Tax Incidence

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Public Economics - Lecture 2 - 5

Partly based on slides by Raj Chetty and John Friedman

Tax incidence

Tax Incidence

- effect of taxes on prices and utilities
- what are the parameters that determine it

Outline of tax incidence

1. Definition and Introduction
2. Partial Equilibrium Incidence
3. Partial Equilibrium Incidence: Empirical Applications
4. Partial Equilibrium Incidence with Salience Effects
5. Firm-level Incidence
6. General Equilibrium Incidence

Tax Incidence: Definition and Introduction

Main references on classical theory of tax incidence

- Kotlikoff and Summers (1987) handbook chapter

Definition of tax incidence

- Study of the effects of tax policies on
  - Prices
  - Distribution of utilities
- What happens to market prices when change in a tax?
  - Increase tax on cigarettes by $1 per pack
  - Introduction of Earned Income Tax Credit (EITC)
  - Food stamps program
- Effect on price has implications for
  - distributional effects on smokers,
  - profits of producers,
  - shareholders, etc

Economic VS statutory incidence

- Equivalent when prices are constant but not in general
- Example:
  - Government should tax capital income b/c it is concentrated at the high end of the income distribution
- Neglects general equilibrium price effects
  - Tax might be shifted onto workers
  - If capital taxes $\rightarrow$ less savings and capital flight, then capital stock may decline, driving return to capital up and wages down
  - Some argue that capital taxes are paid by workers and therefore increase income inequality (Hassett and Mathur, 2009)

Why is tax incidence useful?

- Tax incidence is an example of positive analysis
  - Typically the first step in policy evaluation
  - An input into identifying policies that maximize social welfare
- Theory is informative about signs and comparative statics but is inconclusive about magnitudes. Mostly helpful in identifying key parameters to estimate:
  - Incidence of cigarette tax: elasticity of demand w.r.t. price is crucial
  - Labor vs. capital taxation: mobility of labor, capital are critical

What we do in practice

- Ideally, characterize effect of a tax change on utility of all agents
- Useful simplification: aggregate agents into a few groups
- Incidence analyzed at a number of levels:
  1. Producer vs. consumer (tax on cigarettes)
  2. Source of income (labor vs. capital)
  3. Income level (rich vs. poor)
  4. Region or country (local property taxes)
  5. Across generations (social security reform)

Tax Incidence: Partial Equilibrium

Partial equilibrium incidence: key assumptions

1. Two good economy
   - Only one relative price $\rightarrow$ partial and general equilibrium are same
   - Can be viewed as an approx. of incidence in a multi-good model if
     - the market being taxed is "small"
     - there are no close substitutes/complements in the utility function
2. Tax revenue is not spent on the taxed good
   - Tax revenue is used to buy untaxed good or thrown away
3. Perfect competition among producers
   - Relaxed in some studies of monopolistic or oligopolistic markets

Partial equilibrium model: Setup

- Two goods: x and y
- Government levies an excise tax on good x
  - Excise or specific tax: levied on a quantity (e.g. gallon, pack)
  - Ad-valorem tax: fraction of prices (e.g. sales tax)
- p is pretax price of x and $q = p + t$ denote the tax inclusive price of x
- Good y, the numeraire, is untaxed

Partial equilibrium model: Demand

- Consumer has wealth Z and has utility $u(x, y)$
- Let $\varepsilon_D = \frac{\partial D}{\partial q}\frac{q}{D(q)} = \frac{\partial \log D}{\partial \log q}$ denote the price elasticity of demand
  - Elasticity: % change in quantity when price changes by 1%
  - Widely used measure because elasticities are unit free

Partial equilibrium model: Supply

- Price-taking firms
- Use $c(S)$ units of the numeraire y to produce S units of x
- Cost of production is increasing and convex:

$$c'(S) > 0 \text{ and } c''(S) \geq 0$$

- Profit at pretax price p and level of supply S is

$$\pi(S) = pS - c(S)$$

- Supply function for good x is implicitly defined by marginal condition $p = c'(S(p))$
- Let $\varepsilon_S = \frac{\partial S}{\partial p} \frac{p}{S(p)}$ denote the price elasticity of supply

