The Economic Impacts of COVID-19: Using Big Data for Real-Time Economic Analysis

Raj Chetty, Harvard University

John N. Friedman, Brown
Nathaniel Hendren, Harvard
Michael Stepner, Univ. of Toronto
and the Opportunity Insights Team

October 2022
How has COVID-19 affected economic activity?

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 limitations:

1. Available only at low frequencies, sometimes with significant lags
2. Cannot be disaggregated to examine variation across areas or subgroups

We build a new publicly available database using transaction data from private companies to address these challenges and apply it to analyze the impacts of COVID-19.
Data

- Impacts of COVID-19
- Impact of Stimulus Policies
- Conclusion & Next Steps

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

Goal: transparency and reproducibility of findings [Miguel et al 2014, Christensen and Miguel 2018]

Challenge: constructing public statistics that are sufficiently granular for research yet sufficiently aggregated and masked to protect privacy

Demonstrate how data from private companies can be combined to produce publicly available statistics available in real time to support diagnostic analyses and policy decisions
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

Posting resulting data publicly for free download and visualization on a weekly basis at www.tracktherecovery.org
Consumer Spending: National Accounts vs. Credit/Debit Card Data
Retail and Food Services in Affinity Solutions vs. Monthly Retail Trade Survey

RMSE: 5.01 p.p. 
Correlation: 0.93

RMSE: 3.2 p.p. 
Correlation: 0.92
Impacts of COVID-19
Spending
Consumer Spending by Income Quartile

Top Income Quartile

- April 15 2020
- $0.9 Billion
- (12% of Agg. Decline)

Bottom Income Quartile

- ~$2.9 Billion
- (40% of Agg. Decline)

Credit and Debit Card Spending Per Day ($ Billions)

Jan 1 2020 to Nov 1 2021
Consumer Spending by Income Quartile

Top Income Quartile

August 15, 2020
+$0.1 Billion

Bottom Income Quartile

+$0.7 Billion

Credit and Debit Card Spending Per Day ($ Billions)

Jan 1, 2020 to Nov 1, 2021
Consumer Spending by Income Quartile

Top Income Quartile

December 31, 2021: +$0.7 Billion

Credit and Debit Card Spending Per Day ($ Billions)

January 1, 2020 to December 31, 2021

Bottom Income Quartile

+$0.7 Billion

Jan 2020 Spending

Jan 2020 to Nov 2021
Change in Consumer Spending by Sector

- In-Person Services (57%)
- Durable Goods
- Non-Durable Goods
- Remote Services
- Other In-Person Services
- Recreation
- Health Care
- Transportation
- Hotels & Food

Share of Decline (Jan to Mar 25-Apr 14)
Share of Pre-COVID Spending
Change in Consumer Spending by Sector

- Durable Goods
- Non-Durable Goods
- Remote Services
- Other In-Person Services
  - Recreation
  - Health Care
  - Transportation
  - Hotels & Food
- In-Person Services (57%)

In-Person Services (28%)

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

Share of Pre-COVID Spending

0%  25%  50%  75%  100%
Changes in Small Business Revenues from January to April by ZIP Code
San Francisco
Changes in Small Business Revenues vs. Rent, by ZIP Code
From January to April 2020

Change in Small Business Revenue
Relative to January

Slope = -16.45%/$1000 (s.e. = 0.95)
Changes in Low-Skill Job Postings vs. Rent, by County
From January to July 2020

Change in Low-Skill Job Postings
Relative to January 2020

Slope = -27.65%/$1000 (s.e. = 3.09)
Employment
Employment Changes by Wage Quartile

- Top Wage Quartile:
  - April 15, 2020: -37% (-12.0m jobs)

- Bottom Wage Quartile:
  - April 15, 2020: -14% (-4.3m jobs)
Employment Changes by Wage Quartile

August 15 2020

Change in Employment (%) Relative to January 2020

Top Wage Quartile
-4% (-1.2m jobs)

Bottom Wage Quartile
-19% (-6.2m)
Employment Changes by Wage Quartile

- **Top Wage Quartile**:
  - December 31, 2020: 3% (0.9m jobs)

- **Bottom Wage Quartile**:
  - December 31, 2020: -21% (-6.8m jobs)
Dec 31

64% (13.5 p.p.) of decline unexplained

36% (7.7 p.p.) of decline explained by wage growth

Employment Changes by Wage Quartile

Change in Employment (%) Relative to January 2020

- Employment changes by wage quartile are shown over time from January 2020 to November 2021.

- The graph indicates a significant decline in employment, with a peak of -64% in December 2020 and a recovery towards -36% by November 2021.

