Online Appendices for

UNEMPLOYMENT INSURANCE TAXES AND LABOR DEMAND: QUASI-EXPERIMENTAL EVIDENCE FROM ADMINISTRATIVE DATA

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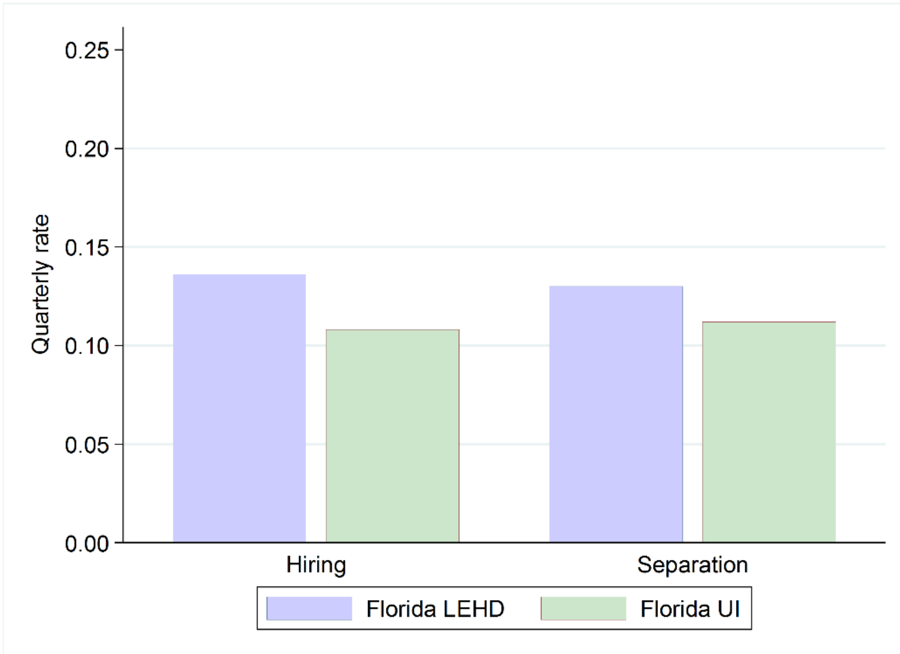
January 2020

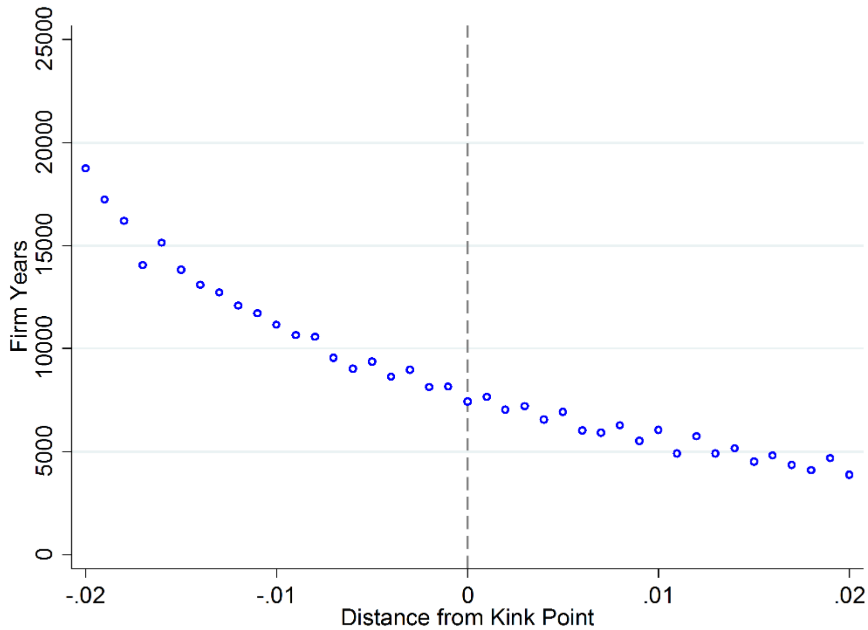
Online Appendix A: Additional Results

Online Appendix Figure 1



Note.—This figure shows how the quarterly rates of hiring and separation compare in the Florida UI data and in the LEHD files covering Florida. The rates suggested here in administrative data are much higher than in survey data, but are similar to other administrative records.

Online Appendix Figure 2

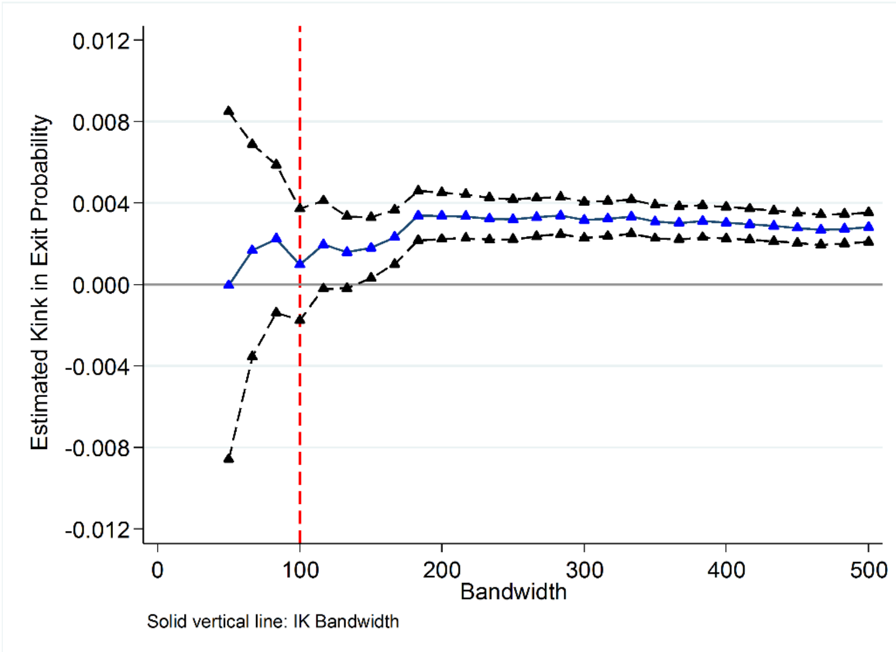


Smoothness of Firm Density around Florida Tax Kink

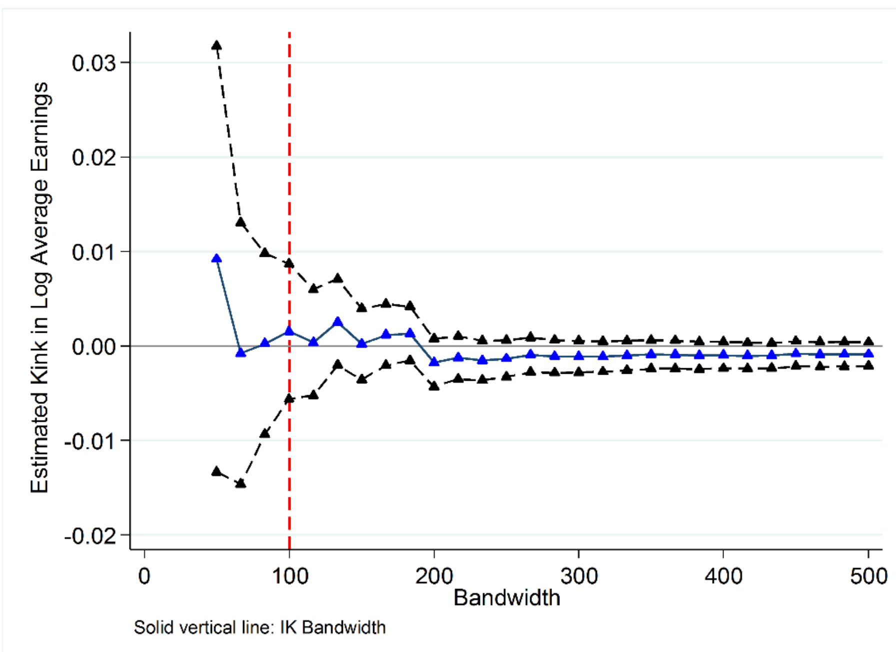
Note.—This figure plots the number of rated firms (firm-years) in bins around the kink point. The vertical line indicates the location of the kink point. There is no bunching in the density, and the number of observations is smooth around the kink with no visible change in the slope. Data are from Florida DEO.

