Causal Effects of Closing Businesses in a Pandemic

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Research question

Effects of social distancing policies in response to pandemics

- In absence of vaccine or cure, governments typically impose drastic social distancing measures
- This raises important questions
  - Do these policies have a *causal* effect on contact rates and infections?
  - What is there economic cost?
- How should we think of the trade off?

This paper

Quantify the effects of state-mandated **business closures** on health and economic outcomes

- Exploit plausibly exogenous variations in **labor restrictions**
  - Staggered US state-mandated closure of "non-essential" businesses
  - Within-state variations in exposure to restrictions due to local industry composition
- Estimate the **elasticity of economic and health outcomes** to these restrictions
  - Economic outcomes: firms' employment, sales, profits and value
  - Health outcomes: infections and mortality

Preview of results

A 10 pp increase in the share of restricted labor leads to

- Economic outcomes
  - $\sim$ 10% drop in employment and hours
  - $\sim$ 2% decline in firm sales
  - $\sim$ 3% decline in firm value
- Health outcomes
  - A drop in infections by 2.3/10,000 weekly
  - A drop in Covid-19-related deaths by 0.15/10,000 weekly

These findings suggest that state-mandate business closures implied

- Lost value added $\sim$ \$115 billion (0.5% of GDP)
- Saved lives $\sim$ 24,000
- Cost per life saved $\sim$ \$4.8M

Roadmap

- State-mandated business closures
- Data
- Fim-level analysis
- Commuting-zone level analysis

State-mandated business closures

Focus on US states' Executive Orders closing businesses considered "non-essential"

- 45 states issued such orders between March 19 (California) and April 6 (Missouri)
- 35 of them had an explicit end date
- All but three where then extended
- We map each sector to 4-digit NAICS codes

State-mandated business closures

Example: Pennsylvania

Industry	Sector	Subsector	Industry Group	May Continue Physical Operations	Notes
In extenuating circumstances, special exemptions will be granted to businesses that are supplying or servicing health care providers.					
Natural Resources and Mining	Agriculture, Forestry, Fishing, and Hunting	Crop Production	Oilseed and Grain Farming	Yes	
			Vegetable and Melon Farming	Yes	
			Fruit and Tree Nut Farming	Yes	
			Greenhouse, Nursery, and Floriculture Production	Yes	
			Other Crop Farming	Yes	
		Animal Production	Cattle Ranching and Farming	Yes	
			Hog and Pig Farming	Yes	
			Poultry and Egg Production	Yes	
			Sheep and Goat Farming	Yes	
			Animal Aquaculture	Yes	
			Other Animal Production	Yes	
		Forestry and Logging	Timber Tract Operations	No	
			Forest Nurseries and Local Gathering of Forest Products	No	
			Logging	No	
		Fishing, Hunting, and Trapping	Fishing	Yes	
			Hunting and Trapping	Yes	
		Support Activites for Agriculture & Forestry	Support Activities for Crop Production	Yes	
			Support Activities for Animal Production	Yes	
			Support Activities for Forestry	No	
	Mining, Quarrying, and Oil and Gas Extraction	Oil and Gas Extraction		Yes	
		Mining	Coal Mining	No	
			Metal Ore Mining	No	
			Nonmetallic Mineral Mining and Quarrying	No	
		Support Activites for Mining		No	
Construction	Construction	Construction of Buildings	Residential Building Construction	No	
			Nonresidential Building Construction	No	
		Heavy and Civil Engineering Construction	Utility Subsystem Construction	No	
			Land Subdivision	No	
			Highway, Street, and Bridge Construction	No	
			Other Heavy and Civil Engineering Construction	No	
		Specialty Trade Contractors	Foundation, Structure, and Building Exterior Contractors	No	
			Building Equipment Contractors	No	
			Building Finishing Contractors	No	
			Other Specialty Trade Contractors	No	
			Animal Food Manufacturing	Yes	

Data

- Labor restrictions
  - List of closed sectors (and dates) from state Executive Orders
  - Work-from-home: occupation level from Dingel & Neiman (2020)
  - Local industry composition from County Business Patterns (CBP)
- Employment and Hours
  - High frequency from Homebase, weekly $\times$ county level
- Infections and deaths
  - Johnn Hopkins Univ Covid-19 Data, weekly $\times$ county level
- Firms
  - Stock returns and accounting data from Compustat
  - Establishment level headcount from Infogroup
- Other controls
  - Contact-intensive sectors: O*Net data
  - Share of adults with kids: American Community Survey
  - Demographics: US Census

Firm-level analysis

Exploit variations in firm-level exposure to restrictions

1. Compute employment weight of industry *ind* and state *state* in firm f:

$$\omega^{f}_{ind,state} = \frac{Emp_{ind,state}}{\sum_{ind,state} Emp_{ind,state}}$$

with $\sum_{ind} \sum_{state} \omega^{f}_{ind,state} = 1$.