- A portion of the decline is explained by wage growth, suggesting that factors other than wage growth contributed to the employment decline.
Changes in Low-Skill Job Postings vs. Rent, by County

July 2020

Slope $= -27.65\%$ (s.e. = 3.09)
Changes in Low-Skill Job Postings vs. Rent, by County

July 2020

Slope = -27.65% (s.e. = 3.09)

December 2021

Slope = -0.46% (s.e. = 3.14)
**Changes in Bottom-Wage-Quartile Employment vs. Rent, by County**

**July 2020**

- Change in Employment (%)
  - from January 2020 to July 2020

- Rent
  - Median Two Bedroom Monthly Rent in 2014-2018 ($)

Slope: $-8.77/\$1000$ (s.e. = 2.02)

**December 2021**

- Change in Employment (%)
  - from January 2020 to December 2021

- Rent
  - Median Two Bedroom Monthly Rent in 2014-2018 ($)

Slope: $-17.47/\$1000$ (s.e. = 3.62)
Impacts of Stimulus Policies

- Data
- Impacts of COVID-19
- Impact of Stimulus Policies
- Conclusion & Next Steps
Evaluating the Impacts of Government Policies

- Were government policies effective in stemming the chain of events we have documented?

- Illustrate how new data can help us evaluate impacts of government policies nearly in real time by focusing on impacts of stimulus payments made to households.
Three Rounds of Stimulus Payments to Households During the COVID-19 Pandemic

- April 15, 2020: $1,200
- January 4, 2021: $600
- March 17, 2021: $1,400
Impact of First Stimulus Payments on Consumer Spending in April 2020
Bottom Income Quartile Households

Total Spending Jumps by 30% on April 15, 2020
Effect of the COVID Stimulus Bills on Spending, by Income Group

Consumer Spending
Estimate of 1-month spending per $1,200

<table>
<thead>
<tr>
<th>Income Quartile</th>
<th>Spending Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>$407</td>
</tr>
<tr>
<td>Q2</td>
<td>$499</td>
</tr>
<tr>
<td>Q3</td>
<td>$530</td>
</tr>
<tr>
<td>Q4</td>
<td>$653</td>
</tr>
</tbody>
</table>
Effect of the COVID Stimulus Bills on Spending, by Income Group

Consumer Spending
Estimate of 1-month spending per $1,200

Income Quartile

Q1
Q2
Q3
Q4

April 2020 impacts
January 2021 impacts

$407
$261
$499
$284
$530
$183
$653
$129

April 2020 impacts are shown in teal, while January 2021 impacts are shown in orange.
Estimated Cumulative Increase in Savings

\[ \text{Savings} = \text{Earnings} + \text{Unemployment Insurance} + \text{Stimulus Checks} - \text{Spending} \]

\[ \Delta \text{Savings Per Person} \]

compared to 2019
Cutting off stimulus checks to Americans earning over $75,000 could be wise, new data suggests

Biden is debating another round of $1,400 stimulus payments. Some in Congress have proposed sending aid to lower-income families only. (Washington Post, January 26, 2021)

Live Updates: 10 Republicans Outline Smaller Stimulus Proposal Before Meeting With Biden

The New York Times, February 1, 2021

Opinion: It’s not progressive to give money to the rich

Washington Post, January 28, 2021
Stimulus Payments by Income Level
Couple with No Children

March 2021
Stimulus
Proposed Policy

Household Income

$1400

$0

$150,000

$200,000
Stimulus Payments by Income Level
Couple with No Children

March 2021
Stimulus
Actual Policy

$1400
$0
$160,000
$200,000

$75,000

$20 billion reallocated

Household Income
Effect of the COVID Stimulus Bills on Spending (per $1,200 check), by Income Group

Estimated 1-Month Spending Impact Per $1,200 of Stimulus

- **Bottom Quartile**: $407, $261, $232 (April 2020 (CARES Act)), $499, $284, $186 (January 2021 (COVID-Related Tax Relief Act)), $530, $183, $95 (March 2021 (American Rescue Plan Act))
- **Second Quartile**: $653, $129
- **Third Quartile**: $653, $129
- **Top Quartile**: $653, $129 (Note: March 2021 (American Rescue Plan Act) is shown as -$38 in the diagram, likely indicating a negative impact or a different measure.)
Evaluating the Impacts of Government Policies

- Publicly available data released here have been used to evaluate many other stabilization policies
  - UI expansions [Casado et al. 2020, Coombs et al. 2022]
  - Paycheck Protection Program [Granja et al. 2020]
  - Eviction moratoria [An et al. 2021]

- Were these policies effective in stemming the downward spiral in economic activity?
Changes in Bottom-Income-Quartile Spending vs. Workplace Rent, by ZIP Code

April 2020

Change in Consumer Spending (%) from January to April 2020

- Change in Consumer Spending (%) vs. Average Two Br. Monthly Rent in 2014-2018 in Workplace ZIP ($)
  - Slope = -12.84/$1000 (s.e. = 1.85)

October 2020

Change in Consumer Spending (%) from January to October 2020

- Change in Consumer Spending (%) vs. Average Two Br. Monthly Rent in 2014-2018 in Workplace ZIP ($)
  - Slope = 0.62/$1000 (s.e. = 3.45)
Evolution of Bottom-Income-Quartile Spending in High-Rent ZIP codes

Change in Consumer Spending (%)
from January 2020

Mar 2020  May  Jul  Sep  Nov  Jan 2021  Mar  May  Jul  Sep  Nov
Conclusion and Next Steps
1. Fiscal policies can be helpful in limiting secondary declines in consumer spending that arise from loss of income when workers lose their jobs.