Partial equilibrium model: Equilibrium

- Equilibrium condition

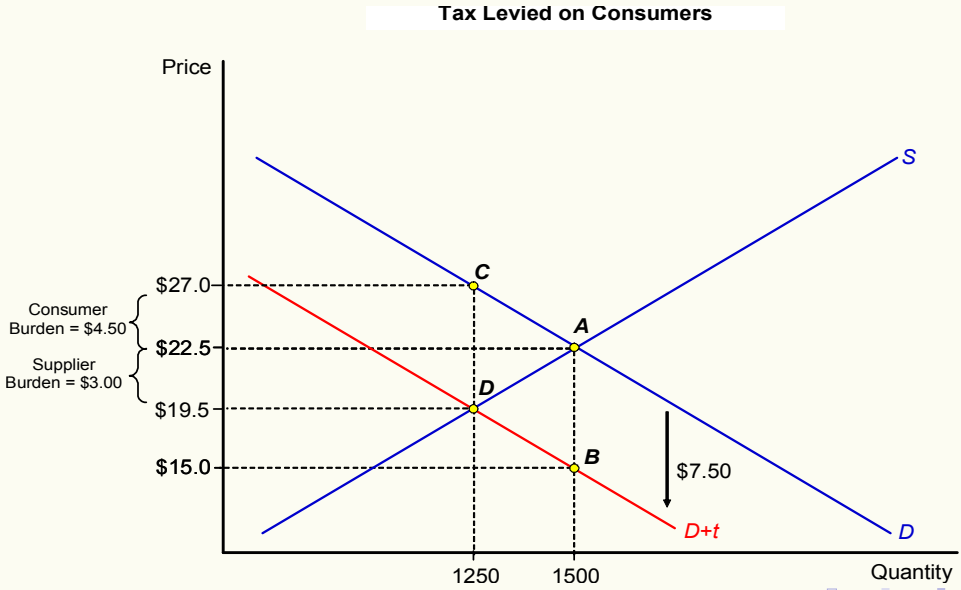
$$Q = S(p) = D(p + t)$$

  defines an equation $p(t)$

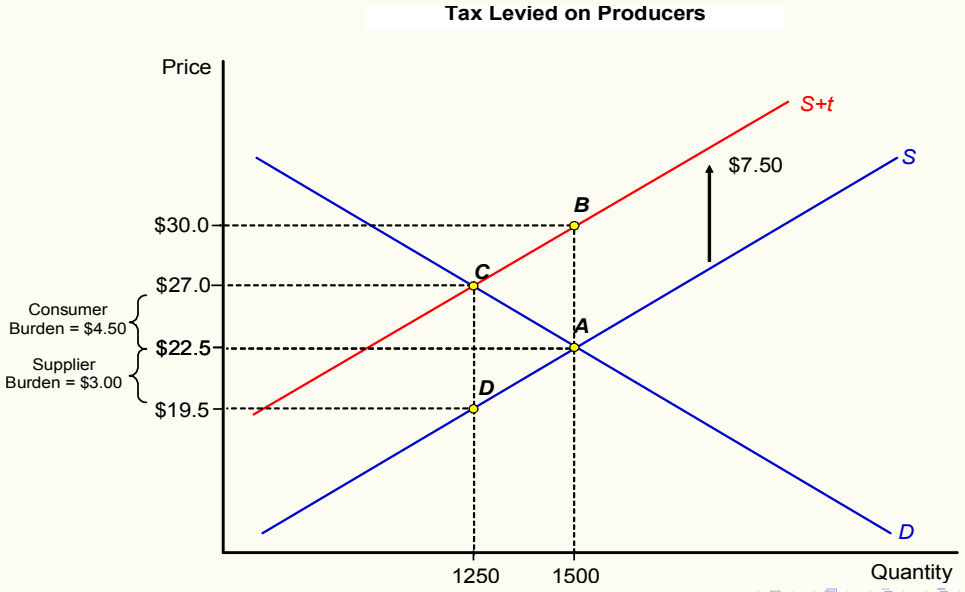
- Goal: characterize $\frac{dp}{dt}$, the effect of a tax increase on price

- First consider some graphical examples to build intuition, then analytically derive formula

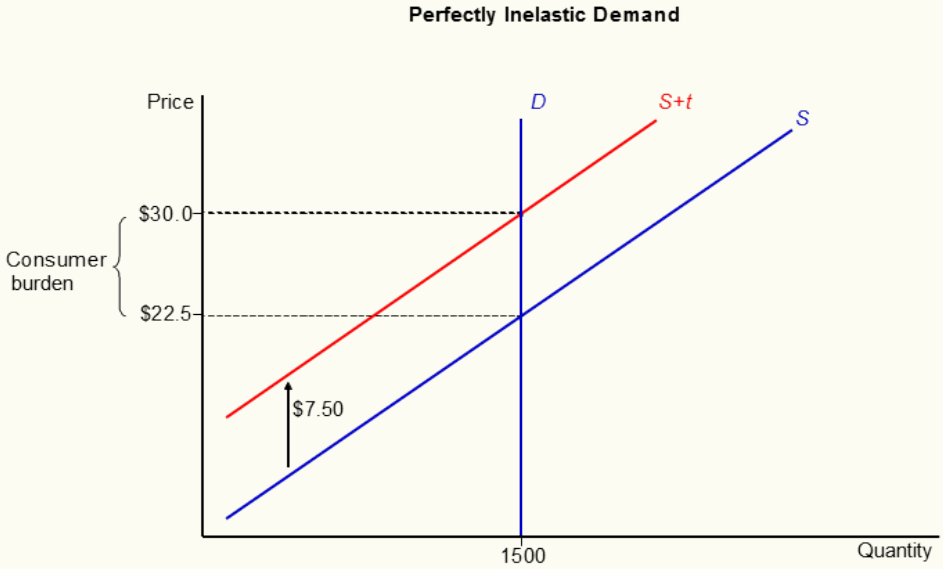
Graphical illustration



Graphical illustration



Graphical illustration



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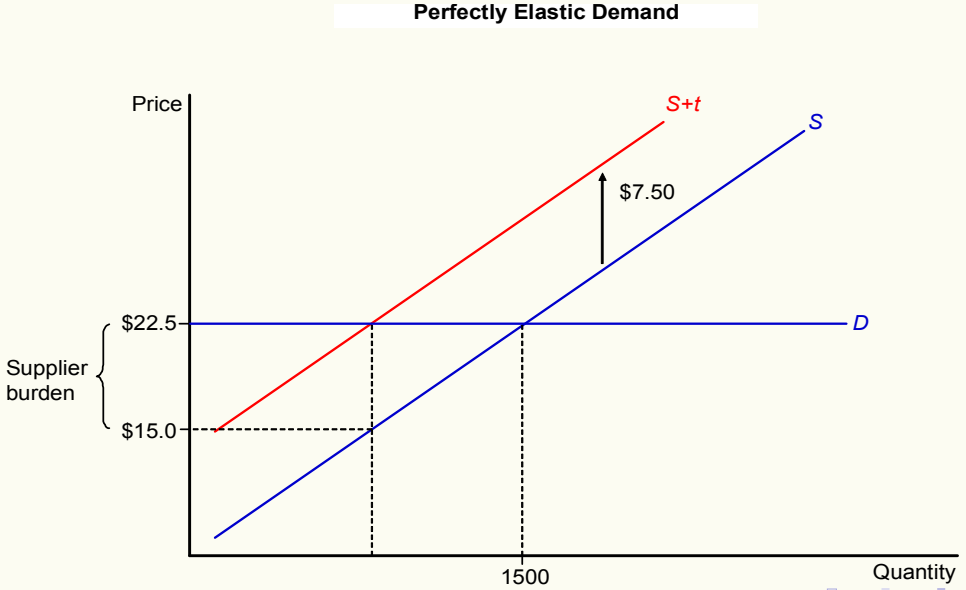


