Covid restrictions, federal assistance and small businesses

What can we learn from electricity data?

Jack Gregory, Katrina Jessoe[1] & Gabriel E. Lade[2]

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[1] University of California, Davis
[2] Macalester University

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- The policy response was enormous.

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- So far, policy evaluation has been primarily concerned with employment, efficiency and inequality.
- What about the effects on businesses?

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Electricity as a proxy

- **Problem**
  - The ideal dataset would measure high-resolution output across businesses and time.
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  - However, this data does not readily exist across sufficient businesses to perform an econometric analysis.
- **Solution**
  - We exploit the correlation between electricity and activity.
  - Electricity is a necessary input lacking substitutes and available at high-resolution both spatially and temporally.
  - Potential weakening of the relationship from energy efficiency improvements and changing patterns of use.
  - However, commercial electricity use remains unambiguously correlated with economic activity (Bover et al., 2020).

Overview

- **Aim**
  - Investigate the effect of the pandemic and subsequent relief packages on small businesses
  - Use high-resolution electricity data and an event study approach
- **Questions**
  1. How have public health orders impacted business activity and exits?
  2. How have federal loan programs mitigated these impacts?
- **Main assumptions**
  - Electricity use is a proxy for business activity; and,
  - Electricity accounts are a proxy for exit.

Preview of results

1. Restrictions caused lower business activity, though both within-day and across-industry heterogeneity exists.
2. Restrictions caused more business exits.
3. Loan receipt correlated with smaller decreases in business activity and smaller increases in business exits.

Literature I

- COVID precipitated a vast literature investigating its effects on, e.g., consumers (Alexander and Karger, 2020), health (Cicala et al., 2020), and the environment (Gillingham et al., 2020).

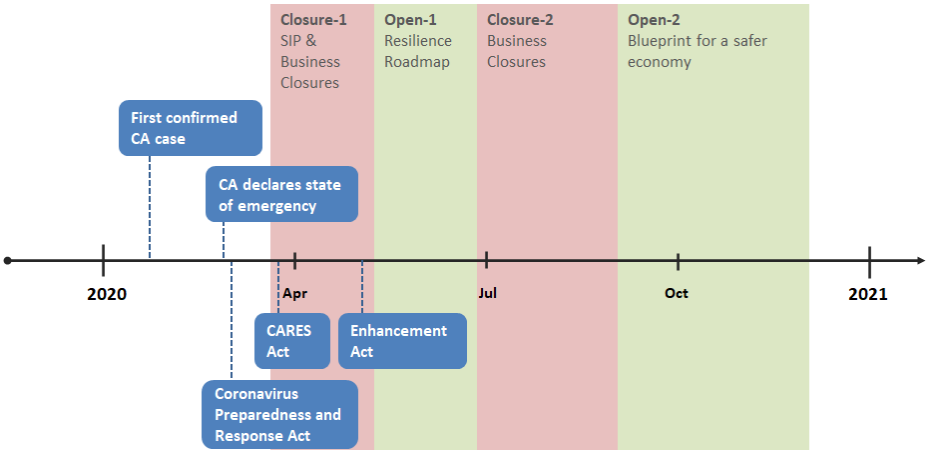
- **Effects on small businesses**
  - Mainly investigate the effects on employment and business survival (e.g., Autor et al., 2022; Bartik et al., 2021; Hubbard and Strain, 2020).
  - Vary based on their designs, including: surveys, instrumental variables, and difference-in-differences.
  - Tend to rely on employment, administrative or financial data.

Literature II

- **High-resolution electricity data**
  - Mainly investigate energy efficiency (Boomhower and Davis, 2019; Novan and Smith, 2018), salience (Gilbert and Graff Zivin, 2014), and behavioural interventions (Allcott and Rogers, 2014).
  - Naturally suits a two-way fixed effects approach (Gillingham et al., 2018; Ghanem and Smith, 2021).
  - For COVID:
    - Many studies use electricity data at the aggregate level to proxy for economic activity (e.g., Agdas and Barooah, 2020; Bahmanyar et al., 2020).
    - Some studies focus on the residential sector (Cicala, 2020; Cheshmehzangi, 2020).
    - To our knowledge, no studies investigate the commercial sector.

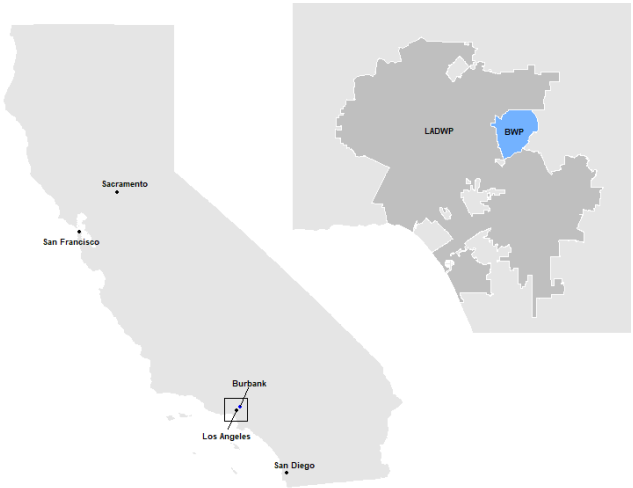
Background & Data

Timeline



Detailed COVID cases

Burbank Water & Power I



Burbank Water & Power II

- **Utility**
  - Municipal utility in Southern California
  - Accounts = 53,272
  - Sales = 1,092 GWh
- **Electricity data**
  - Proprietary dataset containing universe of commercial customers
  - Use: hourly panel with variation in business and time dimensions
  - Bills: monthly panel of use and amount owed