2. Define the share of *RestrictedLabor* of firm f as:

$$RestrictedLabor_f = \sum_{ind} \sum_{state} \omega^{f}_{ind,state} \cdot Closed_{ind,state} \cdot (1 - work\text{-}at\text{-}home_{ind})$$

Empirical strategy

Difference-in-differences estimation with continuous treatment

- Panel regressions at Firm $\times$ Quarter level from 2019 to 2020:

$$Y_{f,t} = \mu + \xi.RestrictedLabor_{f,t} + \alpha_f + \delta_{ind \times t} + \gamma_{state \times t} + \epsilon_{f,t}$$

where

- $RestrictedLabor_{f,t}$: restricted labor share in firm f and quarter t
- Fixed effects: Firm, Sector $\times$ Quarter, State $\times$ Quarter

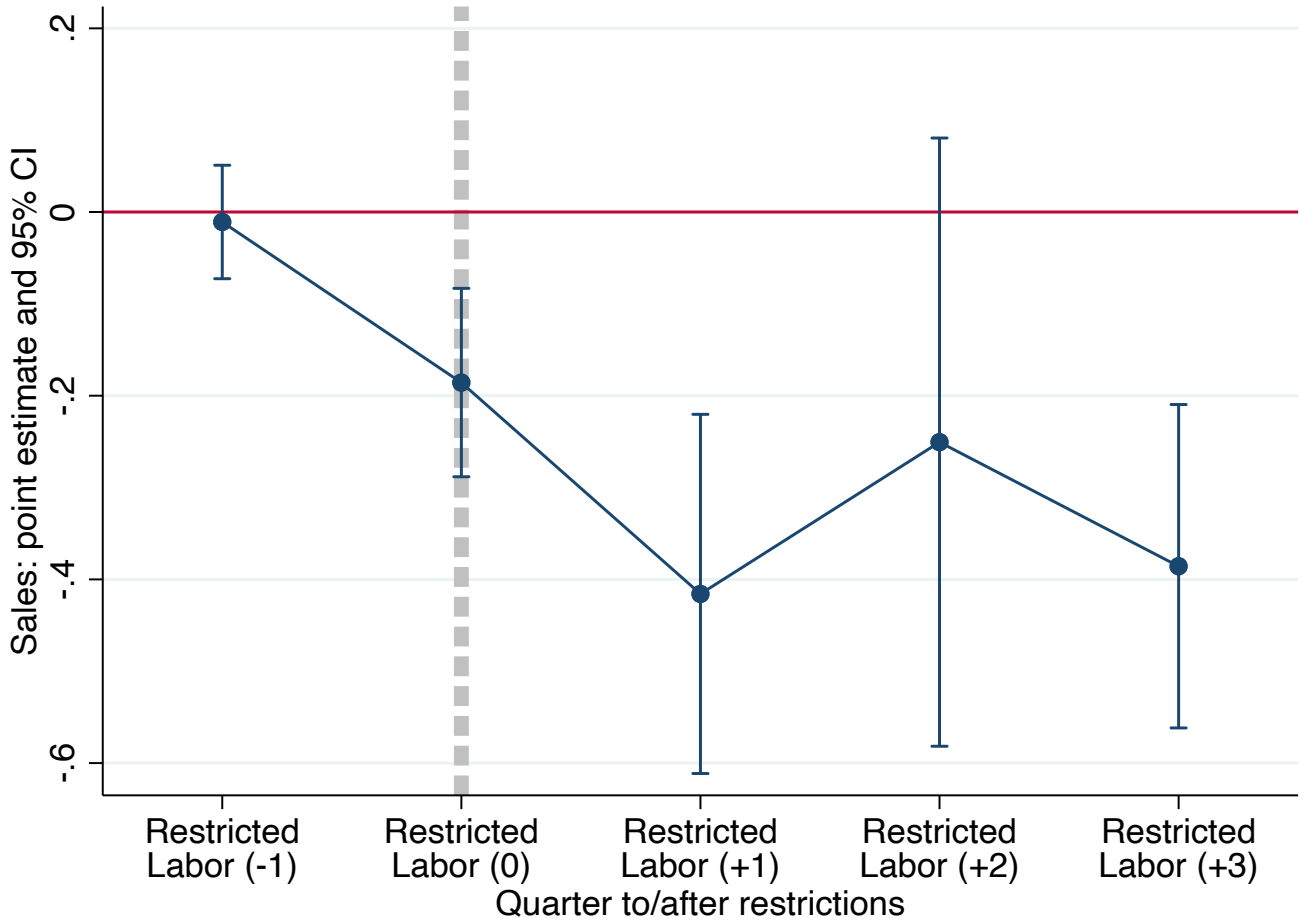
Effects on firms' sales and profits

10 pp ↑ in restricted labor share ⇒ ↓ sales by 2% and profits by 9%

	Panel A: Sales/Sales$_{2018}$			
Restricted Labor	-0.301***	-0.199**	-0.293***	-0.174**
	(0.072)	(0.088)	(0.071)	(0.078)
Firm FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	No	No	No
Sector × Quarter FE	No	Yes	No	Yes
State × Quarter FE	No	No	Yes	Yes
Obs.	12,621	12,621	12,621	12,621
R^2	0.609	0.659	0.626	0.668
	Panel B: Net Income/Sales			
Restricted Labor	-0.650**	-0.646**	-1.002***	-0.888**
	(0.284)	(0.320)	(0.277)	(0.362)
Firm FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	No	No	No
Sector × Quarter FE	No	Yes	No	Yes
State × Quarter FE	No	No	Yes	Yes
Obs.	12,621	12,621	12,621	12,621
R^2	0.757	0.785	0.764	0.792