Formula for tax incidence

- Implicitly differentiate equilibrium condition

$$D(p + t) = S(p)$$

to obtain:

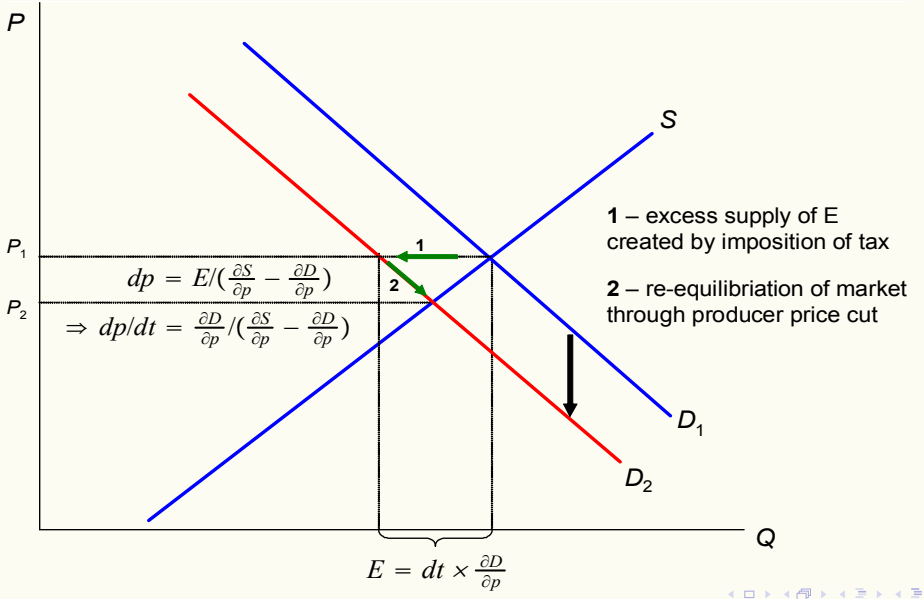
$$\frac{dp}{dt} = \frac{\partial D}{\partial p} \frac{1}{(\frac{\partial S}{\partial p} - \frac{\partial D}{\partial p})}$$

$$\Rightarrow \frac{dp}{dt} = \frac{\varepsilon_D}{\varepsilon_S - \varepsilon_D}$$

- Incidence on consumers:

$$\frac{dq}{dt} = 1 + \frac{dp}{dt} = \frac{\varepsilon_S}{\varepsilon_S - \varepsilon_D}$$

Formula for tax incidence



Tax Incidence: Empirical Applications

Tax Incidence: Empirical applications

1. Evans, Ringel, and Stech 1999: Cigarette excise taxes
2. Harding, Leibtag, and Lovenheim 2010: Geography and cigarette excise taxes
3. Benzarti and Carloni 2019: VAT and Production

Evans, Ringel, and Stech (1999)

- Question: How do cigarette tax increases affect prices?
  - Do they take money from cigarette companies or smokers?
- Partial equilibrium is a plausible approximation for cigarettes, so use that framework here

Cigarette taxation: Background

- Cigarettes taxed at both federal and state levels in U.S.
- Total revenue of about $35 billion per year, similar to estate taxation
- Federal tax increased from $0.39 to $1.01 per pack in 2009
- Also variation among states: from 30 cents per pack in VA to $4.35 in NY in 2015
- Controversial commodity due to health and paternalism concerns

Evans, Ringel, and Stech (1999)

- Since 1975, more than 200 state tax changes $\rightarrow$ natural experiments to investigate tax incidence
- Exploit these state-level changes in excise tax rates using simple diff-in-diff research designs
- Idea: Suppose federal govt. implements a tax change. Compare cigarette prices before and after the change

$$D = [P_{A1} - P_{A0}]$$

- Identification assumption: absent the tax change, there would have been no change in cigarette price

DID strategy

- What if price fluctuates because of climatic conditions or trends in demand?

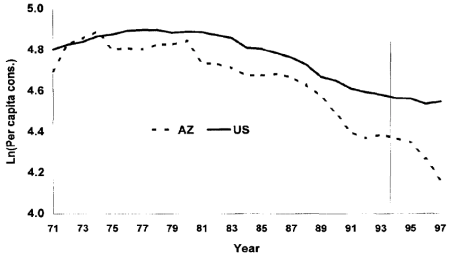
  $\rightarrow$First difference (and time series) estimate biased

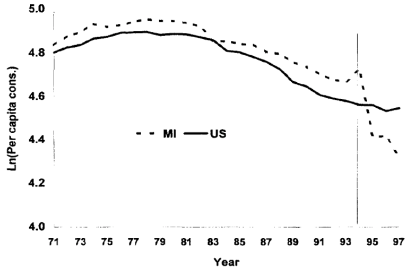
- Can relax ID assumption using diff-in-diff

$$DD = [P_{A1} - P_{A0}] - [P_{B1} - P_{B0}]$$

- State A: experienced a tax change (treatment)
- State B: does not experience any tax change (control)
- Identifying assumption for DD: parallel trends
  - absent the policy change, $P_1 - P_0$ would have been the same for A and B

Suggestive evidence





Source: Evans, Ringel, and Stech 1999

Two-Way fixed effects approach

- Data for 50 states, 30 years, and many tax changes
- Pool all this data to obtain single incidence estimate
- Fixed effects generalize DD with S $>$ 2 periods and J $>$ 2 groups
- Suppose that group j in year t experiences policy T of intensity T_{jt}
- Want to identify effect of T on price P. OLS regression:

$$P_{jt} = \alpha + \beta T_{jt} + \epsilon_{jt}$$

- With no fixed effects, the estimate of β is biased if treatment T_{jt} is correlated with ϵ_{jt}
  - Ex: states with higher taxes may have more anti-tobacco campaigns

Two-Way fixed effects approach

- Include time and state dummies to solve this problem:

$$P_{jt} = \alpha + \gamma_t + \delta_j + \beta T_{jt} + \epsilon_{jt}$$

- Fixed effect regression is equivalent to partial regression

$$\hat{P}_{jt} = \beta \hat{T}_{jt} + \epsilon_{jt}$$

  where $\hat{P}_{jt} = P_{jt} - P_j - P_t$ and $\hat{T}_{jt}$ is defined analogously