Online Appendix Figure 3: RKD Estimates with Varying Bandwidths

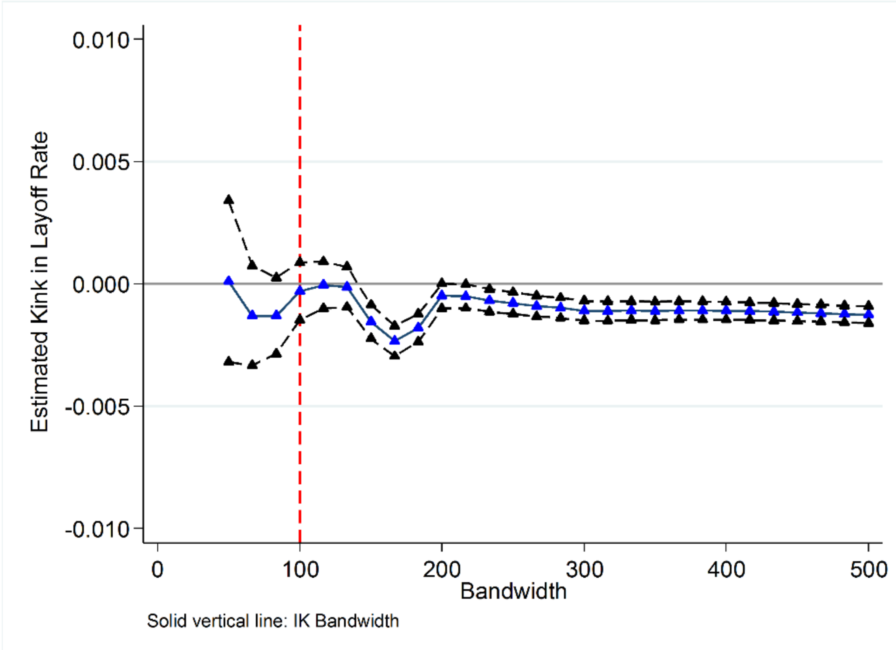
Panel A: Effect on Exit Probability



Panel B: Effect on Log Average Earnings

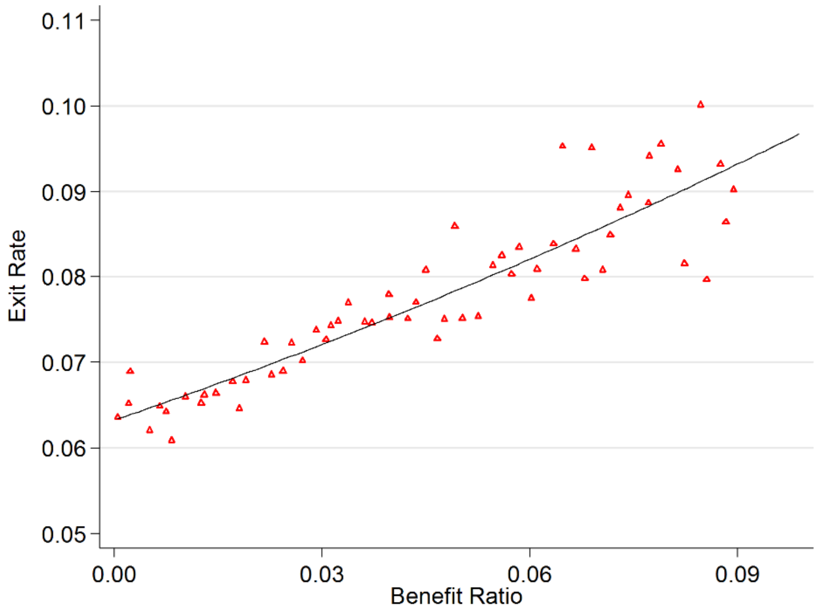


Panel C: Effect on Layoff Rate



NOTE.— Each center triangle represents the estimated effect of UI taxes at a given bandwidth with the accompanying standard errors. The red dashed line represents the optimal IK bandwidth. Administrative data are from Florida DEO.

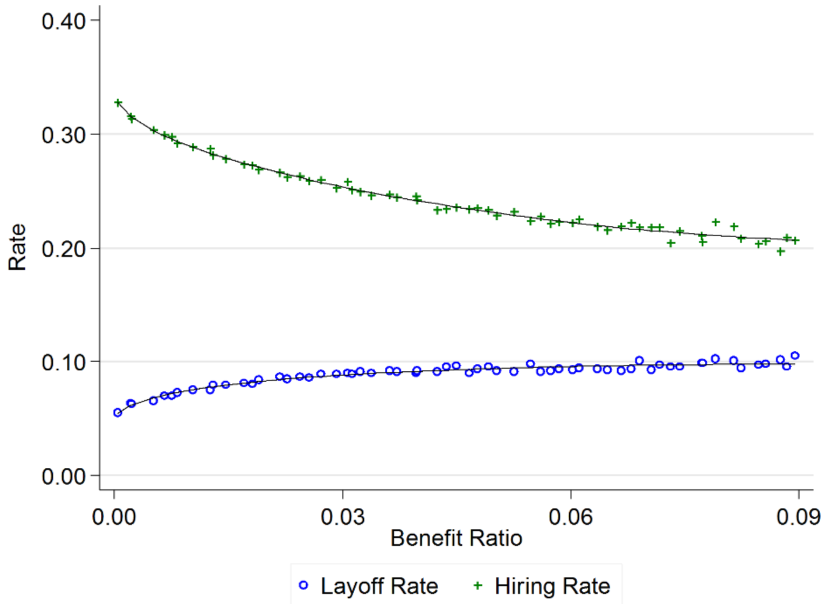
Online Appendix Figure 4



Firm Exit and the Benefit Ratio

Note.—This figure plots the rate of firm exit along the benefit ratio to demonstrate that financial distress inclines with the benefit ratio. Data from Florida DEO.

