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.
Growing number of papers use transaction data to analyze economic activity

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
Outline

1. Data

2. Impacts of COVID-19

3. Impacts of Stabilization Policies

4. Policy Implications
Data Partners

Consumer Spending
- affinity solutions
- COINOUT

Small Business Revenues
- WOMPLY

Employment
- PAYCHEX
- Intuit
- earnin
- KRONOS

Job Postings
- burningglass

Education
- ZeARN
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
Changes in Consumer Spending: National Accounts vs. Credit/Debit Card Data

Food Services in Affinity Solutions Purchase Data vs. Monthly Retail Trade Survey

Total Revenue (Indexed to 1 in January 2020)

Date


RMSE: 0.04

Affinity Solutions Purchase Data

Monthly Retail Trade Survey
Changes in Consumer Spending: National Accounts vs. Credit/Debit Card Data

Retail Services in Affinity Solutions Purchase Data vs. Monthly Retail Trade Survey

Date


Affinity Solutions Purchase Data

Monthly Retail Trade Survey

RMSE: 0.05
Changes in Employment: Current Employment Statistics vs. Payroll Data

- Paychex-Intuit-Earnin (PIE) Food Services
- PIE Professional Services
- CES Food Services
- CES Professional Services

Percent Change in Employment Rates Since January 2020

Apr 15

July 15
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

- All results that follow are constructed from these publicly available statistics
Impacts of COVID-19
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

Contribution: -$1.73T (-31.7%)
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
- Govt. Expend.: $0.04T
- Net Exports: $0.05T
- Personal Consumption Expend. (PCE): -$1.35T
National Accounts Data: Changes in GDP and its Components

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- Govt. Expend.: $0.04T
- Net Exports: $0.05T
- Personal Consumption Expend. (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

- 2019 Bottom Income Quartile
- 2020 Bottom Income Quartile
- 2019 Top Income Quartile
- 2020 Top Income Quartile

- $3.1 Billion (-40.0%)
- $0.77 Billion (-9.9%)
Consumer Spending by Income Quartile

- **2019 Bottom Income Quartile**: -$3.1 Billion (-40.0%)
- **2019 Top Income Quartile**: -$1.0 Billion (-30.5%)
- **2020 Bottom Income Quartile**: -$0.06 Billion (-1.8%)
- **2020 Top Income Quartile**: -$0.77 Billion (-9.9%)
Consumer Spending by Income Quartile

- $3.1 Billion (-40.0%)
- $1.0 Billion (-30.5%)
- $0.77 Billion (-9.9%)
- $0.06 Billion (-1.8%)

Top quartile accounts for more than half of aggregate spending reduction.
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

In-person services (67%)

- 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)
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

<table>
<thead>
<tr>
<th>Sector</th>
<th>Great Recession</th>
<th>COVID-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durables</td>
<td>19.5%</td>
<td>13.3%</td>
</tr>
<tr>
<td>Non-Durables</td>
<td>44.3%</td>
<td>13.3%</td>
</tr>
<tr>
<td>Services</td>
<td>-2.9%</td>
<td>67.2%</td>
</tr>
</tbody>
</table>

Pct. of decline in personal consumption expenditures from peak to trough
Business Revenues
Impacts of COVID-19 on Businesses

- 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 → variation in size of spending shock that local businesses face

- Begin by analyzing impacts on small business revenue
Changes in Small Business Revenues from January to April by ZIP Code
San Francisco

Change in Small Business Revenue
- < -69.8%
- -69.8% to -61.2%
- -61.2% to -56.5%
- -56.5% to -53.2%
- -53.2% to -48.8%
- -48.8% to -44.1%
- -44.1% to -41.0%
- -41.0% to -36.7%
- -36.7% to -31.9%
- > -31.9%
Changes in Small Business Revenues from January to April by ZIP Code
New York
Changes in Small Business Revenues vs. Rent, by ZIP Code

Slope = -13.00 per Thousand Dollars (SE = 0.38)
Changes in Small Business Revenues vs. Rent, by ZIP Code
Finance and Professional Services

Slope = 0.02 per Thousand Dollars (SE = 1.26)
Impacts of COVID-19 on Employment

- How did businesses react to loss in revenues?