- Identification obtained from within-state variation over time

- Note: common changes that apply to all groups (e.g. fed tax change) captured by time dummy; not a source of variation that identifies β

Fixed effects vs. Difference-in-difference

- Advantage relative to DD: more precise estimates by pooling several changes
- Disadvantage: fixed effects is a black-box regression, more difficult to check trends non-parametrically as with a single change
  - Combine with graphical, non-parametric evidence around certain policy changes
  - Also useful to scatter residuals $\hat{P}_{jt}$ vs. $\hat{T}_{jt}$
  - Recent literature shows biases in these regressions when heterogeneous treatment effects over time and across treatment cohorts
- Same parallel trends identification assumption as DD
  - Potential violation: policy reforms may respond to trends in outcomes
  - Ex: tobacco prices falling $\rightarrow$ state decides to raise tax rate

Evans, Ringel, and Stech (1999)

- Implement a fixed effects model for prices
  - Regress price on state+year fixed effects, covariates, and tax rate (in cents)
- Also estimate demand elasticities using fixed effects estimator
  - Reg log-quantity consumed on state/year fixed effects, covariates, and real tax rate (in cents)

Results of price regressions

TABLE 2

OLS Estimates, Retail Price Model: Tobacco Institute Data

	Average state retail price, 1985–1996		Net retail price in Tennessee, 1970–1994	
Independent variable	Nominal (1)	Real (2)	Nominal (3)	Real (4)
Nominal/real tax	1.01 (0.04)	0.92 (0.04)		
Nominal/real wholesale price			1.07 (0.02)	0.86 (0.04)
R^2	0.972	0.933	0.989	0.963
Observations	612	612	25	25

Standard errors in parentheses. Real prices in 1997 cents/pack. Models in columns (1) and (2) control for state effects.

Source: Evans, Ringel, and Stech 1999

Evans, Ringel, and Stech: Price incidence

100% pass through implies supply elasticity of $\varepsilon_S = \infty$ at state level

- From Theory: pass through would be lower at national level
  - producer can accomodate change at state level, not at national
- Important to understand how variation used (state level) determines what parameter you are identifying

Evans, Ringel, and Stech (1999): Quantity regression

TABLE 3
OLS Estimates, Log Per Capita Consumption Model, Tobacco Institute Data, 1985–1996

Independent variable	Coefficients (standard errors) on Real tax (1)	(2)	(3)	Real price (4)	(5)	(6)
Current value	−0.254 (0.037)	−0.165 (0.040)	−0.173 (0.041)	−0.176 (0.027)	−0.176 (0.027)	−0.167 (0.029)
1-year lag		−0.215 (0.413)	−0.188 (0.047)		−0.027 (0.032)	−0.031 (0.032)
2-year lag			−0.061 (0.045)			−0.017 (0.033)
Price elasticity	−0.424 (0.062)	−0.635 (0.074)	−0.705 (0.090)	−0.294 (0.045)	−0.337 (0.058)	−0.359 (0.072)
R^2	0.975	0.977	0.977	0.975	0.975	0.976

Source: Evans, Ringel, and Stech 1999

Evans, Ringel, and Stech: Demand elasticity

- Model estimate implies that: $\varepsilon_D = -0.42$

  $\rightarrow$ 10% increase in price reduces consumption by 4.2%

- How to compute price elasticity of demand from here?

- Tax passed 1-1 onto consumers, so $\Delta P = \Delta T$

- Then compute ε_D from $\hat{\beta} = (\Delta Q/Q)/\Delta T$ from regression coefficient of log demand on cigarette tax:

$$\varepsilon_D = \frac{P}{Q}\frac{\Delta Q}{\Delta T} = \hat{\beta} P$$

  with P (price) and Q (quantity) are sample means

IV estimation of price elasticities

- How to estimate price elasticity of demand when tax and prices do not move together 1-1?
  - Instrument for post-tax prices using taxes
- First stage:

$$P_{jt} = \alpha' + \gamma'_t + \delta'_j + \beta T_{jt} + \epsilon_{jt}$$

- Second stage:

$$Q_{jt} = \alpha + \gamma_t + \delta_j + \lambda \widehat{P}_{jt} + \epsilon_{jt}$$

- Reduced form, using T_{jt} as an instrument for P_{jt}:

$$Q_{jt} = \alpha + \gamma_t + \delta_j + \mu T_{jt} + \epsilon_{jt}$$

- 2SLS regression coeff. is ratio of redued-form to first-stage coeff.:

$$\hat{\lambda} = \hat{\mu} / \hat{\beta}$$

- 2SLS rescales reduced-form to account for $\Delta P / \Delta T \neq 1$

IV estimation of price elasticities

- Estimate ε_D requires instrumenting for post-tax price with tax
- Estimate ε_S requires instrumenting for pre-tax price with tax

Curve	First Stage	Reduced Form	IV elasticity estimate
Demand	$d(P+T)/dT$	dQ/dT	$\frac{dQ/dT}{d(P+T)/dT}$
Supply	dP/dT	dQ/dT	$\frac{dQ/dT}{dP/dT}$

- Incidence formula $\frac{dP}{dt} = -\frac{\varepsilon_D}{\varepsilon_S - \varepsilon_D} \Rightarrow \frac{dP/dT}{d(P+T)/dT} = \frac{\varepsilon_D}{\varepsilon_S}$
- Identify both slopes using two moments: quantity and price impacts

Evans, Ringel, and Stech: Distributional incidence

- Use individual data to see who smokes by education group and income level
- Spending per capita decreases with the income level
- Tax is regressive on an absolute level (not only that share of taxes relative to income goes down)
- Conclusion: Taxes levied on cigarette companies lead to poor paying more for same goods, with no impact on companies!