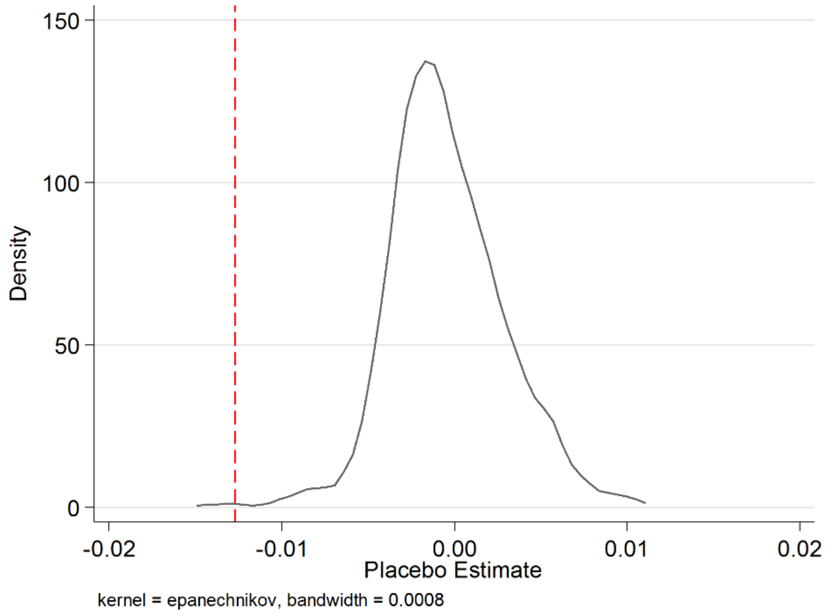
Online Appendix Figure 5



Measures of Firm Health as the Benefit Ratio Evolves

Note.—This figure plots the rate of firm layoffs and hiring over the benefit ratio. Low rates of hiring and high rates of layoffs are associated with higher benefit ratios, suggesting firm distress. Notice that hiring rates do not kink in this figure because the placement of the kink point changes yearly depending on the tax formula. The data are from Florida DEO.

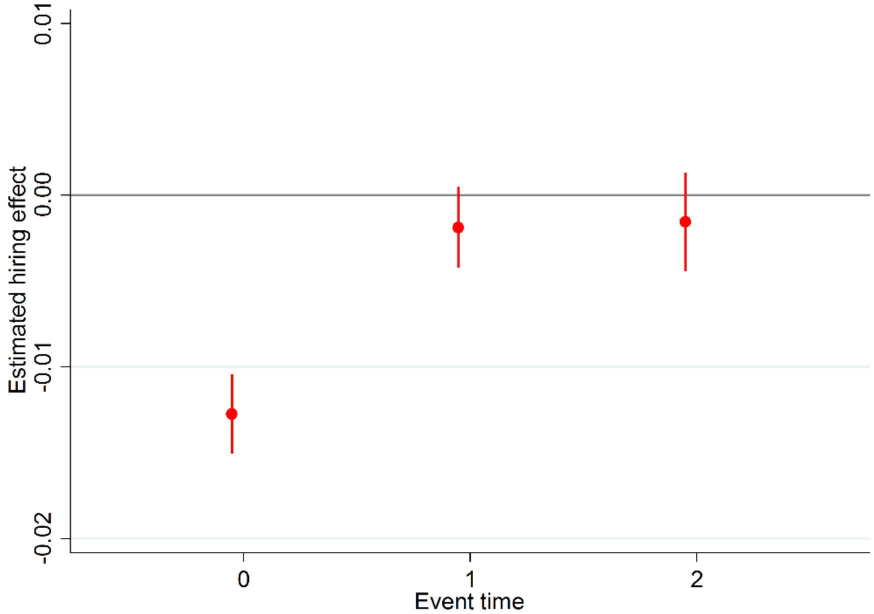
ONLINE APPENDIX FIGURE 6



EMPIRICAL DISTRIBUTION OF RKD PLACEBO ESTIMATES

NOTE.—This figure plots the empirical distribution of the RKD placebo estimates on hiring. I estimate the RKD at each point from the minimum running variable to 0.5 (on a scale that goes from 0.0 to 99.99) while keeping the bandwidth constant. I exclude points in the region of the true kink and points with sparse data at the left boundary. This process produces 450 placebo estimates, only one of which is smaller than estimate from the actual kink.

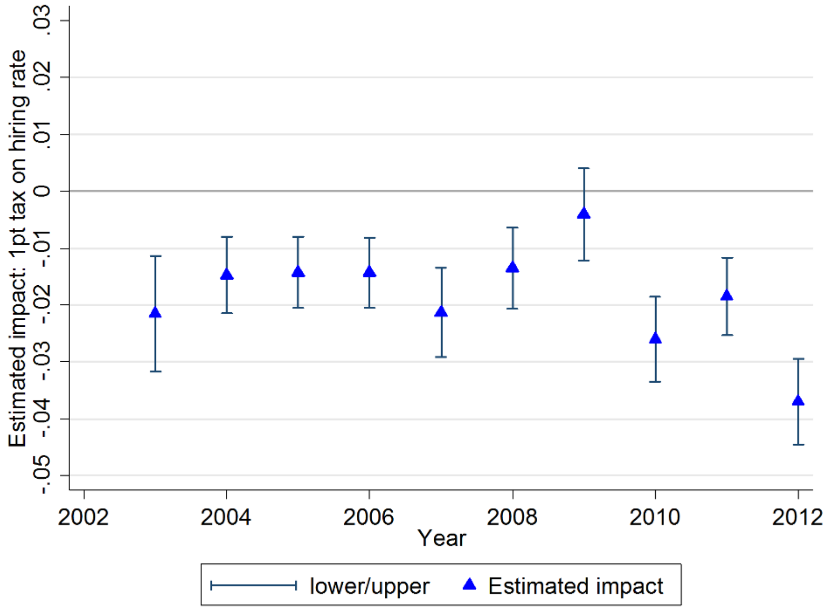
Online Appendix Figure 7



Lagged Effects of UI tax Rates

Note.—The plotted points represent the estimated effect of a 1-point tax increase on the hiring rate at event time t, estimated using the preferred specification with the optimal bandwidth, year fixed effects, and firm fixed effects.

Online Appendix Figure 8



Impact of Tax Kink Over Business Cycle

Note.—The triangles represent the estimated effect of a 1-point tax increase on the hiring rate in each year; I estimate these coefficients by interacting tax rates, the running variable, and the kink instrument with year fixed effects. The estimation accounts for year and firm fixed effects and uses the IK-optimal bandwidth.

Online Appendix Tables

Online Appendix Table 1—Florida Tax Formula Parameters over Time

Year	α (1)	λ (2)
2003	0.0013	0.3380
2004	0.0035	0.6000
2005	0.0042	0.6516
2006	0.0032	0.6187
2007	0.0009	0.3652
2008	0.0009	0.3524
2009	0.0012	0.3438
2010	0.0036	0.4171
2011	0.0103	0.5833
2012	0.0151	0.9074

Note.—This table presents the parameter values for Florida's UI tax formula in each year.

Online Appendix Table 2—First Stage: The Influence of the Kink on Firm Tax Rates

	Tax rate (1)	Tax rate (2)	Tax rate (3)
Kink instrument	-152.80	-146.06	-148.38
	(0.094)	(0.112)	(0.105)
Running variable	152.91	145.62	150.25
	(0.087)	(0.097)	(0.073)
Constant	5.35	5.34	5.36
	(0.001)	(0.001)	(0.002)
Year FE		X	X
Firm FE			X
R-squared	0.973	0.973	0.987
F-statistic	9,220,000	1,880,000	1,030,000
Observations	337,829	337,829	337,829

Note.—This table presents the first stage to evaluate the power of the kink as an instrument on UI tax rates using a single kink (i.e., not allowing the kink to differ by year) so as to show the general tendency of the first stage.

Online Appendix Table 3—First Stage:
How much Tax-Rate Variation is Explained by Yearly Kinks?