- Begin by analyzing national trends in employment by wage group and then turn to geographic variation
Employment Changes by Wage Quartile

Since January 2020

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

- Apr 15: -10% (3.1m jobs lost)
- Jul 15: -1% (0.3m)
- July 15: -4% (1.4m)
- July 15: -5% (2.0m)
- July 15: -14% (4.6m)

- Apr 15: -16% (5.0m)
- Jul 15: -4% (1.4m)
- July 15: -6% (2.0m)
- July 15: -14% (4.6m)

- Apr 15: -22% (7.1m)
- Jul 15: -1% (0.3m)
- July 15: -4% (1.4m)
- July 15: -6% (2.0m)
- July 15: -14% (4.6m)

- Apr 15: -32% (10.1m)
- Jul 15: -1% (0.3m)
- July 15: -4% (1.4m)
- July 15: -6% (2.0m)
- July 15: -14% (4.6m)
Employment Changes by Wage Quartile

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

Percent Change in Employment Rates Since January 2020

- April 15: -10% (-3.1m jobs lost)
- July 15: -1% (-0.3m)
- August 23: -14% (-4.6m)

Predicted Using Time Sheet Data
Changes in Wage Rates
Chained Estimates Using Wage Growth for Job Stayers from Week t to t+1

![Graph of changes in wages relative to Jan. 2020 from Feb 12 to May 20.](image-url)
Changes in Employment Rates by ZIP Code

San Francisco

Change in Low-Income Employment at Small Businesses (Earning Data)

- < -69.0%
- -69.0% to -58.9%
- -58.9% to -52.9%
- -52.9% to -47.2%
- -47.2% to -43.0%
- -43.0% to -38.2%
- -38.2% to -32.3%
- -32.3% to -26.2%
- -26.2% to -12.8%
- > -12.8%
- No Data
Slope = -12.7%/\$1000 (s.e. = 0.53)
Changes in Employment and Job Postings vs. Rent
Job Postings for Low-Education Workers and County Median Rent (Burning Glass)
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?
National Trends in Consumer Spending vs. Employment Rates


Date

Feb 22 Mar 7 Mar 21 Apr 4 Apr 18 May 2 May 16 May 30 Jun 13 Jun 27 Jul 11

Total Consumer Spending

-6.7%
National Trends in Consumer Spending vs. Employment Rates


Date
Feb 22 Mar 7 Mar 21 Apr 4 Apr 18 May 2 May 16 May 30 Jun 13 Jun 27 Jul 11

Employment: Bottom Wage Quartile
Total Consumer Spending

Pct. Change
0%
-20%
-40%
National Trends in Consumer Spending vs. Employment Rates


- Feb 22: Bottom Wage Quartile (0%), Top Wage Quartile (0%)
- Mar 7: Bottom Wage Quartile (40%), Top Wage Quartile (40%)
- Mar 21: Bottom Wage Quartile (6.7%), Top Wage Quartile (6.7%)
- Apr 4: Bottom Wage Quartile (-10%), Top Wage Quartile (-10%)
- Apr 18: Bottom Wage Quartile (-15.2%), Top Wage Quartile (-15.2%)
- May 2: Bottom Wage Quartile (-10%), Top Wage Quartile (-10%)
- May 16: Bottom Wage Quartile (-5%), Top Wage Quartile (-5%)
- May 30: Bottom Wage Quartile (-1.0%), Top Wage Quartile (-1.0%)
- Jun 13: Bottom Wage Quartile (-0.5%), Top Wage Quartile (-0.5%)
- Jun 27: Bottom Wage Quartile (-0.5%), Top Wage Quartile (-0.5%)
- Jul 11: Bottom Wage Quartile (-0.5%), Top Wage Quartile (-0.5%)

Date

Employment: Bottom Wage Quartile
Employment: Top Wage Quartile
Total Consumer Spending
National Trends in Consumer Spending vs. Employment Rates

Bottom Wage Quartile Reweighted to Match Top Quartile by Industry and County

Employment: Bottom Wage Quartile
Total Consumer Spending
Employment: Top Wage Quartile
Employment: Bottom Wage Quartile, Reweighted to Match Q4 on County x Industry

Date
Feb 22  Mar 7  Mar 21  Apr 4  Apr 18  May 2  May 16  May 30  Jun 13  Jun 27  Jul 11

0%
-1.0%
-6.7%
-14.3%
-15.2%
-40%
-20%
-20%
0%
National Trends in Consumer Spending vs. Employment Rates