Evans, Ringel, and Stech: Distributional incidence

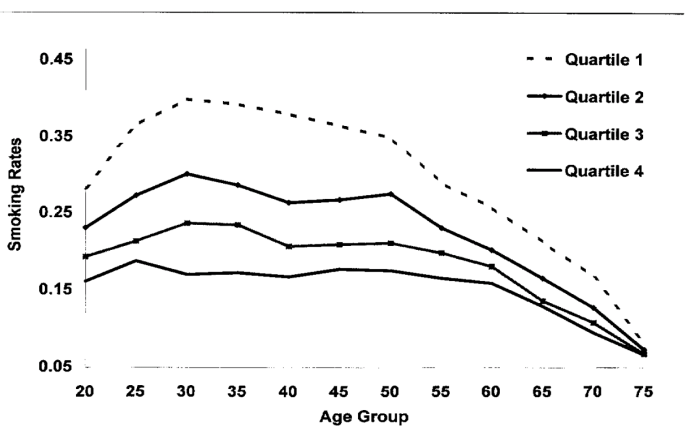


FIGURE 8. *Smoking Rates by Income Quartiles and Age—1992–1993 CPS TUS*

Source: Evans, Ringel, and Stech 1999

Harding, Leibtag, and Lovenheim (2012)

- Questions:
  1. How does incidence of cigarette taxes vary spatially, given variation in tax rate from state to state?
  2. Which consumers bear a greater burden?

- Transaction-level data from Nielsen Homescan Data for cigarettes
  - Two years of data (2006-2007), short-term compared with Evans et al. (1999)
  - Records purchase at the UPC-level, allowing exact comparisons across space
  - Use location to match consumers to the nearest lower-tax state
  - Also includes detailed demographic information

Harding, Leibtag, and Lovenheim (2012) - Identification

- Uses state-level changes in cigarette taxes to identify elasticities
- Essentially a difference-in-difference at the product-level:
  - Completely reduced form, makes no assumption about underlying industry structure
  - Product-level fixed effect allows consumers to switch products when taxes change
- Identification concerns similar conceptually, but over shorter horizon:
  1. No differential trends in cigarette demand between states
  2. Stockpiling of cigarettes around tax changes

Harding, Leibtag, and Lovenheim (2012) - Event window

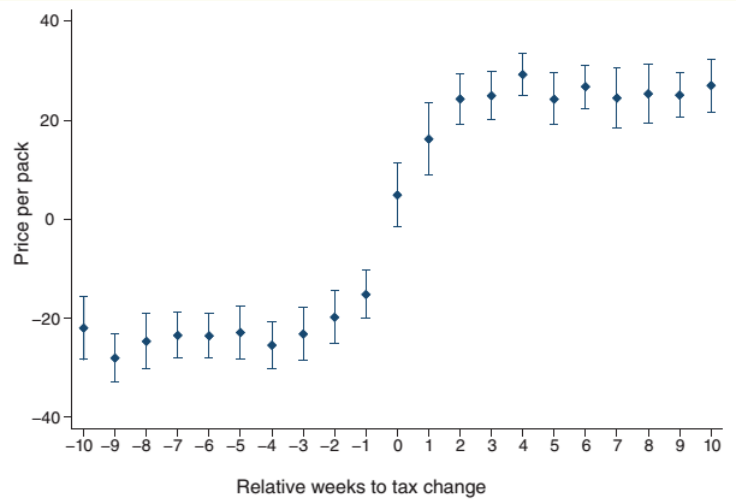


FIGURE 1. CIGARETTE PRICES SURROUNDING STATE EXCISE TAX CHANGES

Harding, Leibtag, and Lovenheim (2012) - Over distance

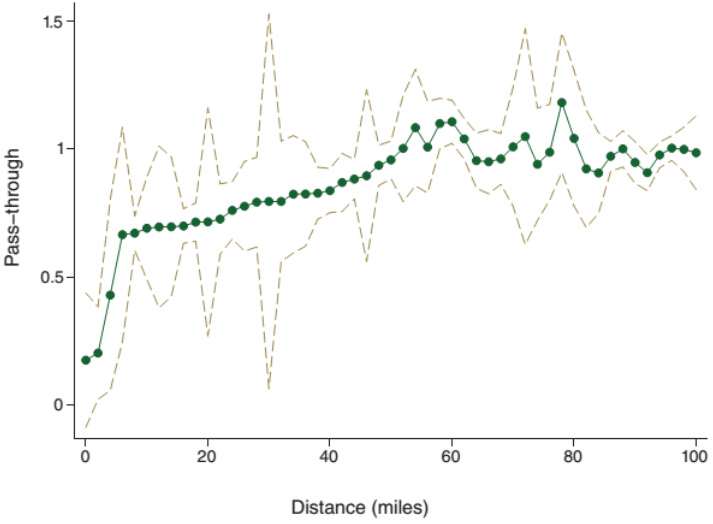


FIGURE 2. LOCAL LINEAR REGRESSION ESTIMATES OF THE EFFECT OF EXCISE TAXES ON CIGARETTE PRICES BY DISTANCE TO A LOWER-TAX BORDER

Harding, Leibtag, and Lovenheim (2012) - Incidence table

TABLE 3—OLS ESTIMATES OF THE EFFECT OF EXCISE TAXES ON CIGARETTE PRICES BY DISTANCE TO LOWER-TAX BORDERS

Independent variable	(1)	(2)	(3)
Panel A. Distance from home census tract			
Excise tax (cents)	0.798**	0.807**	0.856**
	(0.077)	(0.073)	(0.043)
Tax difference with nearest lower-tax state	−0.514**	−0.587**	−0.362**
	(0.180)	(0.176)	(0.091)
Log distance to nearest lower-tax state	−3.412	−4.490*	−1.489
	(2.406)	(2.352)	(1.005)
Log distance-tax difference interaction for nearest lower-tax state	0.139**	0.153**	0.076**
	(0.042)	(0.041)	(0.020)
Demographic controls:	No	Yes	Yes
UPC fixed effects:	No	No	Yes
Panel B. Distance from store zip code			
Excise tax (cents)	0.869**	0.860**	0.874**
	(0.075)	(0.071)	(0.042)
Tax difference with nearest lower-tax state	−0.407**	−0.479**	−0.304**
	(0.165)	(0.155)	(0.089)
Log distance to nearest lower-tax state	−3.454*	−4.362**	−1.760*
	(1.896)	(1.801)	(0.917)
Log distance-tax difference interaction for nearest lower-tax state	0.102**	0.118**	0.059**
	(0.039)	(0.036)	(0.018)
Demographic controls:	No	Yes	Yes
UPC fixed effects:	No	No	Yes