	Tax rate (1)	Tax rate (2)	Tax rate (3)	Tax rate (4)
R-squared	0.825	0.831	0.985	0.999
Running variable	X	X	X	X
Kink indicator		X	X	X
Single kink IV			X	
Yearly kink IV				X
Observations	337,829	337,829	337,829	337,829

Note.—This table presents the proportion of the tax-rate variation that is explained by various first-stage specifications, including interacting the kink variation with yearly indicators to allow the kink to differ each year.

ONLINE APPENDIX TABLE 4—BALANCE TEST:
PREDICTED OUTCOMES ACROSS THRESHOLD

Outcome	RKD (1)	RKDFE (2)	RKDFE (3)	RKDFE (4)	RKD (5)
Hiring rate (×10)	0.002	0.002	0.002	-0.001	0.001
	(.000)	(.000)	(.000)	(.000)	(.001)
Employment (%Δ) (×10)	0.001	0.001	0.002	0.001	0.006
	(.001)	(.001)	(.001)	(.002)	(.004)
Firm exit (×10)	0.000	0.000	-0.001	0.001	0.000
	(.000)	(.000)	(.000)	(.001)	(.002)
Log earnings (%) (×10)	0.003	0.002	0.001	-0.001	-0.008
	(.003)	(.003)	(.001)	(.003)	(.009)
Layoff rate (×10)	0.000	0.000	0.000	0.000	0.000
	(.000)	(.000)	(.000)	(.000)	(.000)
Controls					
Year fixed effects	X	X	X	X	X
Firm fixed effects		X	X	X	
Linear control	X	X	X		X
Quadratic control				X	
Bandwidth (times optimal)	1	1	2	2	½

NOTE.—This table serves as a covariate balance test. I use predetermined covariates (firm age, firm age squared, year, entity type, county, and detailed industry code) to predict each outcome. Then I use these predicted outcomes and estimate placebo kinks. The estimates are precise, small, and very close to zero, suggesting that in absence of the tax kink, outcomes would likely be smooth across the kink.

Online Appendix Table 5—Pre-Trend Differences at the Kink Point

	Emp (%Δ) (1)	Hiring Rate (2)	Layoff Rate (3)
Panel A: Year $t-2$			
Estimated discontinuity	0.001	0.000	0.000
	(0.001)	(0.008)	(0.002)
Observations	537,965	735,057	741,480
Bandwidth	0.041	0.023	0.021
DV mean	-0.002	0.340	0.054
Panel B: Year $t-3$			
Estimated discontinuity	-0.001	0.001	0.001
	(0.001)	(0.009)	(0.002)
Observations	431,848	638,530	643,031
Bandwidth	0.021	0.023	0.024
DV mean	0.002	0.341	0.050

Note.—This table presents the pre-trends in employment across the kink point using a local-linear regression discontinuity design within the optimal bandwidth and a standard kernel.

ONLINE APPENDIX TABLE 6—MAIN RKD PLACEBO ESTIMATES

Outcome	RKD (1)	RKDFE (2)	RKDFE (3)	RKDFE (4)	RKD (5)
Hiring rate (t–3)	0.002	0.001	0.007	-0.010	0.002
	(.003)	(.003)	(.002)	(.004)	(.008)
Employment (%Δ) (t–3)	0.016	0.019	0.048	-0.004	0.015
	(.008)	(.009)	(.004)	(.012)	(.029)
Firm exit (t+3)	0.003	0.002	0.001	0.001	0.004
	(.002)	(.002)	(.001)	(.002)	(.005)
Log earnings (t–3)	0.010	0.004	0.008	0.001	-0.014
	(.003)	(.003)	(.001)	(.003)	(.009)
Layoff rate (t–3)	0.003	0.003	0.007	0.004	-0.001
	(.001)	(.001)	(.000)	(.001)	(.002)
Controls					
Year fixed effects	X	X	X	X	X
Firm fixed effects		X	X	X	
Linear control	X	X	X		X
Quadratic control				X	
Bandwidth (times optimal)	1	1	2	2	½

NOTE.—This table serves as a placebo test in which each coefficient reflects the causal estimate from a separate regression. I use the same specifications as those in the main results but use outcome variables from a placebo year. Recall that the cost of a given layoff affects a firm's benefit ratio, and thus tax rate, for multiple years; thus, tax rates for a given firm are serially correlated even when layoffs are not. The kink in year *t*, for instance, predicts tax rates one and two years away, but not three, which is why placebos use period *t-3*. Since there is no exit prior to observing a tax rate, the placebo uses future exit.

Online Appendix Table 7—Timing of Hiring Effect over the Year

Outcome	RKDFE Hiring Q1 (1)	RKDFE Hiring Q2 (2)	RKDFE Hiring Q3 (3)	RKDFE Hiring Q4 (4)	RKDFE Total hiring (5)
Estimated effect	-0.002	-0.004	-0.005	-0.001	-0.012
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Controls					
Year fixed effects	X	X	X	X	X
Firm fixed effects	X	X	X	X	X
Linear control	X	X	X	X	X
Bandwidth (× optimal)	1	1	1	1	1

Note.—This table demonstrates how the tax affects firm hiring over the year. The effect is concentrated in Q2 and Q3, when the bulk of the UI tax bill is due.

Online Appendix Table 8—Estimated Effect in Industry Subgroups

Outcome	RKDFE Mining (1)	RKDFE Manufact. (2)	RKDFE Construc. (3)	RKDFE Tran/Com (4)	RKDFE Wholesale (5)	RKDFE Retail (6)	RKDFE Fin/Ins/Rl (7)	RKDFE Services (8)
Hiring rate	-0.042	-0.059	-0.003	-0.051	-0.003	-0.034	-0.006	-0.013
	(.066)	(.017)	(.015)	(.010)	(.057)	(.012)	(.008)	(.012)
Employment (%Δ)	-0.165	-0.068	-0.004	-0.044	-0.089	-0.032	-0.002	-0.011
	(.116)	(.036)	(.024)	(.018)	(.131)	(.026)	(.019)	(.021)
Exit	0.005	-0.003	0.000	0.005	-0.008	-0.002	0.005	0.012
	(.019)	(.008)	(.007)	(.005)	(.018)	(.004)	(.006)	(.007)
N	8,072	33,945	66,376	125,103	8,883	159,471	64,127	87,560
Average emp.	68.3	67.8	30.4	66.4	109.5	63.8	46.5	56.5
Firm/Year FE	X	X	X	X	X	X	X	X
Linear control	X	X	X	X	X	X	X	X

Note.—This table presents RKD estimates of the tax for each major industry group. Each coefficient reflects the causal estimate from a separate regression within a major industry group using the preferred specification from the main results.

Online Appendix Table 9—Test for Cash Constraints at the Kink: Panel Estimates of Deterrence in Florida

Outcome	Panel (1)	Panel (2)	Panel (3)	Panel (4)	IV-BW1 (5)	IV-BW2 (6)
Layoff rate (×10)	-0.008	0.083	0.007	0.004	0.009	0.004
Cls. st. err.	(0.002)	(0.002)	(0.004)	(0.004)	(0.012)	(0.006)
(Ave=.043)						
Temp. layoff rate (×10)	-0.003	0.002	0.000	-0.001	0.002	0.002
Cls. st. err.	(0.000)	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)
(Ave=.002)						
All separations rate	0.016	0.005	0.000	-0.001	-0.001	-0.002
Cls. st. err.	(0.000)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)
(Ave=.287)						
Year fixed effects	X	X	X	X	X	X
Firm fixed effects		X	X	X	X	X
Benefit ratio polynomial			X	X	X	X
Log size				X		
Observations	694,541	694,541	694,541	694,541	254,956	413,937

Note.—Each coefficient represents the causal estimate of a 1-point implicit tax penalty on a separation behavior indicated in the left column. Data from Florida DEO.