COVID Restrictions

- **Restrictions**
  - Manually compiled public health orders from state & county websites
  - Similar to Alexander and Karger (2020) and Goolsbee et al. (2020)
- **Data**
  - Contains restrictions enacted from 16 Mar 2020
  - Orders include industry scope, measures and effective dates

California Department of PublicHealth CDPH

County of Los Angeles Public Health

Federal assistance

- **Loan programs**
  - Economic Injury Disaster Loans (EIDL) & Paycheck Protection Program (PPP)
  - Primarily enacted through the CARES Act 2020
  - Administered through the Small Business Administration (SBA)
  - For our analysis, we ignore differences between the programs
- **Data**
  - Public dataset containing universe of federal loans

Other Data I

- **Industry classifications**
  - Sources: BWP, SBA & Employment Development Department (EDD)
  - Concordance between businesses and business classification codes (NAICS)
  - BWP provided an initial matching
  - Supplemented with data from the SBA and the California EDD

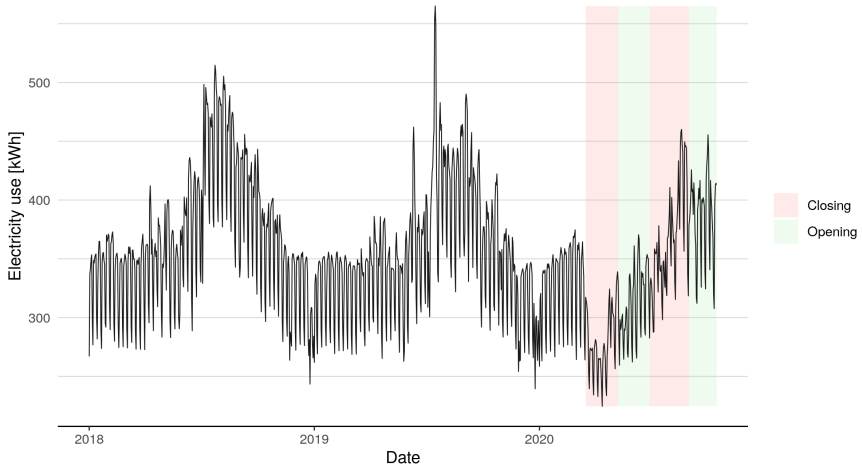
Businesses by industry

Other Data II

- **Local Climatology Data (LCD)**
  - Source: National Oceanic and Atmospheric Administration (NOAA)
  - Hourly temperature data from the Hollywood Burbank Airport
- **US Census Data**
  - Source: IPUMS National Historical Geographic Information System (NHGIS)
  - Cross-section of socio-economic data by block-group

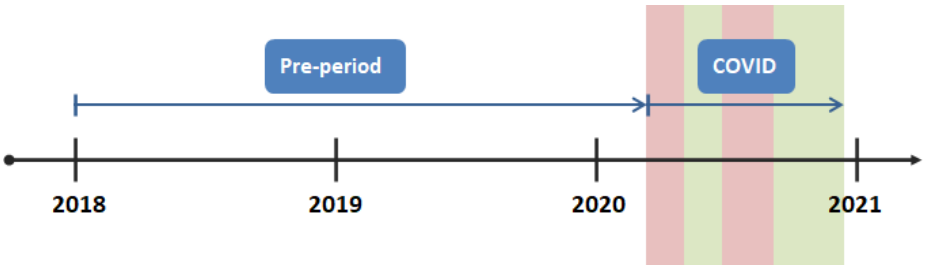
Empirical Strategy & Results

Average electricity use



Empirical strategy I

- **Event study**
  - All businesses in the panel receive treatment simultaneously
  - Allow for heterogeneous effects across restriction periods



Empirical strategy II

- **Two-way fixed effects** estimation using OLS:

$$y_{it} = \sum_{j} \beta_j 1[r = j] + \mathbf{X}_{it}\boldsymbol{\gamma} + \alpha_{idm} + \varepsilon_{it} \tag{1}$$

  - y_{it} is the outcome of interest for business i in period t.
  - $1[r = j]\ \forall\ j$ are the event indicators for a specific close or open period.
  - $\mathbf{X}_{it}$ are controls related to local weather and COVID case numbers.
  - α_{idm} represents unit and time fixed effects combinations.
  - ε_{it} is an error term clustered at the business level.