2. But fiscal policy itself does not have the capacity to restore full employment when root cause of reduction in spending is health concerns [Guerrieri et al. 2020].
   - Full economic recovery requires addressing health concerns themselves.

3. Furthermore, even after health concerns have abated, changes in labor supply among those who have lost their jobs may lead to persistent employment reductions.
Looking Forward: A New Way to Measure Economic Activity

1. Big data can help us design a new system of real time national accounts that can be useful for diagnosing issues in the economy

   ▪ Currently collaborating with U.S. govt. agencies to construct a more permanent system of granular, high frequency national accounts, building on prototype constructed here

2. Big data can also open new pathways for macro policy: fine tuning based on state of the economy and observed policy impacts

   ▪ Can link between local spending levels and employment shocks tell us when fiscal policies are adequate?

   ▪ Can real-time data be used to monitor where hysteresis is emerging in the labor market and target job retraining programs accordingly?
Supplementary Appendix
Change in Real GDP from Q1 2020 to Q2 2020 (in trillions of chained 2012 dollars)

- Gross Domestic Product: -$1.61T (-29.9%)
- Credit Card Spending in PCE: -$0.90T
- Private Domestic Investment: -$0.53T
- Government Expenditures: +$0.06T
- Net Exports: +$0.06T
- Personal Consumption Expenditures (PCE): -$1.20T

Consumer Spending in National Accounts vs. Credit and Debit Card Data
Spending Changes by Sector: COVID vs Great Recession

- **Durables**
  - Great Recession: 61.0%
  - COVID-19: 17.5%

- **Non-Durables**
  - Great Recession: 46.0%
  - COVID-19: 11.6%

- **Services**
  - Great Recession: -7.0%
  - COVID-19: 71.0%
Association Between COVID-19 Incidence, Spending, and Mobility

**Change in Consumer Spending vs. COVID-19 Case Rate, by County**

- **Low-Income Counties (Q1)**
  - Slope: -2.50 (s.e. = 0.70)

- **High-Income Counties (Q4)**
  - Slope: -1.01 (s.e. = 0.56)

**Change in Mobility vs. COVID-19 Case Rate, by County**

- **Low-Income Counties (Q1)**
  - Slope: -2.45 (s.e. = 0.34)

- **High-Income Counties (Q4)**
  - Slope: -1.65 (s.e. = 0.23)
Changes in Small Business Revenues vs. ZIP Code Characteristics

**Median Income, by ZIP**

- Change in Small Business Revenue (%)
- From January to April 2020
- Slope = -0.14%/1000 (s.e. = 0.01)

**Population Density, by ZIP**

- Change in Small Business Revenue (%)
- From January to April 2020
- Slope = -3.71% (s.e. = 0.34)
Changes in Job Postings vs. Rent

Job Postings for Low-Education Workers vs. Median Rent, by County

[Graph showing a negative slope with the equation \( \text{Slope} = -11.91\% \text{/}$1000 (s.e. = 2.56)]

Job Postings for High-Education Workers vs. Median Rent, by County

[Graph showing a negative slope with the equation \( \text{Slope} = -0.35\% \text{/}$1000 (s.e. = 1.78)]
Changes in Employment Rates Over Time

April 15 2020

RMSE CES: 1.89 p.p.  
Corr CES: 0.93

Corr CPS: 0.95

Month-to-Month Change in Employment (p.p.)

Tracker Employment Series

CES

CPS
Changes in Employment Rates Over Time
Accommodation and Food Services vs. Professional Services

Food and Accommodation Services

- April 15 2020
- Correlation: 0.92

Professional Services

- April 15 2020
- Correlation: 0.81

Tracker Employment Series

Month-to-Month Change in Employment (p.p.)