Online Appendix Table 10—Hiring Response by High- and Low-Wage Firms

Outcome	RKD (1)	RKDFE (2)	RKDFE (3)	RKDFE (4)	RKD (5)
Hiring rate effect	-0.025	-0.022	-0.020	-0.035	-0.025
among low-wage firms	(0.002)	(0.003)	(0.002)	(0.004)	(0.006)
Hiring rate effect	-0.006	-0.005	-0.006	-0.023	0.003
among high-wage firms	(0.005)	(0.005)	(0.002)	(0.007)	(0.014)
Difference	-0.019	-0.017	-0.015	-0.012	-0.028
	(0.005)	(0.006)	(0.003)	(0.008)	(0.015)
Controls					
Year fixed effects	X	X	X	X	X
Firm fixed effects		X	X	X	
Linear control	X	X	X		X
Quadratic control				X	
Bandwidth (times optimal)	1	1	2	2	½

NOTE.—This table presents estimates of the effect of tax rates among firms that paid above-median quarterly earnings and below-median quarterly earnings over the data period, and the analysis is bifurcated into these two subsamples. The row labeled "Difference" presents the difference between the hiring effect among high- and low-wage firms.

Online Appendix Table 11—Labor Demand Elasticities in Related Work

Study	LD Elasticity Equivalent	Setting	Data	Empirical Design	Data Years	Explanation for Large Response by Authors
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Elasticities from Targeted Tax and Subsidy Programs						
Johnston (2020)	-4	UI tax variation in Florida	Administrative worker earnings and firm files	Regression Kink Design, comparing firms around the kink, including with firm FE.	2003-2012	Firm-specific tax variation, targeting cash-constrained firms, head tax.
Saez, Schoefer, and Seim (AER 2019)	-0.2	Studies a payroll tax rate cut for young workers in Sweden (younger than 26)	Administrative worker earning file and firm tax data from the Tax Agency 2003-2013.	Difference-in-difference design using young workers that didn't quality for the tax relief as a control group.	Changes occurred in 2007-2009	
Cahuc, Carcillo, Le Barbanchon (ReStud 2018)	-4	Hiring credits in France during the Great Recession	Administrative worker earnings and firm files	DiD comparing trends eligible small firms (≤10 employees) with slightly larger firms (11-14 employees).	2005-2009	Not anticipated (no ability to reduce wages), temporary, and targetted at low-income jobs.

Kramarz and Philippon (JPubEc 2001)	**-1.5**	Studies impact of French payroll tax subsidies for low-wage workers	French Labor Force survey (Enquete Emploi)	DiD comparing minimum-wage workers to those earning more than the minimum.	1990-1998	Wages fixed by minimum-wage law, only margin available is employment. Apparently not the result of substitution.
Anderson & Meyer (JPubEc 1997)	**-2.3** [-1.4, -3.2]	Elasticity estimates come from changes in industry-level UI tax rates	Continuous Wage and Benefit History (CWBH) project	Changes-in-changes design (changes in employment regressed on changes in tax rates).	1978-1984	If all firms face a tax hike, taxes can be passed on to workers in the form of lower earnings. If firms face different taxes, the firm cannot reduce wages more than other firms, so must reduce employment.

Elasticities from Standard Payroll Tax

Kugler and Kugler (2009)	[-0.4, -0.5]	Studies the rise in payroll taxes in Colombia during the 1980s and 1990s	Panel of manufacturing plants	Changes-in-changes design (changes in employment regressed on changes in tax rates).	1982-1996	Potentially tax increases shifted employment to the informal sector.

Heckman and Pages (2003)	**-1** (OECD) **-0.45** (Latin America)	Estimates from panel data of countries	Compiles data from Latin American Household Surveys and various supplemental data from the UN Population database and World Bank Development Indicators	Within-country changes identify the elasticity.	1983-1999	
Gruber (JOLE 1997)	**-0.26** (insignificant)	Large reduction in payroll taxes in Chile from 1979-1986 arising from the privitization of social security	Survey of manufacturing plants in Chile	Changes-in-changes design in which the tax change is instrumented by the geographic area leveraging spatial differences in tax reductions.	1979-1986	
Traditional Labor-Demand Elasticities						
Beaudry, Green, and Sand (AER 2018)	**-1** at the city-industry level **-0.3** at the city level	American cities and city-industries over time using Bartik-type variation	1970-2000 U.S. Censuses; American Community Survey for 2007-08 and 2014-15	A Bartik-type instrument with long-differences (decadal) for city-industry wages based on the wages of the outside options for workers in that particular industry-city cell.	1970-2015	The employment effects of city-wide increases may be partly offset by reductions in labor-market tightness and search externalities.

Lichter, Peichl, and Siegloch (EER 2015)	**-0.55**	Meta analysis of labor-demand studies from around the world	Hand-collected data on 1,334 elasticity estimates from 151 studies on labor demand	Meta-regression analysis.	1947-2009 (data in papers span those years)	Studies using panel data find larger elasticities (partial = -0.25); larger elasticities from administrative data (partial = -0.12); larger elasticities for low-skilled workers (partial =-0.21); larger elasticities over time (partial = -0.08 per decade).
Acemoglu, Autor, and Lyle (JPE 2004)	**[-1.2, -1.5]**	Study the impact on wages of exogenous increases in female labor supply from differential male mobilization during WWII	1940-1960 U.S. Census	Instrumental variables using various demographic predictors of male mobilization during WWII.	1940-1960	
Borjas (QJE 2003)	**-0.4**	Leverages immigration exposure across education-experience cells.	1960-1990 U.S. Census and CPS from 1998-2001	Leverages variation across schooling groups, experience cells, and over time among local immigrant populations.	1960-2001	Argues that this is likely near the true value at the aggregate level (may be larger in absolute value for cost changes that affect some firms but not others).
Hamermesh (1993)	**-0.39**	Meta analysis of labor-demand studies from North America and Europe	Hand-collected elasticity estimates from ˜70 studies. Covers an older literature that held output fixed	Mean of estimates.	1968-1990 (papers published in those years)	

NOTE.—This table compares estimates of labor-demand elasticity. Column (1) lists the article evaluating each relationship between employment and effective wages; column (2) reports the estimated labor demand elasticity from that study. Column (3) describes the geographic setting and the source of variation. Column (4) describes the data used in the paper. Column (5) describes the research design. Column (6) describes what years are covered by the data and variation. And Column (7) provides any rationale that the authors give for the size of the elasticity they recover.

Online Appendix Table 12—Assessment of Generalizability

Outcome	Employment Δ (1)	(2)	(3)
Panel A: Florida data			
RateΔ	-0.049***	-0.012***	-0.012***
	(.001)	(.002)	(.002)
BRΔ	.	.	-0.016
	.	.	(.024)
Controls			
Year Fixed Effects	X	X	X
Firm Trends		X	X
Benefit Ratio			X
Observations	2,645,153	2,645,153	2,645,153
Panel B: Missouri data			
RateΔ	-0.008***	-0.013***	-0.013***
	(.000)	(.001)	(.001)
RRΔ	.	.	0.035*
	.	.	(.016)
Controls			
Year Fixed Effects	X	X	X
Firm Trends		X	X
Benefit Ratio			X
Observations	796,716	796,716	796,716
Panel C: Comparison of rate coefficient			
Difference	-0.041	0.001	0.001
	(.001)	(.002)	(.002)

Note.—This table presents estimates of changes-in-changes regressions estimating the effect of tax rates on firm employment using administrative data from three different states. In each, I regress employment changes on rate changes and year fixed effects, while controlling for changes in benefit ratio/reserve ratio. Across settings, we see a similar relationship between tax increases and reductions in firm employment.