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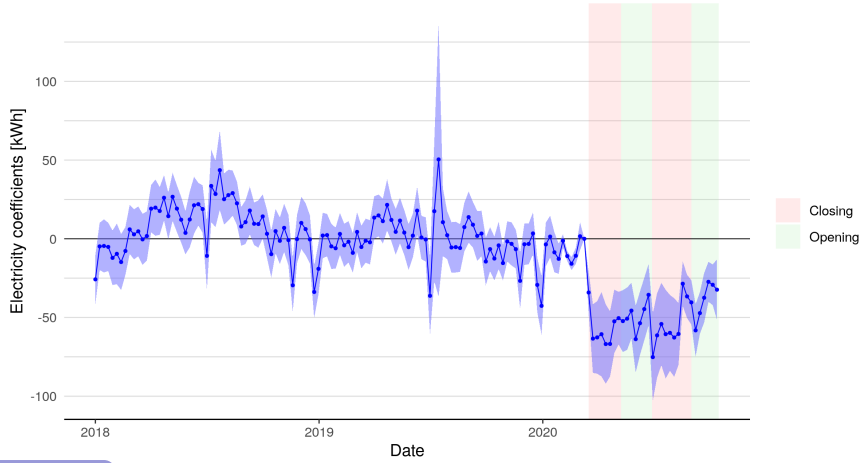
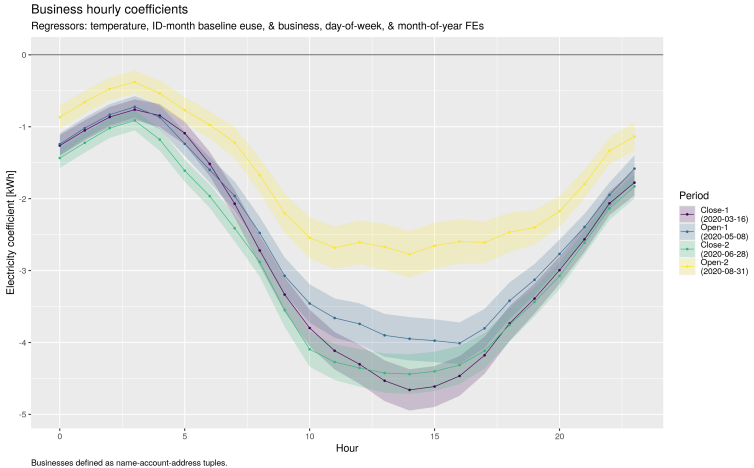
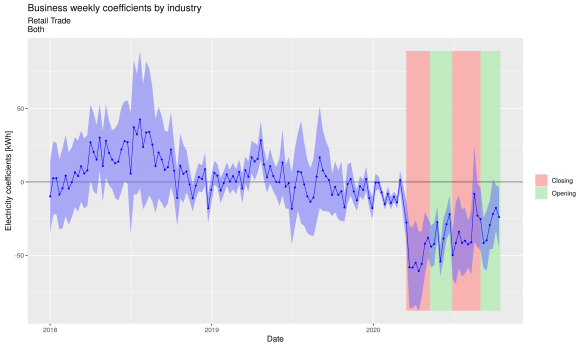


Reg table | With COVID cases

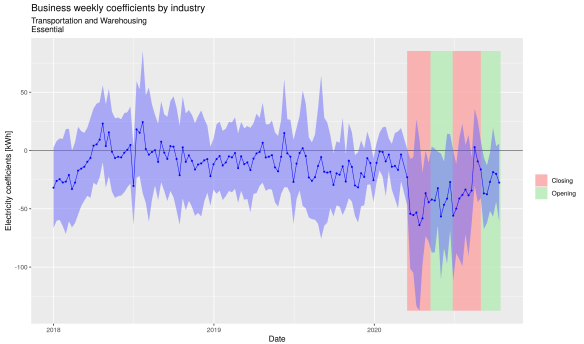
Heterogeneous response I



Heterogeneous response II



Businesses defined as name-account-address tuples.
Shaded areas represent closing and opening periods within LA County.
Regression includes the following controls: business, day-of-week, and month-of-year fixed effects and month-of-year baseline electricity use.



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Other industries

Average electricity use residuals by loans

Reg table

Empirical strategy III

- **Matching**
  - Implement matching to reduce selection bias.
  - Use one-to-one nearest-neighbour matching with replacement.
  - Covariates include the mean, maximum and standard deviation of pre-period energy use, business variables, and socio-economic variables.

Empirical strategy III

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$$y_{it} = \beta_{loan} 1[loan] + \sum_j \beta_j 1[r] + \beta_{loan} \cdot \sum_j \beta_j 1[loan, r] + \mathbf{X}_{it}\boldsymbol{\gamma} + \alpha_{idm} + \varepsilon_{it} \quad (2)$$

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  - All others defined as previously.

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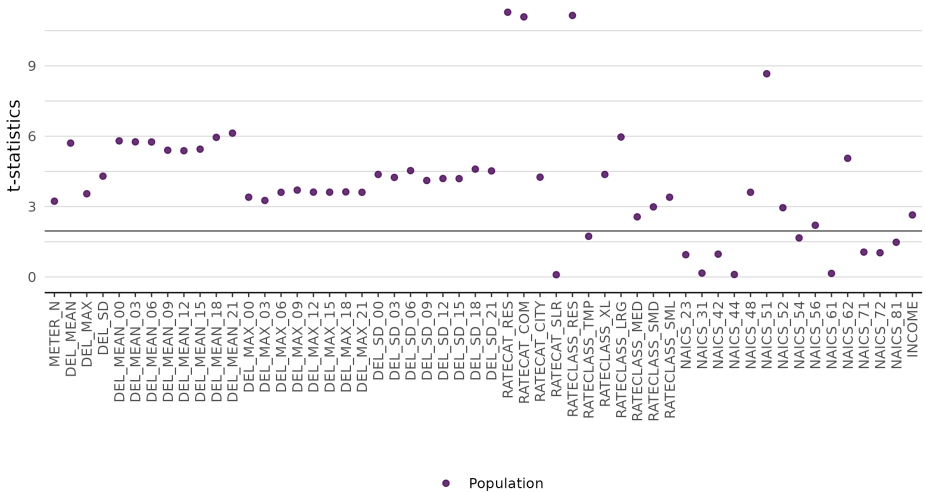

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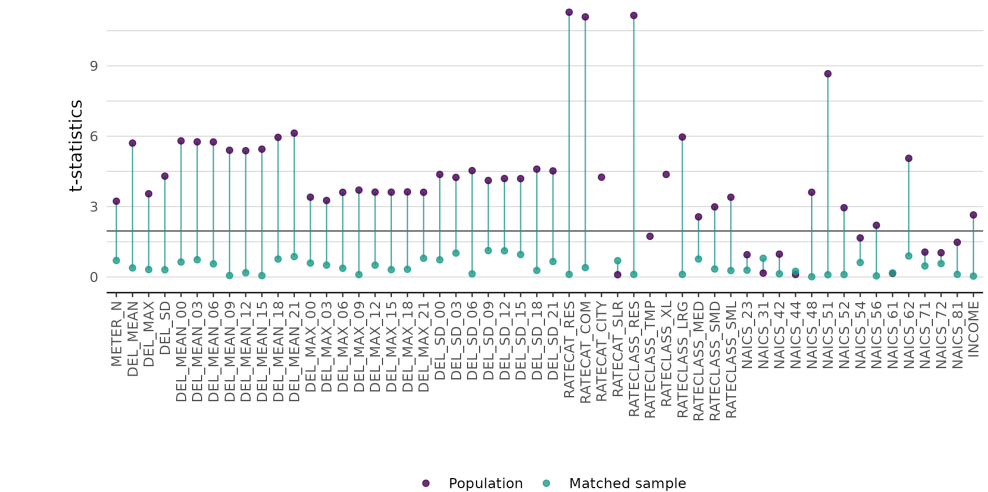