Jan 2020 - Apr 2020 - May 2020 - Sep 2020 - Jan 2021 - May 2021 - Sep 2021

Tracker Employment Series

CES
Changes in Employment by Wage Quartile

All Industries

- Top Wage Quartile (> $32/hr)
- Third Quartile ($19 to $32/hr)
- Second Quartile ($13 to $19/hr)
- Bottom Wage Quartile (< $13/hr)

Change in Employment (%)

Relative to January 2020

Changes from April 15, 2020 to December 31, 2021:
- Top Wage Quartile: +3% (0.9m)
- Third Quartile: +0% (0.1m)
- Second Quartile: -1% (-0.2m)
- Bottom Wage Quartile: -21% (-6.8m)

- April 15, 2020: -14% (-4.3m jobs)
- May 2020: -19% (-6.2m)
- June 2020: -30% (-9.5m)
- July 2020: -37% (-12.0m)
Changes in Employment by Wage Quartile

Reweighting Across Industries and Areas

- Top Wage Quartile
- Bottom Wage Quartile

Reweighted to Match Top Quartile on County x Industry

December 31 2021

+2.7%

-21.8%

-19.0%

-40%

-30%

-20%

-10%

0%

Change in Employment (%) Relative to January 2020
Changes in Employment by Wage Quartile and Consumer Spending, Retail Trade

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail Employment: Top Wage Quartile</td>
<td>-20%</td>
<td>-21.2%</td>
<td>0%</td>
<td>+24.2%</td>
<td>+5.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+24.2%</td>
<td></td>
</tr>
<tr>
<td>Retail Employment: Bottom Wage Quartile</td>
<td>-40%</td>
<td>-20%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-21.2%</td>
<td></td>
</tr>
</tbody>
</table>

Retail Consumer Spending

---

Changes in Employment by Wage Quartile and Consumer Spending, Retail Trade

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail Employment: Top Wage Quartile</td>
<td>-20%</td>
<td>-21.2%</td>
<td>0%</td>
<td>+24.2%</td>
<td>+5.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+24.2%</td>
<td></td>
</tr>
<tr>
<td>Retail Employment: Bottom Wage Quartile</td>
<td>-40%</td>
<td>-20%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-21.2%</td>
<td></td>
</tr>
</tbody>
</table>

Retail Consumer Spending
Geography of Employment Losses in the Great Recession vs. COVID Recession

- **2007 to 2010 Employment Loss**
  - Share of Employment Changes (%)
  - Top Quartile of County Median Income

- **Jan to Apr 2020 Employment Loss**
  - Share of Employment Changes (%)
  - Second Quartile of County Median Income

- **Week 11 to Week 14 2020 UI Claims**
  - Share of Employment Changes (%)
  - Third Quartile of County Median Income

- **Bottom**
  - Orange
- **Second**
  - Blue
- **Third**
  - Purple
- **Top**
  - Green
Low-Education Job Postings and Low-Wage Employment vs. Rent, by County

**Low-Education Job Postings vs. Median Rent, by County**

**Low-Wage Employment vs. Median Rent, by County**

[Graphs showing changes in low-education job postings and low-wage employment vs. median rent, by county, with 95% confidence intervals.]
Effects of Stimulus Payments on Card Spending

**April 2020 Stimulus, Low-Income ZIPs**

- First-Differenced Change in Indexed Spending Relative to DoW FEs (%)

**April 2020 Stimulus, High-Income ZIPs**

- First-Differenced Change in Indexed Spending Relative to DoW FEs (%)

<table>
<thead>
<tr>
<th>Date</th>
<th>Low-Income ZIPs</th>
<th>High-Income ZIPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar 18 2020</td>
<td>-20%</td>
<td>-20%</td>
</tr>
<tr>
<td>Mar 25 2020</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Apr 1 2020</td>
<td>+20%</td>
<td>+20%</td>
</tr>
<tr>
<td>Apr 8 2020</td>
<td>+40%</td>
<td>+40%</td>
</tr>
<tr>
<td>Apr 15 2020</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Apr 22 2020</td>
<td>+20%</td>
<td>+20%</td>
</tr>
<tr>
<td>Apr 29 2020</td>
<td>+40%</td>
<td>+40%</td>
</tr>
<tr>
<td>May 6 2020</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Effects of Stimulus Payments on Card Spending

January 2021 Stimulus

<table>
<thead>
<tr>
<th>Date</th>
<th>Bottom Income Quartile</th>
<th>Top Income Quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 4 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec 8 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec 12 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan 4 2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan 8 2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan 12 2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan 16 2021</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

March 2021 Stimulus

<table>
<thead>
<tr>
<th>Date</th>
<th>Bottom Income Quartile</th>
<th>Top Income Quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 17 2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb 24 2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mar 3 2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mar 10 2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mar 17 2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mar 24 2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mar 31 2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apr 7 2021</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Low-Wage Employment vs. Workplace Rent, by ZIP

Slope = -10.04%/$1000 (s.e. = 0.59)
Effects of COVID-19 on Educational Progress by Income Group

- Top Income Quartile:
  - Students Using Zearn Platform: +0.0%

- Bottom Income Quartile:
  - Students Using Zearn Platform: -41.2%