Online Appendix Table 13—Demographic Comparison

	Florida	All Other States
High School (HD)	24.2	24.7
	(42.83)	(43.13)
Bachelors (HD)	16.9	17.3
	(37.48)	(37.78)
Married	54.9	56.8
	(49.76)	(49.54)
Never Married	21.0	22.7
	(40.72)	(41.92)
Working Age	69.4	74.3
	(46.08)	(43.68)
Seniors	26.3	20.7
	(44.02)	(40.54)
Makes <30k	61.5	58.0
	(48.65)	(49.35)
Makes <50k	80.1	76.8
	(39.92)	(42.24)
Makes <75k	90.6	88.7
	(29.19)	(31.66)
Black	12.6	9.7
	(33.22)	(29.63)
White	81.1	79.4
	(39.14)	(40.44)
Non-White	18.89	20.6
	(39.14)	(40.44)
Observations	148,833	2,177,888

Note.—This table compares the demographic attributes of Florida residents to residents in the remainder of the country from the public 2010 Census among adult respondents (those older than eighteen).

Online Appendix B: Additional Test for Cash Constraints

How Do Firms Behave when Cash Constrained?

A stable payroll tax rate reduces wages with little impact on employment (Britain 1971; Hamermesh 1996; Gruber 1997). Unlike traditional payroll taxes, UI tax rates change yearly. Therefore, since wages are rigid in the short run, UI tax hikes may reduce employment rather than earnings (Bewley 2002; Kaur 2014; Cahuc, Carcillo, and Le Barbanchon 2018). To frame the empirical work, I consider the implications of the tax for a firm maximizing the sum of a sequence of profits, Π_t:

$$\Pi_t = p_t f(N_t) - N_t - c - \tau\left(\frac{L_{t-1}}{N_{t-2}}\right) N_t - \psi_t H_t \qquad (1)$$

Element p_t is the unit price of output, which is a function of employment, N_t; element c represents periodic operating costs, and τ represents the UI tax rate, which is an increasing function of the benefit ratio $\left(\frac{L_{t-1}}{N_{t-2}}\right)$, mirroring experience rating.[1] The production function $f(N_t)$ reflects a decreasing marginal product of labor, and the marginal cost of hiring workers is ψ_t. Firms adjust their employment by choosing non-negative hires (H_t) and layoffs (L_t) in each period, and workers attrit naturally at rate, $1 - \delta$, so that:

$$N_t = N_{t-1}\delta - L_t + H_t;\ L, H \geq 0. \qquad (2)$$

Because there are costs to both layoffs and hiring, there is always a corner solution for at least one choice variable, hiring or layoffs.[2] Under normal conditions, the firm's behavior is influenced both by the tax rate, τ, which makes employment more costly, and the implicit penalty for layoffs, approximately τ', which discourages layoffs. A forward-looking firm will intuitively choose to layoff fewer employees when the layoff penalty is higher. Moreover, a firm will find it advantageous to reduce its employment on the margin when exogenously faced with a higher tax level, τ. Notice that firms may not be able to follow their optimal employment

[1] This representation contains the essential features of equation (1). The immediate effect of hiring (to increase wage base) on next year's tax rate is quite modest because one hire does little to change the total stock of employment in percentage terms; in contrast, an additional layoff will have a significant effect on the stock of relevant layoffs.

[2] Suppose that this is not the case. By reducing L and H by the same amount, total output is unchanged, but the firm has avoided costs associated with hiring and layoffs.

path, however, when they are cash constrained since they need profits to be positive in each period ($\Pi_t \geq 0\ \forall t$) to cover the concurrent costs of their operation, similar to the cash constraint in Clower (1967) as well as Lucas and Stokey (1987) and Schoefer (2015). When the constraint binds, and firms do not have the revenue to cover their expenses, the firm is forced to reduce employment or exit. By shrinking employment, the firm reduces costs faster than it reduces revenue because the marginal product of labor increases while the marginal cost of labor remains constant.

To better see this point, consider a toy numerical example in which firms are paid \$10 per unit and respond to an unexpected demand shock in which prices fall to \$5 for two periods, and the tax is a simple linear function of the benefit ratio. I set $f = \sqrt{N_t}$, $\delta = 0.9$, $c = 2$, $\tau = ¼$, ψ=¼, and $\dot{\psi}$=⅛, and the initial employment $N_{t-1} = 25$, which would be the long-run optimal employment if prices remained stable.[3] Profit in period t is expressed:

$$\Pi_t = p_t\sqrt{N_t} - N_t - 2 - \tau\frac{L_{t-1}}{N_{t-2}}N_t + \psi_t H_t \tag{4}$$

In the benchmark case, the penalty τ naturally discouraged layoffs. But, in this example, the shock induces the firm to contemplate negative profits. If the firm is without cash or credit, the firm must reduce employment by at least five to satisfy the constraint, maintaining non-negative profits to cover its costs. If the firm does not reduce its employment, it will fail to cover its costs and be forced to exit ($\Pi_t = 5 \times \sqrt{25} - 25 - 2 = -1.5$). Since $\delta = 0.1$, the firm reduces employment by two and a half workers by attrition and must layoff an additional two and a half workers to cover its costs completely ($\Pi_t = 5 \times \sqrt{20} - 20 - 2 = 0.4$). Notice that the firm prefers to layoff no one, since hiring is costly, but no employment reduction fewer than five will cover the firm's imminent costs. Importantly, a future penalty—no matter how large—cannot deter the firm from these layoffs because the layoffs are necessary to survive the period. Later,

[3] Here, the fact that it may be easier to hire during recessions when there is excess supply of labor is reflected in a lower cost of hiring during the demand shock.

I test this prediction to evaluate whether firms at the kink are cash constrained when assessing whether cash constraints plausibly drive the large firm response.

In the period following the initial shock, the firm's tax rate increases, again inducing negative profits $\left(\Pi_{t+1} = 5 \times \sqrt{20} - 20\left(1 + \tau\frac{2.5}{25}\right) - 2 = -0.1\right)$. Without the tax, the firm would maintain positive profits while hiring workers to replace those that attrit, in this case hiring one worker $\left(\Pi_t = 5 \times \sqrt{20} - 20 - 2 - \frac{1}{4} = 0.1\right)$. With the tax, the firm prefers to maintain its employment but hires one fewer with the tax than without in order to satisfy the binding cash constraint $\left(\Pi_t = 5 \times \sqrt{20} - 20\left(1 + \tau\frac{2.5}{25}\right) - 2 - \frac{1}{4} = -0.4\right)$. In short, cash constraints can make firm hiring more responsive to tax increases, consistent with Schoefer (2015), generating labor demand elasticities that are arbitrarily large for firms approaching the constraint (i.e., as $\Pi + \tau\left(\frac{L_{t-1}}{N_{t-2}}\right) N_t \rightarrow 0^+$). Because the tax functions as a fee per employee, tax increases may create an incentive for employers to transition to fewer employees who work more, or shifting toward fewer, highly capable workers, depressing labor demand among the neediest while ticking up demand among higher-earning workers. If this prediction were borne out, we would expect to see that the reduction in employment accompanies an increase in average earnings, a prediction for which I find no evidence in the empirical section.