Average electricity use by loans

	(1) pretrend	(2) +naics	(3) +res	(4) ±rate	(5) +income	(6) ±plevel
Loan	-15.39	1.79	-4.26	-4.01	-2.66	-2.93
	(-1.45)	(0.99)	(-0.75)	(-0.82)	(-1.68)	(-1.89)
Loan × Close-1	71.08	13.24	32.89	29.30	23.03*	20.11
	(1.33)	(1.16)	(1.59)	(1.45)	(2.25)	(1.93)
Loan × Open-1	66.56	16.00	33.46	27.85	26.51**	23.57*
	(1.34)	(1.31)	(1.63)	(1.39)	(2.66)	(2.33)
Loan × Close-2	90.59	31.69*	54.51*	57.05*	34.50**	32.39**
	(1.63)	(2.57)	(2.43)	(2.48)	(2.86)	(2.66)
Loan × Open-2	51.83*	20.67	30.07*	24.78*	23.51*	21.86*
	(2.04)	(1.93)	(2.42)	(2.02)	(2.19)	(2.00)
Businesses	2,042	2,043	2,058	2,055	1,913	1,903
Observations	1,139,468	1,119,493	1,139,696	1,134,504	1,040,462	1,029,133
R^2	0.962	0.988	0.977	0.983	0.963	0.965

Notes: Regressions include event dummies, weather covariates as well as industry, day-of-week and month-of-year fixed effects. Significance is represented as *** for $p<0.001$, ** for $p<0.01$, and * for $p<0.05$; while, t-statistics are in parentheses.

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Survival analysis by loans

	All Data	No Loan	Loan
	(1)	(2)	(3)
Close-1 (2020-03-16)	0.00013***	0.00016***	0.00002
52 days	(4.59)	(4.44)	(1.18)
	0.68%	0.83%	0.10%
Open-1 (2020-05-08)	0.00032***	0.00032***	0.00031***
50 days	(7.80)	(6.74)	(3.94)
	1.60%	1.60%	1.55%
Close-2 (2020-06-28)	0.00055***	0.00055***	0.00055***
63 days	(12.05)	(10.35)	(6.16)
	3.47%	3.47%	3.47%
Open-2 (2020-08-31)	0.00052***	0.00052***	0.00051***
45 days	(11.85)	(10.24)	(5.98)
	2.34%	2.34%	2.30%
ID FE	X	X	X
Businesses	4,602	3,387	1,215
Observations	1,234,032	898,582	335,450
R^2	0.02849	0.03278	0.01278
Adjusted R^2	0.02485	0.02912	0.00918

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Extensions

1. High spatial resolution of our data means we can recover matches across our datasets at the business level.
   - Modify restriction periods to be industry specific.
   - Explore heterogeneous effects across industries and loan programs.
2. Use synthetic control or machine learning approaches to generate a business-level conterfactuals.
   - Improved matches may allow us to overcome loan selection bias.

Summary

Contribution

1. Deepening understanding of how the pandemic affected business activity and exits.
2. First to assess the combined effect of both the PPP and EIDL programs.
3. First to study the high-resolution effects of federal loan receipt.

Main takeaways

- **COVID**
  - Average commercial electricity use decreased due to COVID restrictions.
  - Closure periods experienced lower activity than re-opening periods.
  - Exits increased over the duration of the pandemic and accelerated during closure periods.
- **Federal loans**
  - Loan receipt correlated with smaller decreases in electricity use.
  - Loan receipt also correlated with increased survival probability during the initial closure period, though the effect dissipates rapidly.

Thank You!

jack@ucdavis.edu

References

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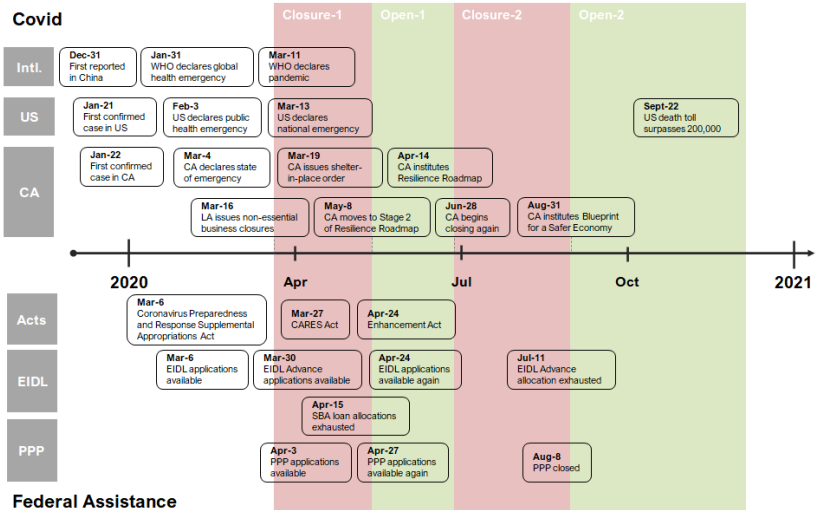
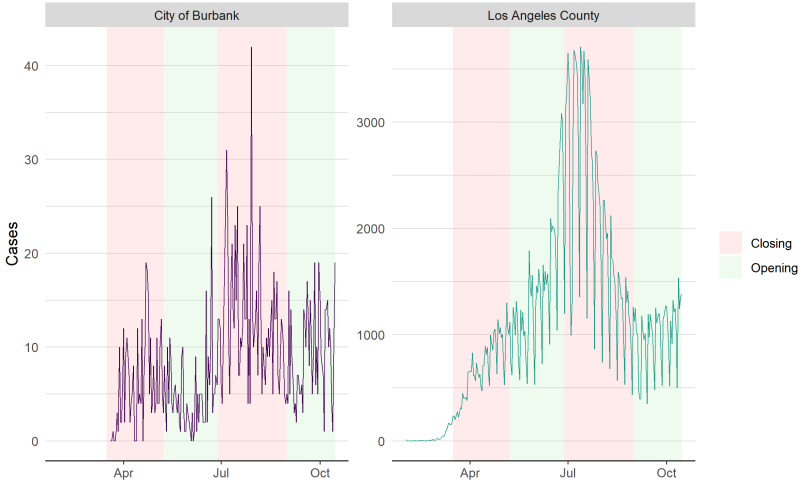
Appendices