Firms' sales

No prior trend



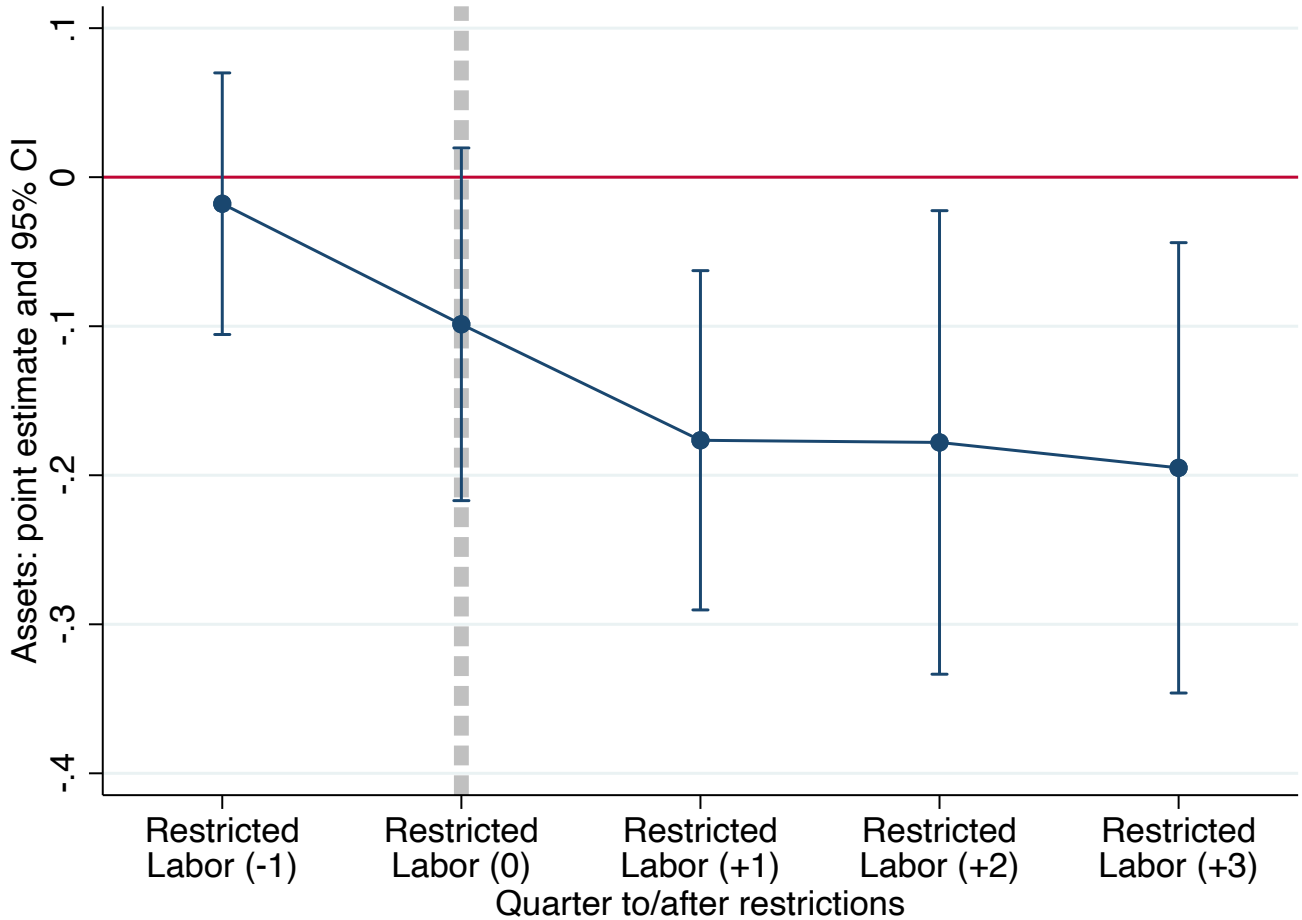
Firms' balance sheets

10 pp ↑ in restricted labor share ⇒ ↓ by 1% in book assets

	Assets/Assets$_{2018}$			
Restricted Labor	-0.155**	-0.083**	-0.171***	-0.105***
	(0.059)	(0.039)	(0.036)	(0.034)
Firm FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	No	No	No
Sector × Quarter FE	No	Yes	No	Yes
State × Quarter FE	No	No	Yes	Yes
Obs.	12,621	12,621	12,621	12,621
R^2	0.719	0.753	0.729	0.759

Firms' assets

No prior trends



Firms' value

10 pp ↑ in restricted labor share ⇒ ↓ in firm value by 3%

	Announcement Cum Returns (0,2)			
Restricted Labor	-0.370***	-0.298**	-0.374***	-0.299**
	(0.120)	(0.110)	(0.122)	(0.109)
Log(Market Cap)			-0.004	0.001
			(0.009)	(0.006)
B/M			-0.057*	-0.057**
			(0.032)	(0.021)
ROA			-0.184	-0.202***
			(0.117)	(0.059)
CAPX/Assets			0.405*	0.207
			(0.208)	(0.240)
Cash/Assets			0.068	-0.014
			(0.068)	(0.042)
β			-0.013	-0.001
			(0.017)	(0.016)
Debt/Assets			0.009	-0.002
			(0.039)	(0.034)
Sector FE	Yes	Yes	Yes	Yes
State FE	No	Yes	No	Yes
Obs.	1,286	1,286	1,286	1,286
R^2	0.163	0.378	0.178	0.387

CZ-level analysis

- Commuting zone (CZ) level analysis
  - Represent local labor markets (700+ in the US)
  - 4-5 counties per CZ
- Sample: Weekly data from January to October 2020
- Exploit within-state variations in employment share affected by state-level Executive Orders
- Define CZ-level share of $RestrictedLabor_{cz,state,t}$:

$$\sum_{ind \in industries} EmpWeight_{ind,cz} \cdot Closed_{ind,state,t} \cdot (1 - work\text{-}from\text{-}home\ share_{ind})$$

Empirical strategy

Difference-in-differences estimation with continuous treatment

- Panel regressions at Commuting Zone $\times$ Week level:

$$Y_{cz,state,t} = \mu + \xi.RestrictedLabor_{cz,t} + \rho.S_{cz,t} + \sigma_{cz} + \tau_{state \times t} + \epsilon_{cz,state,t}$$

- $RestrictedLabor_{cz,t}$: restricted labor share in cz in week t
- $S_{cz,t}$: CZ-level controls interacted with shutdown dummies
  - Urban, Density, Initial Infection, work-from-home share
  - Contact-intensive, dependent kids shares
  - Census demographic controls
  - Hospitals, ICU Beds, Trump vote share