The important elements for determining whether the tax promotes employment are the overhang effect $(\partial H_t / \partial \tau)$ and a deterrent effect $(\partial L_t / \partial \tau')$, the effect of implicit tax penalties on the propensity of firms to engage in layoffs.[4] The goal of the empirical analysis is to estimate the overhang effect and to use predictions about the deterrent effect to test whether firms at the kink are cash constrained. For cash-constrained firms, $\partial H_t / \partial \tau$ will be larger (more negative) than for firms without such constraints.

Test for Cash Constraints among Firms with Recent Layoffs

A core hypothesis explaining the large employment response to UI tax increases is that affected firms are cash constrained. To test this, I leverage variation in the penalties firms face

[4] In practice, τ' could also influence a firm's decision to hire, but the effect is second-order since the τ' in the year of hiring is likely different than the τ' a firm faces when it comes time to layoff the worker.

because of the placement of the maximum rate. The statutory maximum differentially shields firms from rate increases based on where they reside on the tax schedule at the onset of the maximum rate. For instance, firms with benefit ratios that put the firm just under the maximum rate will bear a modest penalty for layoffs, while those with benefit ratios barely reaching the maximum rate confront no penalty at all. I estimate the relationship between a firm's layoff rate (layoffs as a percentage of last year's employment) and the tax penalty the firm faces:

$$y_{it} = \beta P_{it} + \psi(BR_{it}) + \alpha_t + \delta_i + \varepsilon_{it}.$$

Here, P reflects the implicit tax penalty a given firm faces for layoffs given its placement on the tax schedule. I calculate this variable by simulating how the firm's tax rate would change in response to a 1-percent layoff.[5] Firms with a benefit ratio 0.02 below (in terms of the benefit ratio) the onset of the maximum incur tax increases of 1.8 percentage points for a layoff, a penalty that declines to zero as the firm approaches the maximum rate. That is, within 0.02 SDs of the benefit ratio, the penalty ranges from 0 to 1.8 percentage points for a 1% layoff. Negative estimates of β reflect that penalties discourage layoffs. Firm fixed effects (δ_i) account for stable firm differences in their propensity to layoff workers, time fixed effects (α_t) control for broad macroeconomic trends, and a quadratic polynomial of the firm's benefit ratio (BR_{it}) accounts for differences related to the firm's evolving layoff history. In practice, P is not randomly assigned and the penalties firms face depend in part on the slope of the tax schedule each year as well as the minimum rate applied to firms. To train the regression on plausibly exogenous variation unrelated to yearly formula changes and variation that firms are more likely to be aware of, I employ an instrumental variables strategy (Angrist 2009).

[5] To calculate the cost, I assume claimants received the average weekly benefit for the average duration which causes a benefit-ratio to increase by 0.011905 for a typical firm. To calculate P, I calculate the rate increase that the firm faces from that increase as $P_{it} = 100 \times \{\min(0.054, a_t + (1 + b_t) \times (\text{BenefitRatio}_{it} + 0.011905)) - \text{TaxRate}_{it}\}$ for a firm i in year t. Here, a_t is the minimum tax rate in year t and b_t is the policy slope parameter in the tax formula in year t. In words, I calculate the tax rate penalty the firm would expect if it were to lay off 1 percent of its workers.

I operationalize this approach by instrumenting the penalty a firm confronts (P) with the "rate distance" between the firm's rate and the maximum allowable rate, which is plausibly exogenous to the firm. The maximum generates this variation by shielding firms from penalties based on their distance to the maximum when below the maximum rate. The instrumental variables (IV) approach also focuses the empirical estimation on tax-penalty variation of which firms are more likely to be aware since they can easily know their rate and the maximum, but are unlikely to know the exact slope of the tax formula each year. By comparing firms within a narrow bandwidth around the maximum rate, I implicitly compare like firms that face different tax penalties for layoffs. The first stage is strong with the instrument predicting 12 percent of the variation in the endogenous regressor and a t-statistic of 1,005. The resulting estimates represent the effect of a 1 point higher tax penalty for a layoff. I implement the specification using firm-year observations within the optimal-IK bandwidth of the onset of the maximum rate and cluster the standard errors at the firm level.

Firms facing larger penalties do not have fewer layoffs (see online App. table 8). The estimated deterrence effects from the IV model are all small, insignificant, and wrong-signed, ranging from 0.0004 to 0.0009 (recall that negative coefficients reflect deterrence). The estimates from the panel and the instrumental variable rule out layoff deterrence effects of magnitudes greater (in absolute value) than –0.001 (layoffs per employee), –0.0004 (temporary layoffs per employee), and –0.0007 (separations per employee).

In theory, a layoff penalty has the same effect on labor demand as a wage reduction of the penalty size since the employer will pay the dismissal cost regardless. Average estimates of labor demand elasticities cluster around 0.5 (Katz 1996; Lichter, Peichl and Siegloch 2015), suggesting that firms should reduce their layoffs by 6.6 percent, which is equivalent to an estimated –0.0028 (6.6 percent times 0.043 layoff rate). The confidence intervals on the deterrence estimates rule out magnitudes of this size, suggesting that firms are less responsive to penalties than expected under normal conditions, a finding consistent with the hypothesis that firms at the kink are cash constrained.

The conceptual framework demonstrates that firms facing cash constraints cannot be deterred by UI tax penalties—a prediction borne out by the data; this suggests that firms that have recently had layoffs behave as though they are cash constrained. This test relates to the work of Topel (1983), Anderson (1993), and Card & Levine (1994). These papers use data from the 1970s and 1980s to compare the unemployment transitions under different penalties for layoffs and find substantial evidence of deterrence, usually in terms of discouraging firms from temporary layoffs. Topel (1983) uses a sample of individuals from the 1975 *Current Population Survey* (CPS) and relates temporary layoffs to the marginal tax rates in the cross section. Card and Levine (1994) develop this strategy by constructing a panel from the CPS and find deterrence after accounting for state and industry differences.

There may be empirical reasons that the results reported in my setup differ, other than the presence of cash constraints. My analysis uses firm-level data, whereas Topel (1983) and Card and Levine (1994) use industry-level data. I show in table 3 that without firm fixed effect, the estimates would suggest deterrence (column 1). When I account for firm heterogeneity, the sign flips (column 2), suggesting that firm-specific factors may be an important dimension of unobserved heterogeneity when measuring responses to tax penalties. Anderson (1993) constructs a panel of 8,000 retail firms from the 1970s and 1980s and finds evidence of deterrence even after accounting for firm differences with firm fixed effects. To increase the comparability of my results with Anderson (1993), I apply the same test restricted to firms in retail. As in the broader sample, the estimated effects are small, insignificant, and often wrong-signed. I replicate the measure of marginal tax cost that Anderson used but can detect no effect despite significant power.

Three explanations for the null effect are plausible. One, the labor market may have changed significantly. Automation and a rapidly evolving labor market has induced churn and reduced attachment of workers to firms, represented by the fact that temporary layoffs, which were 22 percent of layoffs in 1980, are now only 5 percent of layoffs in my data. Two, it may be that in the 1970s and 1980s, UI tax penalties were correlated with other adjustment costs that no longer differ systematically (e.g., high tax places were those with stronger social cohesion). Third, firms are more likely to be cash constrained in my data and in distress, consistent with the fact that firm exit has exceeded firm entry over this period.

Online Appendix C: A Conceptual Discussion of Firm Head Taxes

A Simple Analysis of Labor Demand in Response to a Head Tax

In this section, I explore how much a head tax levied on employers would reduce a firm's employment in excess of the effect of an equivalent payroll tax.