Retail Trade


Employment: Bottom Wage Quartile
-40%
-20%
0%
20%
40%

Employment: Top Wage Quartile

Total Consumer Spending

Date
Feb 22
Mar 7
Mar 21
Apr 4
Apr 18
May 2
May 16
May 30
Jun 13
Jun 27
Jul 11

-18.15%
11.56%
1.82%
Employment Recovery from the COVID-19 Shock

- 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
State-Ordered Reopenings

- Can executive orders restore economic activity?
- Compare trends in spending and employment in states that reopened earlier vs. later to assess
Causal Effect of Re-Opening on Consumer Spending
Case Study of New Mexico vs. Colorado
Causal Effects of Re-Openings on Economic Activity: Event Studies

Re-Opened States vs. Control States: Consumer Spending

Change in Consumer Spending Relative to January 2020

Days Relative to Re-opening

Diff-in-diff Estimate: +1.12p.p. (s.e. = .85)
Causal Effects of Re-Openings on Economic Activity: Event Studies

Re-Opened States vs. Control States: Employment

Change in Employment Relative to January 2020

Days Relative to Re-opening

Diff-in-diff Estimate: +1.46 p.p. (s.e. = .68)
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, by Income Quartile

Seasonally Adj. Pct. Change in Spending

Bottom Income Quartile
Top Income Quartile

Q1 Apr 7-13: -28.1%
Q4 Apr 7-13: -36.3%
Q1 Apr 15-21: -10.3%
Q4 Apr 15-21: -29.8%
Impact of Stimulus Payments on Consumer Spending
Regression Discontinuity Estimates for Bottom Income Quartile Households

RD Estimate of Stimulus Impact: 26% (s.e. = 7%)
Impact of Stimulus Payments on Consumer Spending
Regression Discontinuity Estimates for Highest Income Quartile Households

RD Estimate of Stimulus Impact: 9% (s.e. = 4%)
Causal Effects of Stimulus

- Stimulus payments increased aggregate consumer spending

- 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
Regression Discontinuity Estimates for Durable Goods

RD Estimate of Stimulus Impact: 21% (s.e. = 6%)
Impact of Stimulus Payments on Consumer Spending

Regression Discontinuity Estimates for In-Person Services


RD Estimate of Stimulus Impact: 7% (s.e. = 4%)
Impact of Stimulus Payments on Business Revenue and Employment Rates

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


Date

Feb 22  Mar 7  Mar 21  Apr 4  Apr 18  May 2  May 16  May 30  Jun 13  Jun 27  Jul 11

Small Bus. Revenue in Top Rent Quartile ZIPS

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

Revenue and Employment Changes Among Small Businesses, by ZIP Rent Quartile
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 Low-Wage Employment
Change in Employment Rates by PPP Eligibility, Reweighted to Match Industries, Excl. Food Services

![Graph showing the impact of PPP on employment rates for different employee size categories, excluding food services, from February to July. The x-axis represents the dates from February 12 to July 15, and the y-axis represents the change in employment since January as a percentage. The graph indicates a significant drop in employment rates after the PPP program begins.]
Impact of Paycheck Protection Program on Low-Wage Employment

Change in Employment Rates by PPP Eligibility, Reweighted to Match Industries, Excl. Food Services

- PPP Program Begins
- 50% to 40%
- 30%
- 20%
- 10%
- 0%

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

Change in Employment Since January

DD Estimate of PPP Impact: +1.9% (s.e. = 0.8%)

1-500 Employees (Eligible for PPP)

501-1000 Employees (Ineligible)
Impact of Paycheck Protection Program on Low-Wage Employment
Change in Employment Rates by PPP Eligibility, Reweighted to Match Industries, Excl. Food Services

- 50% - 40% - 30% - 20% - 10% - 0%

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

PPP Program Begins

DD Estimate of PPP Impact: +1.9% (s.e. = 0.8%)

Cost Per Job Saved = $289K
($163K at lower bound of 95% CI)

Change in Employment Since January
Paycheck Protection Program

- 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
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.
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 empirical impacts
  - E.g. re-target PPP program based on observed short-run empirical impacts?

- Research: estimating transmission and equilibrium impacts of shocks using granular data (with Gabriel Chodorow-Riech and Ludwig Straub)
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