Employment

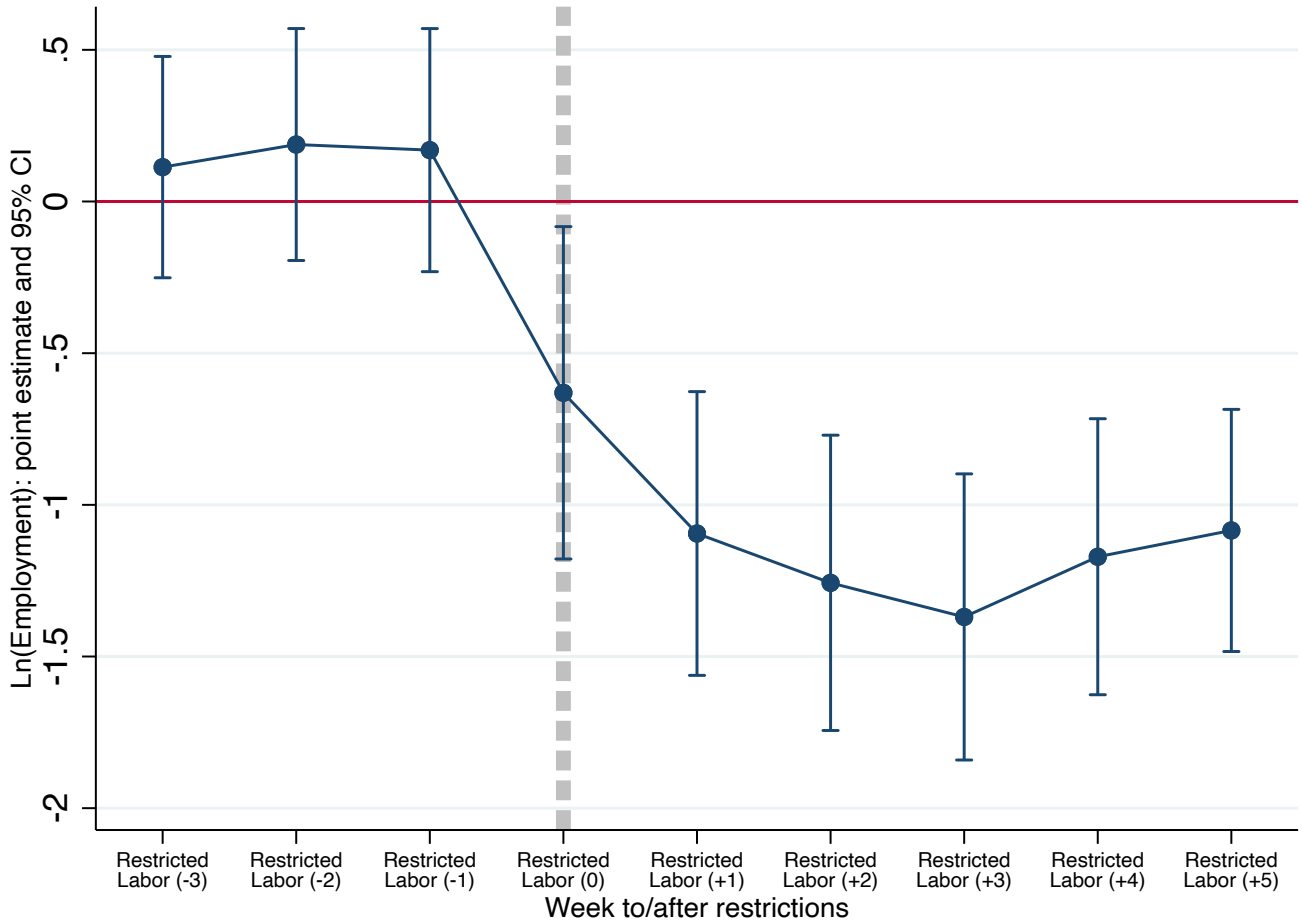
Strong relationship between restricted labor and employment

	Log(Employment)			
Restricted Labor $\times$ $I_{ShutDown}$	-0.559**	-0.550**	-0.577**	-0.554**
	(0.228)	(0.230)	(0.234)	(0.228)
CZ FE	Y	Y	Y	Y
State $\times$ Week FE	Y	Y	Y	Y
Urban, Density, Infection, WFH $\times$ $I_{ShutDown}$	Y	Y	Y	Y
Contact-Intensive, Kids Share $\times$ $I_{ShutDown}$		Y	Y	Y
Census Controls $\times$ $I_{ShutDown}$			Y	Y
Hospitals, ICU Beds, Trump Share $\times$ $I_{ShutDown}$				Y
Obs.	31,463	31,463	31,463	31,463
R^2	0.996	0.996	0.996	0.996