Tax 1: A Tax on Payroll

In one regime, firms maximize profits while paying a tax on all wages paid, generating a tax bill $whQt$:

$$\Pi = pf(Qh) - whQ(1 + t) - \psi(h)Q$$

Here, Π is profits, p is the unit price, f represents a production function $(f' > 0, f'' < 0)$ of Q (the quantity employed) and h (the hours each employee works each week), and w represents the hourly wage. Firms pay a tax of t% on all the wages they pay; it may be costly to the firm to increase hours worked per employee, represented by $\psi' > 0$. This feature of the increasing cost of hours arises if firms have to compensate workers for the convex disutility of work or firms are required to bear additional costs like overtime or mandated benefits for employees who work longer hours. Assuming $f = \log$, I solve for $h^\star$ and $Q^\star$:

$$h^\star = \frac{p}{wQ(1 + t) + \psi'(h)Q}$$

$$Q^\star = \frac{p}{wh(1 + t) + \psi(h)}$$

Notice that both $h^\star$ into $Q^\star$ are decreasing in t. Inserting $h^\star$ into $Q^\star$ and solving, I find:

$$Q_P^\star = \frac{p}{\psi(h)} - \frac{pw(1 + t)}{\psi(h)[w(1 + t) + \psi'(h)]}$$

Tax 2: A Tax on Employment

In the second regime, firms maximize profits while paying a tax on employment, generating a tax bill, $Q\tau$, where $\tau \approx twh$ so that, *ex ante*, the two tax instruments raise the same revenue:

$$\Pi = pf(Qh) - whQ - Q\tau - \psi(h)Q$$

If $f = \log$, I solve for $h^\star$ and $Q^\star$:

$$h^\star = \frac{p}{wQ + \psi'(h)Q}$$

$$Q^\star = \frac{p}{wh + \tau + \psi(h)}$$

Under a head tax, only $Q^\star$ is decreasing in the tax, and h is decreasing in Q; thus, h is increasing in τ. Inserting $h^\star$ into $Q^\star$ and solving, I find:

$$Q_E^\star = \frac{p}{\tau + \psi(h)} - \frac{pw}{\big(w + \psi'(h)\big)\big(\tau + \psi(h)\big)}$$

A useful check on the math is that $Q_E^\star = Q_P^\star$ as the taxes approach zero.

A Comparison

To see how much the implied response differs between a payroll tax and a head tax, I calculate an example in which I set $p = 10$, the hourly wage to 10, the weekly hours to $h = 34$ (the national average), and I calibrate $\psi(h) = A \times h^B$ for a functional form that generates a labour demand elasticity ˜0.5 from the literature (Katz 1995), yielding $\psi(h) = .02 \times h^{2.5}$. When substituting the head tax $\tau = twh$ in place of the payroll tax, the tax generates a labor demand elasticity more than four times as large, about 2.2. This exercise suggests that firms may be far more responsive in their employment decision with respect to employment based on variation in a head tax than variation in a traditional payroll tax, explaining about half of the excess sensitivity firms exhibit in response to UI tax variation.

A Simple Accounting Exercise

To evaluate what sort of earnings increase might occur for a 1 percent decrease in employment, I do a simple accounting exercise. Consider a firm with 100 employees that reduces its workforce by 1 percent and redistributes the hours of that worker to her colleagues. This would lead, intuitively, to a 1 percent increase in the hours and earnings of the remaining workers. Now consider a case that is somewhat less clear. Consider that a firm is composed of 20 percent part-time laborers who work 20 hours a week, while the remaining laborers work 40 hours a week. Because the total amount of hours remains stable while the number of workers is reduced by 1, the average hourly increase is still 1 percent. If the hours are distributed to the other part-time workers, this increase reflects a slight incline in the share of workers that are full-time and longer hours worked by part-time laborers.

Online Appendix D: Implications for Optimal UI Design

Here, I provide the details assessing the impact of UI taxes on the calculation of optimal benefits using the Baily-Chetty formula. Chetty (2006) presents a formula describing the optimal balance of taxes in the high state of the world (employment) and benefit generosity in the low state of the world (unemployment), intuitively setting equal the marginal benefit of consumption in each state with an adjustment for behavioral distortions of UI benefits.

$$u'(c_e)\left[1+\frac{b}{D}\frac{dD}{db}\right]=u'(c_u)$$

In this setup, c_e represents the consumption level when employed, c_u is consumption when unemployed (furnished by weekly benefit b), and D reflects the endogenous duration of the unemployment spell. Chetty explains, the "optimal level of benefits offsets the marginal benefit of raising consumption by $1 in the [unemployed] state…against the marginal cost of raising the UI tax in the [employed] state to cover the required increase in the UI benefit." The marginal cost of raising UI benefits is reflected by a direct cost of taxation reducing consumption in the employed state and the behavioral response of more generous benefits extending the unemployment spell by reducing search intensity ($\frac{b}{D}\frac{dD}{db}$).

The RKD results demonstrate that there is another channel by which more generous benefits affect the duration of unemployment, since higher taxes reduce hiring and thus extend the average duration of unemployment. To account for this channel, the model would include a term reflecting this distortion between benefits and durations, mediated by taxes.

$$u'(c_e)\left[1+\frac{b}{D}\frac{dD}{db}+\frac{b}{D}\frac{dD}{d\tau}\frac{d\tau}{db}\right]=u'(c_u)$$

As a benchmark, researchers have measured $\frac{b}{D}\frac{dD}{db}\approx 0.6$ (Card et al. 2015; Kroft and Notowidigdo 2016; Schmieder and von Wachter 2016), meaning that the marginal utility of consumption in the unemployed state will be about 38 percent *higher*, reflecting lower consumption levels. To quantify and compare the additional distortionary term, $\frac{b}{D}\frac{dD}{d\tau}\frac{d\tau}{db}$, I assume

$b = 300$ and $D = 15$, representative values from UI records. The term, $\frac{dD}{d\tau}$, reflects the influence of the tax on average durations of unemployment. I assume that the implied percent of unemployment caused by the tax for a \$1 tax increase translates to an equal percent increase in the average duration ($(dD = 15$ weeks $\times 12\%)/(d\tau = 1.4\% \times \$7{,}000)$, since a 1.4 percent is responsible for 12 percent of the unemployment in the back-of-the-envelope calculation).[6] To calculate $\frac{d\tau}{db}$, I use the balanced-budget constraint from Chetty (2006), in which the lump-sum tax on the employed must cover the cost of unemployment benefits for the unemployed.

$$\tau \times 114.5\text{m} = b \times D \times 14.5\text{m}$$

Which implies that τ increases by \$1.9 for every \$1 increase in b ($\frac{d\tau}{db} = 1.9$). The product of these three terms is 0.7, representing a distortion unaccounted for in the typical optimal UI formula, somewhat larger than the behavioral distortion from reduced search effort estimated in Card et al. (2015) and other work (Kroft and Notowidigdo 2016). This size of distortion would imply that optimal UI benefits are overestimated by 26 percent when this distortion is ignored, assuming constant relative risk aversion utility ($u(c) = c^{1-\gamma}/[1-\gamma]$), with $\gamma = 1.75$, following Chetty (2008).

[6] This assumption is consistent with a model of job rationing in which unemployed workers queue for a fixed stream of jobs. If there are 12% more unemployed people, the average unemployed person will wait 12% longer to receive a satisfactory job offer.