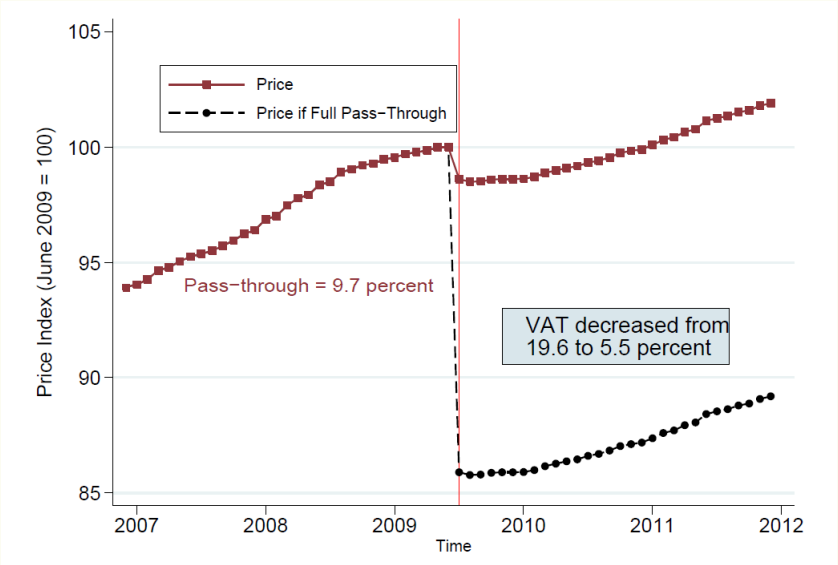
Harding, Leibtag, and Lovenheim (2012) - Conclusions

- Average pass-through of 85%, lower than other short-run estimates but higher than long-term estimates
- Pass-through depends on:
  - Alternative purchase options: Lower pass-through when closer to border, larger tax difference
  - Demographics: Lower pass-through for lower income households

Benzarti and Carloni (2019)

- Question: How does tax incidence affect the factors of production?
- Empirically: Analyze restaurants' responses to VAT reductions in France
  - In July 2009, VAT on sit-down meals fell from 19.6% to 5.5%
    - VAT on take-away restaurants (5.5%) and alcohol (19.6%) did not change
  - Data: Detailed data on firm production (AMADEUS)
  - Design: Compare sit-down restaurants to non-restaurant market services (e.g., retailers and wholesalers)

Benzarti and Carloni (2019): Prices



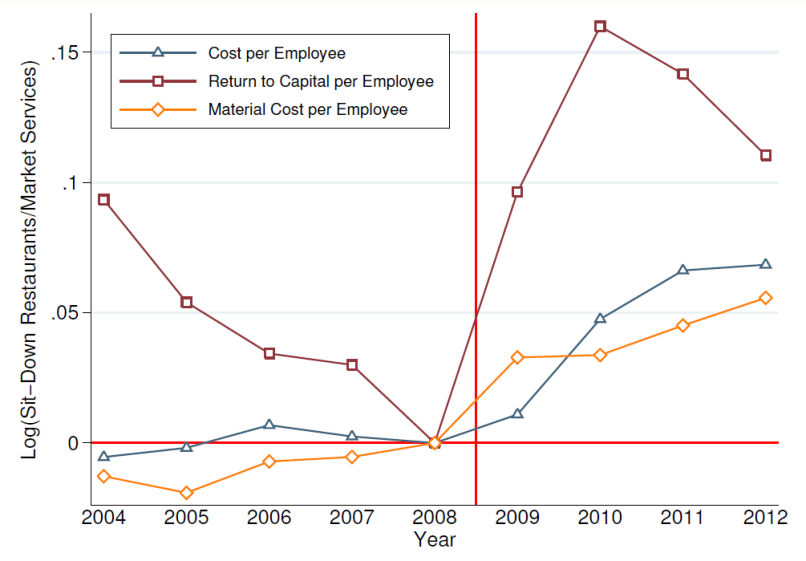
Benzarti and Carloni (2019)

- Producers capture most of the tax reduction. But then what?
  - Profits to restaurant owners?
  - Higher wages to workers?
  - Higher prices to upstream suppliers?
- Diff-in-diff, over different horizons:

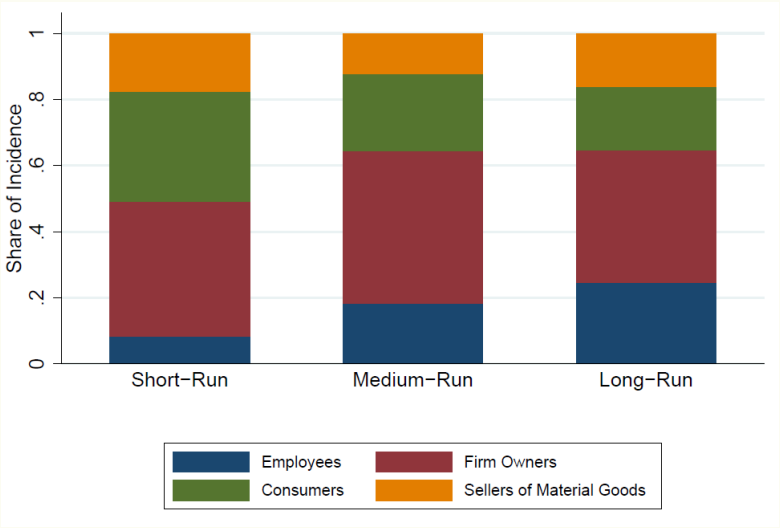
$$\log\left(Y_{idt}\right) = \eta \cdot T_i \cdot After_t + \lambda_t + \omega_i + \epsilon_{idt}$$

$$\log\left(Y_{idt}\right) = \sum_{\nu=-k}^{q} \eta_\nu \cdot T_i \cdot 1\left\{t = \nu\right\} + \lambda_t + \omega_i + \epsilon_{idt}$$