Note: Almost 1-to-1 relationship between restricted labor and hour

Employment: dynamics

No prior trends



Health outcomes: Infections

10 pp ↑ in restricted labor share ⇒ ↓ by 2.3 infected per 10,000

	New Covid-19 Infections per 10,000 (T+1)			
Restricted Labor × $I_{ShutDown}$	-26.631**	-26.862**	-23.529**	-23.268**
	(11.348)	(11.477)	(11.012)	(10.908)
CZ FE	Y	Y	Y	Y
State × Week FE	Y	Y	Y	Y
Urban, Density, Infection, WFH × $I_{ShutDown}$	Y	Y	Y	Y
Contact-Intensive, Kids Share × $I_{ShutDown}$		Y	Y	Y
Census Controls × $I_{ShutDown}$			Y	Y
Hospitals, ICU Beds, Trump Share × $I_{ShutDown}$				Y
Obs.	31,463	31,463	31,463	31,463
R^2	0.856	0.856	0.859	0.859

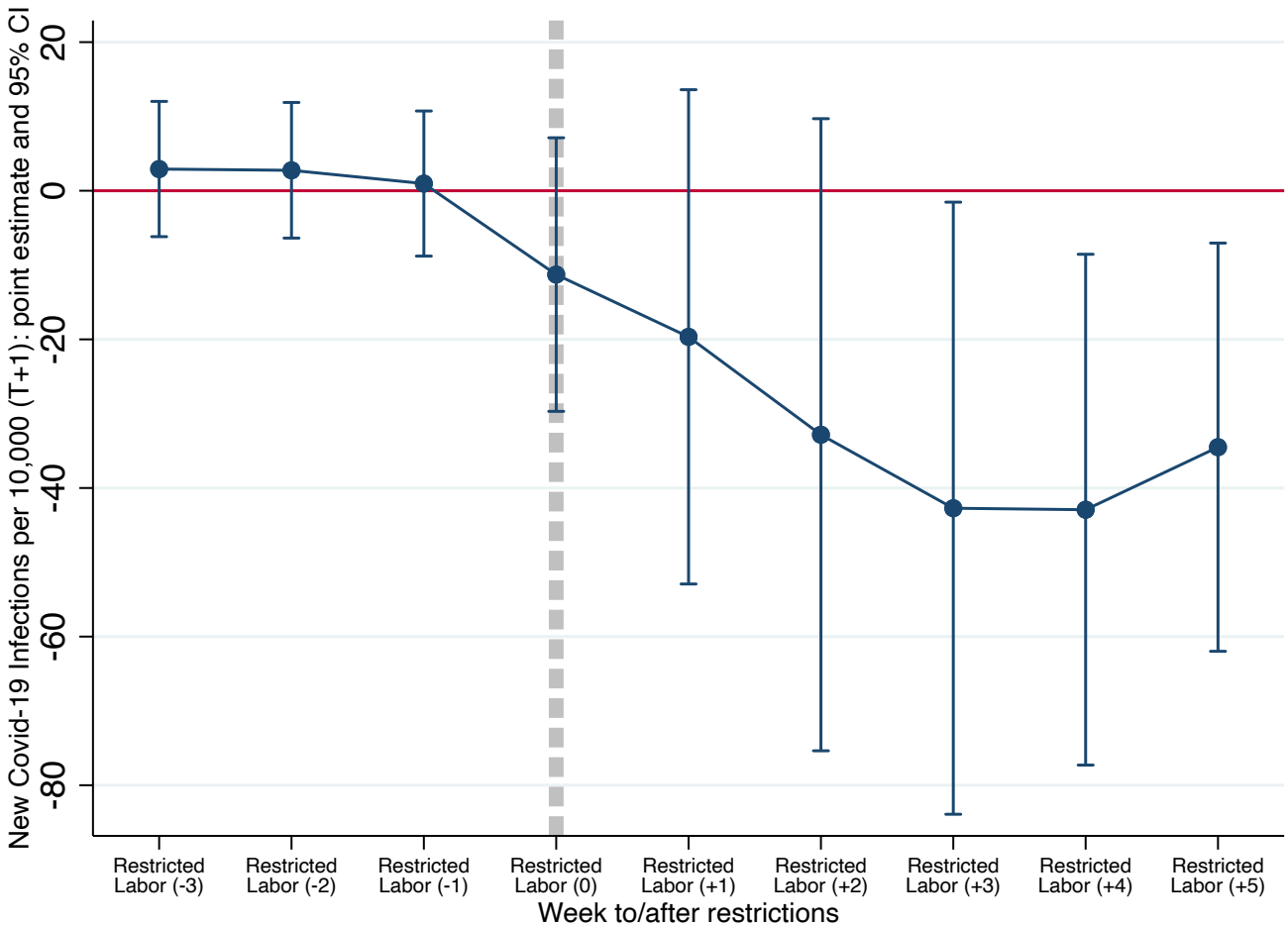
Health outcomes: Mortality

10 pp ↑ in restricted labor share ⇒ ↓ 0.15 death per 10,000

	New Covid-19 Deaths per 10,000 (T+1)			
Restricted Labor × $I_{ShutDown}$	-1.501***	-1.534***	-1.435***	-1.448***
	(0.493)	(0.499)	(0.493)	(0.496)
CZ FE	Y	Y	Y	Y
State × Week FE	Y	Y	Y	Y
Urban, Density, Infection, WFH × $I_{ShutDown}$	Y	Y	Y	Y
Contact-Intensive, Kids Share × $I_{ShutDown}$		Y	Y	Y
Census Controls × $I_{ShutDown}$			Y	Y
Hospitals, ICU Beds, Trump Share × $I_{ShutDown}$				Y
Obs.	31,463	31,463	31,463	31,463
R^2	0.724	0.725	0.728	0.729