Detailed Timeline



Return

COVID cases



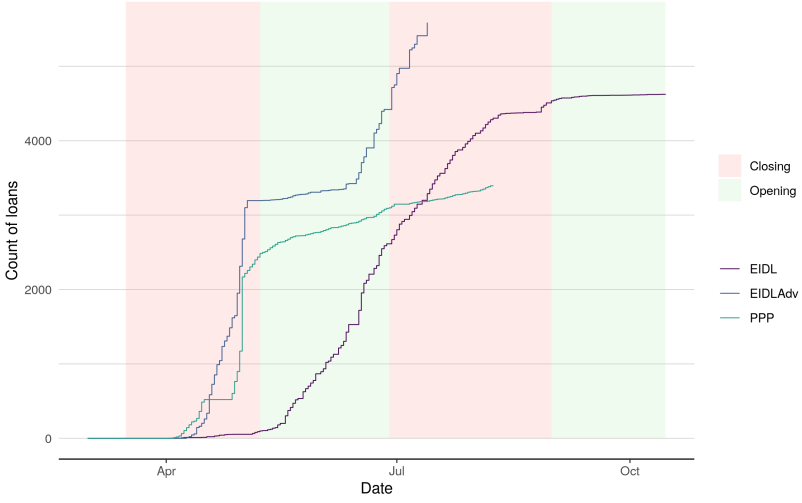
Return

SBA loan programs

	PPP	EIDL
Description	Low-interest, medium-term loan program where applications are processed through a network of private lenders across the US.	Competitive-interest, long-term loan program where applications are processed by the SBA; includes the EIDL Advance where up to $10,000 may be requested separately or in conjunction with a full EIDL loan.
Purpose	To meet operating expenses, primarily payroll.	To meet various financial obligations and operating expenses.
Availability	Apr to Aug 2020; Dec 2020 to present	EIDL Advance Mar to Jul 2020; EIDL Mar 2020 to present
Max	$10 million	Six months of working capital
Terms	Interest of 1% repaid over 2 to 5 years and deferred for 1 year with no collateral and no personal guarantee required.	Interest of 3.75% repaid over up to 30 years where collateral is required for loans over $25,000 and a personal guarantees for loans exceeding $200,000.
Forgivable	Yes, if all employee retention criteria are met and funds used for eligible expenses.	No, loan may be repaid at any time with no prepayment penalties.

Return

Loan count by date & program



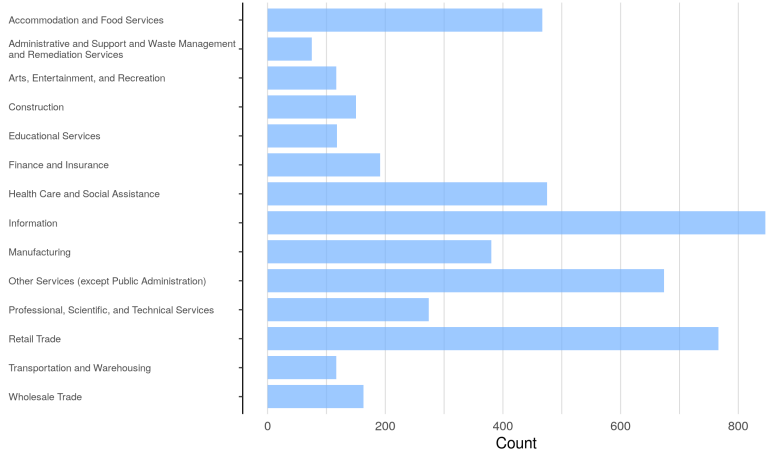
Return

Loan summary stats

Characteristic	No loan	Loan
Number of businesses	3,587	1,226
Daily electricity use pre-pandemic (kWh)	444.5	119.4
Daily electricity use post-pandemic (kWh)	419.4	110.8
Number of business exits post-pandemic	181	61
Share of business exits post-pandemic (%)	5.7	5.2
Mean loans per business		2.0
Mean date of first loan		2020-05-06
Mean date of all loans		2020-05-17
Mean amount of first loan		121,172
Mean amount of total loan		197,504