Benzarti and Carloni (2019) - Cross-Firm comparison



Benzarti and Carloni (2019) - Overall incidence



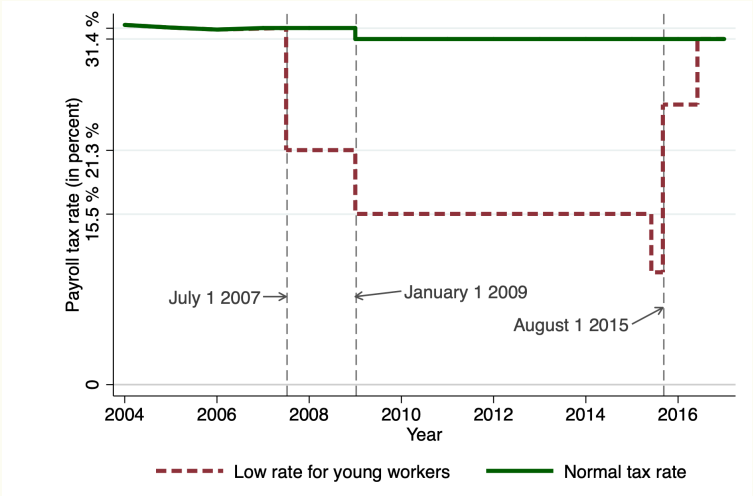
Benzarti and Carloni (2019) - Conclusions

- Summary of Findings:
  - Mostly goes to producers, where money is "spread around"
  - Policy: VAT reductions do not appear to benefit consumers
- Other remarks:
  - Interesting data to push beyond standard producer/consumer split
  - Key Interpretation Question: Why? What elasticities or other factors determine this split?

Saez, Schoefer and Seim (2019)

- Another example of firm-level incidence
- Payroll tax cut for $\leq$ 25 workers in Sweden
- Questions:
  - who bears incidence?
  - what do more affected firms do?
- Administrative matched employer-employee data

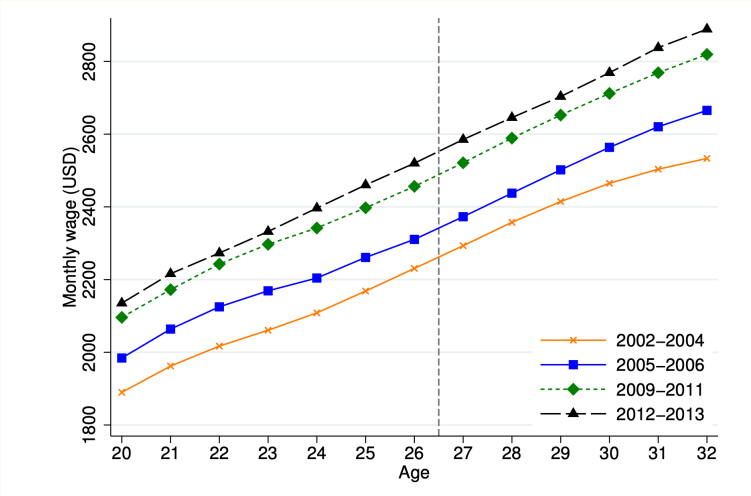
Saez, Schoefer and Seim (2019) - Reform



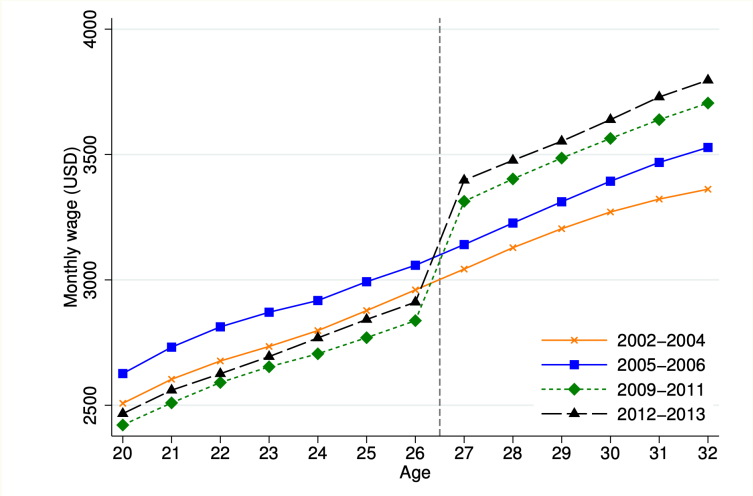
Saez, Schoefer and Seim (2019) - Individual level results

- Compare individuals affected and not-affected by tax cut
- Comparison across cohorts around 26 cutoff
- Look at incidence on
  - net wage earned by worker
  - labor cost paid by firm

Saez, Schoefer and Seim (2019) - Individual wage



Saez, Schoefer and Seim (2019) - Individual labor cost

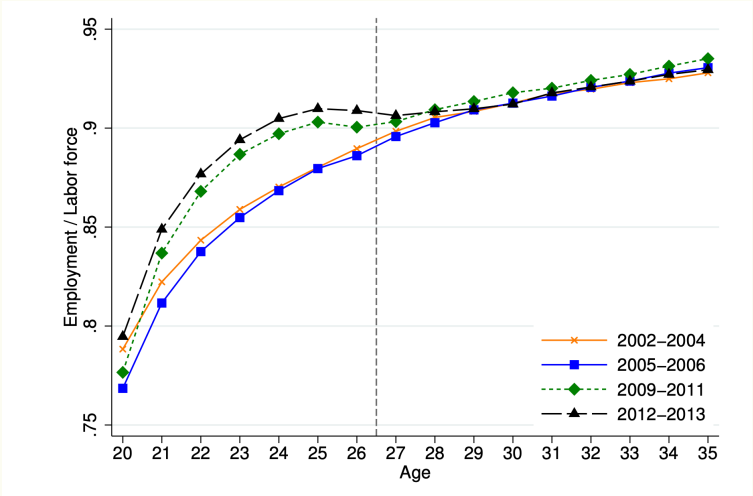


Saez, Schoefer and Seim (2019) - Individual employment

- Look at effect on employment rate
- Employment rate definition:

$$\begin{aligned}\text{Employment Rate}_{y,age} &= \frac{\text{Employed}_{y,age}}{\text{Labor Force}_{y,age}} \\ &= \frac{\text{Employed}_{y,age}}{\text{Employed}_{y,age} + \text{Unemployed}_{y,age}}\end{aligned}$$