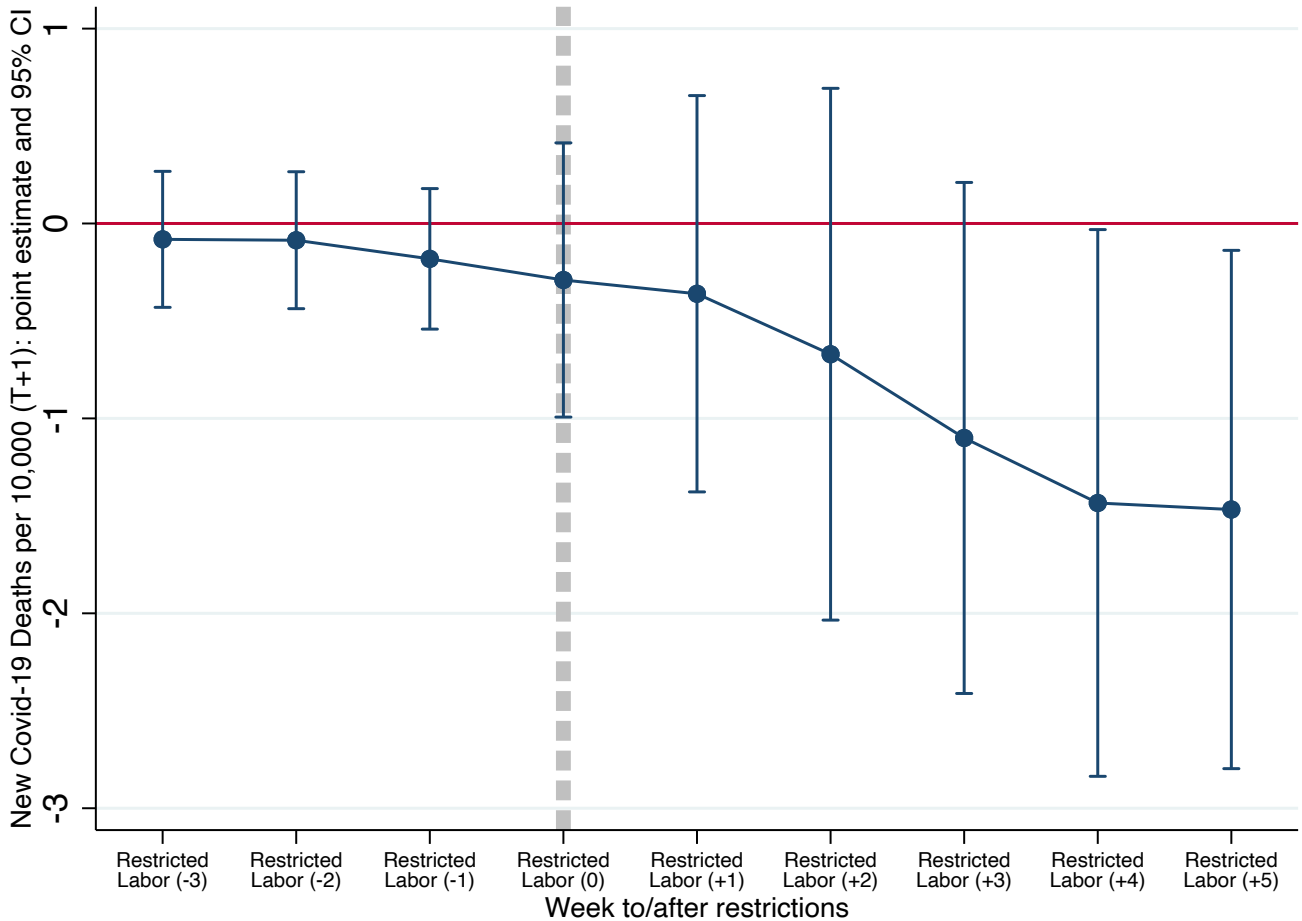
Infections: Dynamics

No prior trends in infections



Deaths: Dynamics

No prior trends in mortality



Health Outcomes: Low versus high-contact CZ

Effects of restrictions on health outcomes only apply in high contact CZ

New Covid-19 Infections per 10,000 (T+1)				
Restricted Labor $\times$ $I_{ShutDown}$	-10.165	-10.224	-8.465	-8.206
	(10.185)	(10.295)	(9.482)	(9.489)
Restricted Labor $\times$ $I_{ShutDown}$ $\times$ High Contact CZ	-10.513***	-10.637***	-9.674**	-9.678**
	(3.653)	(3.732)	(3.732)	(3.809)
New Covid-19 Deaths per 10,000 (T+1)				
Restricted Labor $\times$ $I_{ShutDown}$	-0.524	-0.534	-0.473	-0.484
	(0.437)	(0.443)	(0.442)	(0.445)
Restricted Labor $\times$ $I_{ShutDown}$ $\times$ High Contact CZ	-0.624***	-0.640***	-0.618***	-0.620***
	(0.139)	(0.144)	(0.138)	(0.139)

Health Outcomes: Low versus high-contact CZ

... yet effects of restrictions on labor outcomes apply everywhere

	Log(Employment)			
Restricted Labor $\times$ $I_{ShutDown}$	-0.653**	-0.646**	-0.659**	-0.644**
	(0.289)	(0.288)	(0.302)	(0.292)
Restricted Labor $\times$ $I_{ShutDown}$ $\times$ High Contact CZ	0.060	0.062	0.053	0.058
	(0.100)	(0.101)	(0.098)	(0.097)
	Log(Hours)			
Restricted Labor $\times$ $I_{ShutDown}$	-0.829***	-0.831***	-0.855***	-0.833***