Return

NAICS industry codes



Return

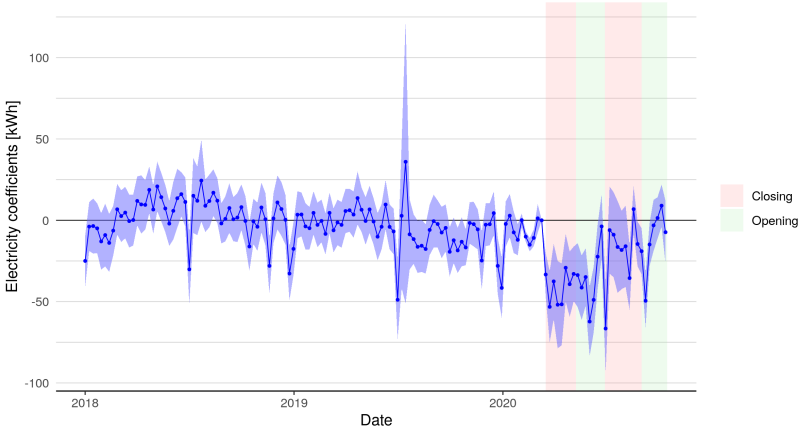
Change in electricity use

	(1)	(2)	(3)	(4)
Close-1 (2020-03-16)	−64.70***	−66.94***	−71.40***	−71.49***
	(−5.12)	(−5.11)	(−5.33)	(−5.33)
Open-1 (2020-05-08)	−51.14***	−61.89***	−61.87***	−61.87***
	(−3.99)	(−4.48)	(−4.48)	(−4.48)
Close-2 (2020-06-28)	−63.50***	−64.68***	−64.00***	−63.87***
	(−4.48)	(−4.39)	(−4.36)	(−4.36)
Open-2 (2020-08-31)	−26.04*	−43.26***	−48.37***	−48.50***
	(−2.27)	(−3.55)	(−3.88)	(−3.88)
Temperature		2.97***	1.55***	1.55***
		(9.13)	(5.68)	(5.67)
HDD			2.57***	2.57***
			(8.46)	(8.46)
ID FE	X	X	X	X
Day-of-Week FE	X	X	X	
Month-of-Year FE	X	X	X	
ID:Day-of-Week FE				X
ID:Month-of-Year FE				X
Businesses	4,813	4,546	4,546	4,544
Observations	4,402,221	4,327,915	4,327,915	4,327,896
R^2	0.957	0.966	0.966	0.977

Notes: Significance is represented as *** for p<0.001, ** for p<0.01, and * for p<0.05; while, *t*-statistics are in parentheses.

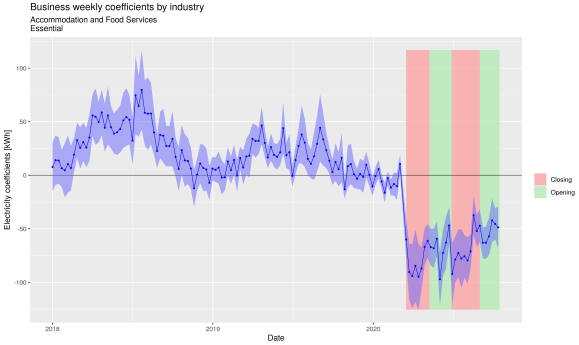
Return

Change in electricity with Burbank cases

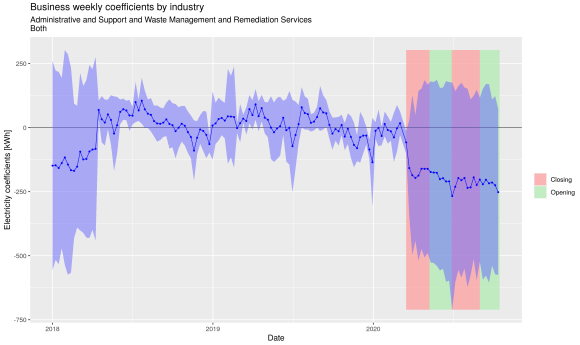


Return

Change in electricity use by industry I



Businesses defined as name-account-address tuples.
Shaded areas represent closing and opening periods within LA County.
Regression includes the following controls: business, day-of-week, and month-of-year fixed effects and month-of-year baseline electricity use.



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Shaded areas represent closing and opening periods within LA County.
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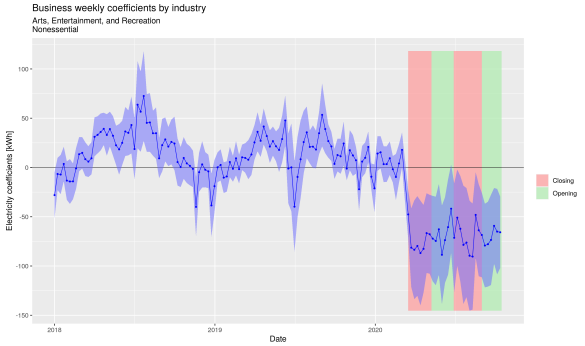
Return

Change in electricity use by industry II



Businesses defined as name-account-address tuples.
Shaded areas represent closing and opening periods within LA County.
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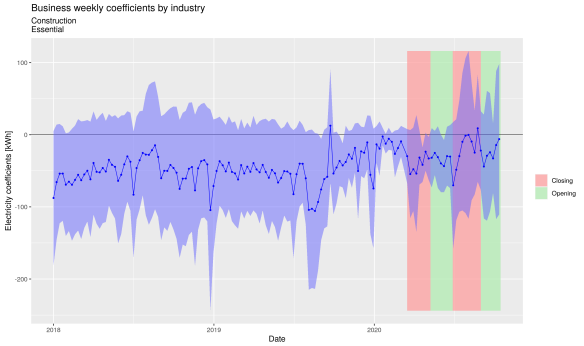
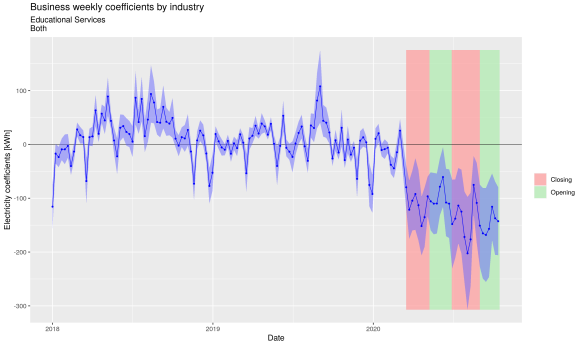


Businesses defined as name-account-address tuples.
Shaded areas represent closing and opening periods within LA County.
Regression includes the following controls: business, day-of-week, and month-of-year fixed effects and month-of-year baseline electricity use.

