce results shown here are freely downloadable at www.tracktherecovery.org