	(0.284)	(0.284)	(0.303)	(0.291)
Restricted Labor $\times$ $I_{ShutDown}$ $\times$ High Contact CZ	0.065	0.068	0.053	0.058
	(0.105)	(0.105)	(0.104)	(0.102)

Cost-benefit analysis

Implied cost per life saved?

- Cost (for 37 days):
  - US employment 158 million
  - Weekly value added per worker: \$2,600
  - Coefficients imply 8.3 million employment drop per week

  $\Rightarrow$ Total loss: $\sim$ \$115 billion or 0.5% of GDP

- Lives saved (for 37 days):
  - US population 328 million
  - Coefficients imply 4,500 lives saved per week

  $\Rightarrow$ Total lives saved: $\sim$ 24,000

$\Rightarrow$ **Cost per life saved: $\sim$ \$4.8 million**

- Might have been lower if restrictions had only applied to CZs with high contact-intensity

Conclusion

Exploit variations in mandated business closures to estimate the effect of labor restrictions on economic and health outcomes

What do we learn?

- **Significant *causal* effect of labor restrictions on employment, firm value, Covid-19-related infections and deaths**
- Drop in GDP by $\sim$ \$115bn or 0.5%
- $\sim$ 24,000 lives saved
- Cost per life saved $\sim$ \$4.8M
- Might have been lower if restrictions had only applied to CZs with high contact-intensity