Return

Change in electricity use by industry III



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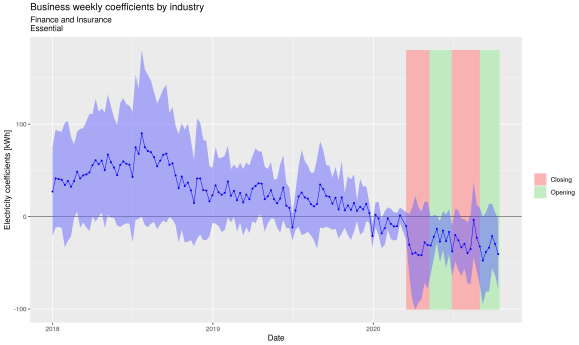

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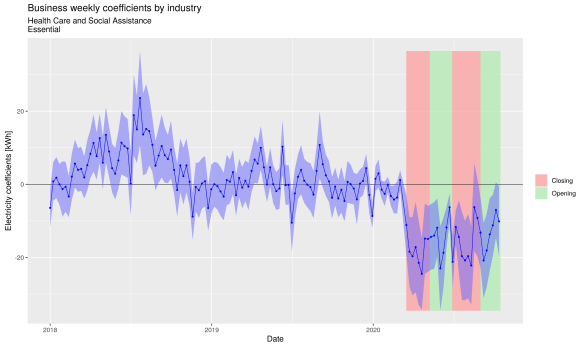
Return

Change in electricity use by industry IV



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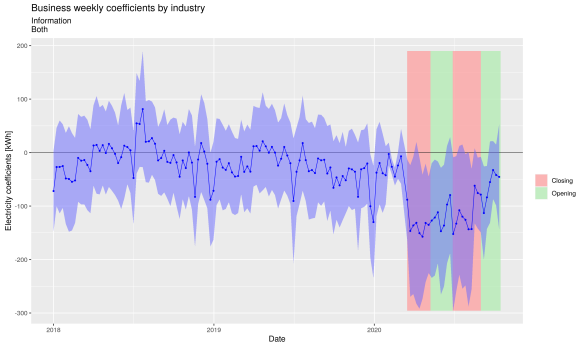

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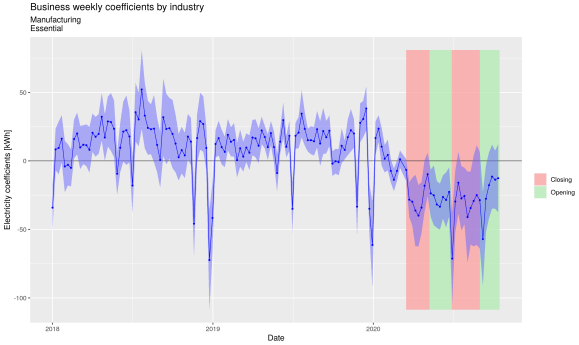
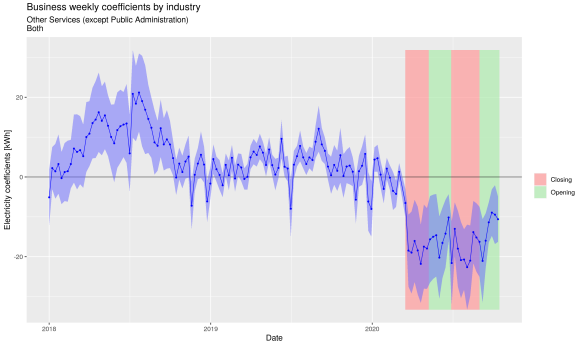
Shaded areas represent closing and opening periods within LA County.
Regression includes the following controls: business, day-of-week, and month-of-year fixed effects and month-of-year baseline electricity use.

Return

Change in electricity use by industry V



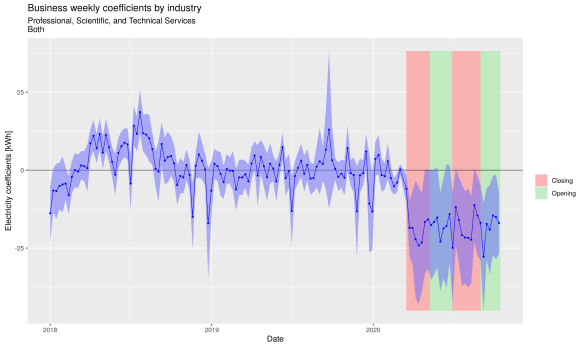
Businesses defined as name-account-address tuples.
Shaded areas represent closing and opening periods within LA County.
Regression includes the following controls: business, day-of-week, and month-of-year fixed effects and month-of-year baseline electricity use.



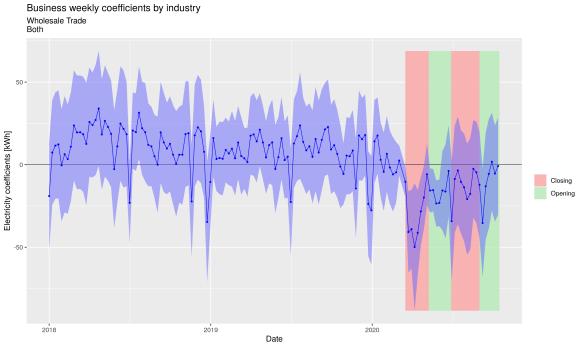
Businesses defined as name-account-address tuples.
Shaded areas represent closing and opening periods within LA County.
Regression includes the following controls: business, day-of-week, and month-of-year fixed effects and month-of-year baseline electricity use.

Return

Change in electricity use by industry VI



Businesses defined as name-account-address tuples.
Shaded areas represent closing and opening periods within LA County.
Regression includes the following controls: business, day-of-week, and month-of-year fixed effects and month-of-year baseline electricity use.



Businesses defined as name-account-address tuples.
Shaded areas represent closing and opening periods within LA County.
Regression includes the following controls: business, day-of-week, and month-of-year fixed effects and month-of-year baseline electricity use.

Return

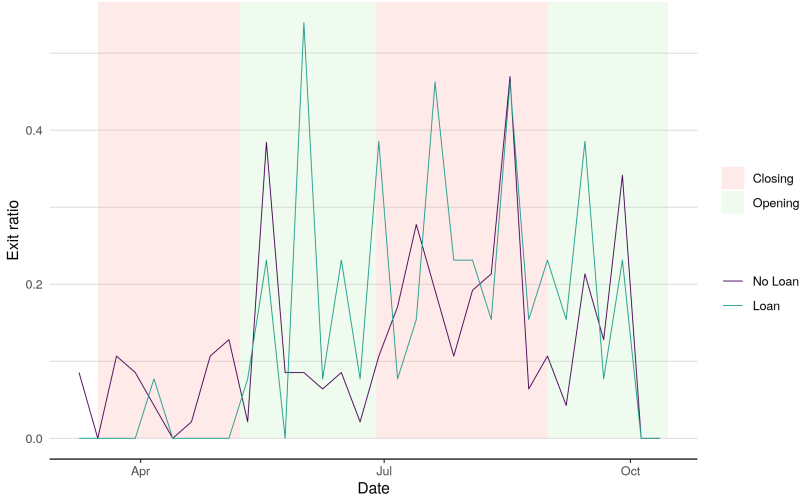
Change in electricity use by loans

	All Data		No Loan		Loan	
	(1)	(2)	(3)	(4)	(5)	(6)
Close-1 (2020-03-16)	−64.76***	−70.05***	−80.38***	−86.54***	−24.12***	−27.05***
	(−5.13)	(−5.38)	(−4.61)	(−4.82)	(−9.69)	(−10.69)
Open-1 (2020-05-08)	−51.29***	−60.78***	−64.99***	−76.47***	−15.49***	−19.59***
	(−4.01)	(−4.53)	(−3.68)	(−4.13)	(−6.63)	(−8.04)
Close-2 (2020-06-28)	−67.84***	−65.79***	−84.03***	−81.60***	−24.03***	−23.03***
	(−4.58)	(−4.48)	(−4.13)	(−4.04)	(−9.10)	(−8.80)
Open-2 (2020-08-31)	−26.16*	−45.60***	−32.26*	−55.48***	−9.86***	−19.02***
	(−2.28)	(−3.75)	(−2.04)	(−3.32)	(−4.25)	(−7.71)
Temperature		1.52***		1.91***		0.46***
		(5.69)		(5.24)		(7.23)
HDD		2.51***		2.90***		1.45***
		(8.49)		(7.20)		(17.30)
ID FE	X	X	X	X	X	X
Day-of-Week FE	X	X	X	X	X	X
Month-of-Year FE	X	X	X	X	X	X
Businesses	4,813	4,813	3,587	3,587	1,226	1,226
Observations	4,402,221	4,402,221	3,221,128	3,221,128	1,181,093	1,181,093
R^2	0.96	0.96	0.96	0.96	0.90	0.90
Adjusted R^2	0.96	0.96	0.96	0.96	0.90	0.90

Notes: Significance is represented as *** for p<0.001, ** for p<0.01, and * for p<0.05; while, *t*-statistics are in parentheses.

Return

Exit count by date & program



Return

Change in account numbers

	(1)	(2)	(3)	(4)	(5)
Close-1 (2020-03-16)	−0.62***	−0.47***	−0.45***	−0.47***	−0.46
	(0.09)	(0.10)	(0.10)	(0.10)	(0.33)
Open-1 (2020-05-08)	−1.00***	−1.05**	−0.96***	−1.00***	−1.00**
	(0.09)	(0.11)	(0.11)	(0.11)	(0.37)
Close-2 (2020-06-28)	−1.54***	−1.83***	−1.82***	−1.83***	−1.83***
	(0.08)	(0.09)	(0.09)	(0.09)	(0.36)
Open-2 (2020-08-31)	−2.18***	−2.43***	−2.28***	−2.26***	−2.28***
	(0.09)	(0.10)	(0.11)	(0.11)	(0.36)
Temp			−0.03***	−0.04***	−0.04***
			(0.01)	(0.01)	(0.01)
HDD				0.03	0.03***
				(0.02)	(0.01)
Industry-Zip FE	X	X	X	X	X
Month-of-Year FE		X	X	X	
IZ:Month-of-Year FE					X
Industry-Zips	68	68	68	68	68
Observations	9,820	9,820	9,820	9,820	9,820
R^2	0.09	0.10	0.10	0.10	1.00
Adjusted R^2	0.08	0.09	0.09	0.09	1.00

Notes: Significance is represented as *** for p<0.001, ** for p<0.01, and * for p<0.05; while, standard errors are in parentheses.

Return