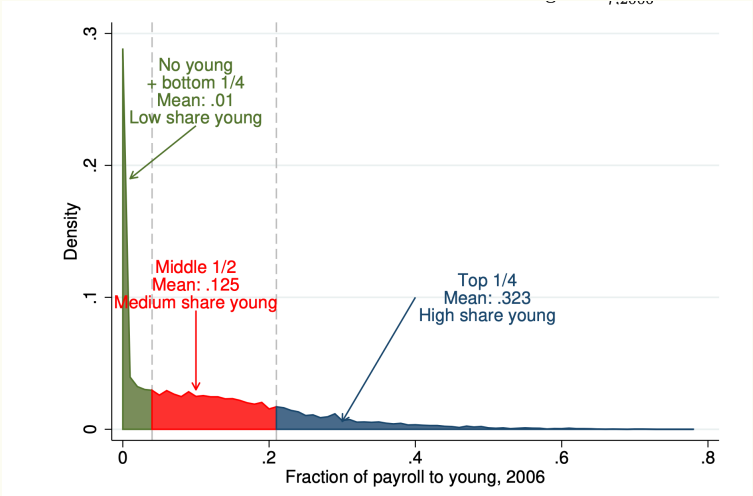
Saez, Schoefer and Seim (2019) - Individual employment rate



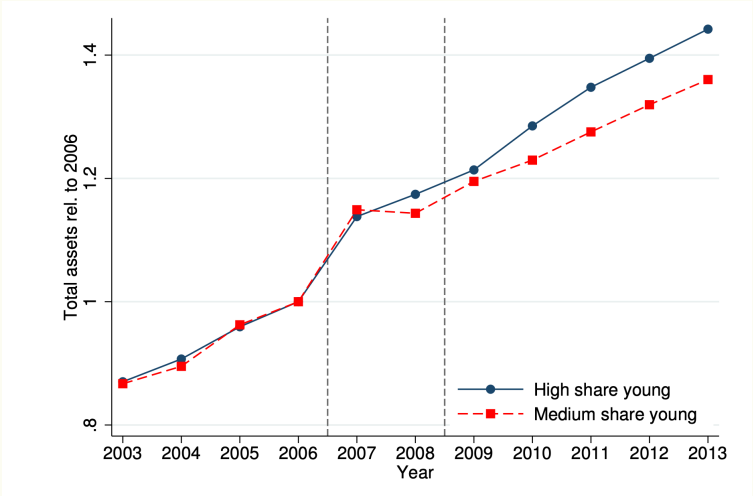
Saez, Schoefer and Seim (2019) - Firm level results

- Full passthrough on firms
- Do they use the windfall to change their choices?
- Maybe some money goes to incumbents
- Look at firms more and less affected
  - ranked using share of $\leq$ 25 incumbents

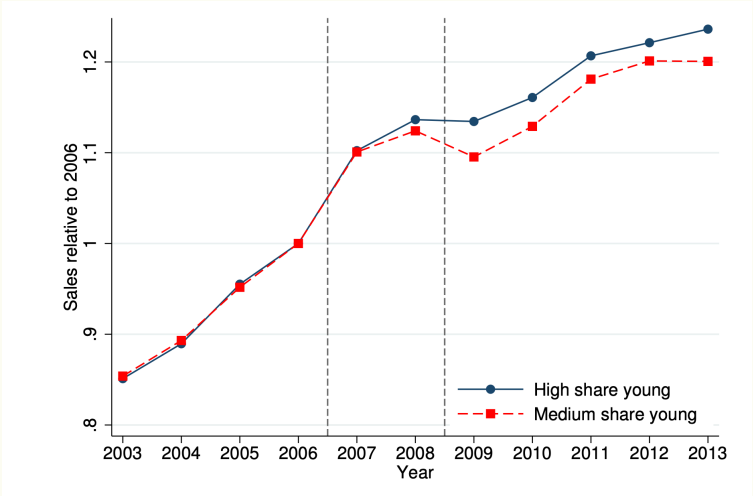
Saez, Schoefer and Seim (2019) - Shares of young



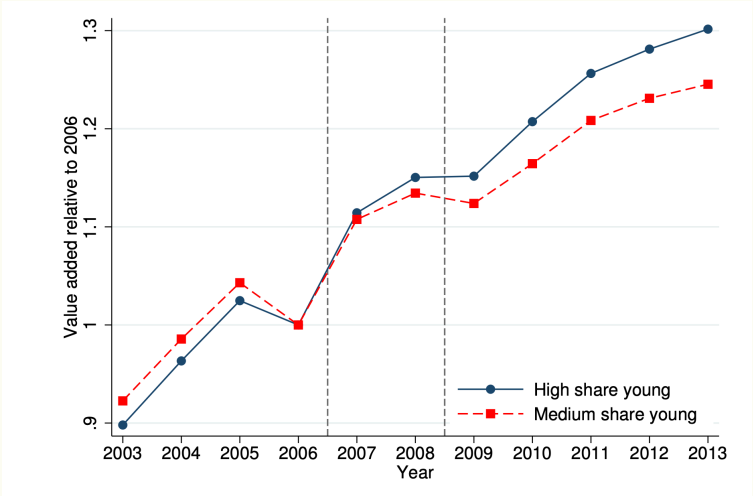
Saez, Schoefer and Seim (2019) - Firm capital



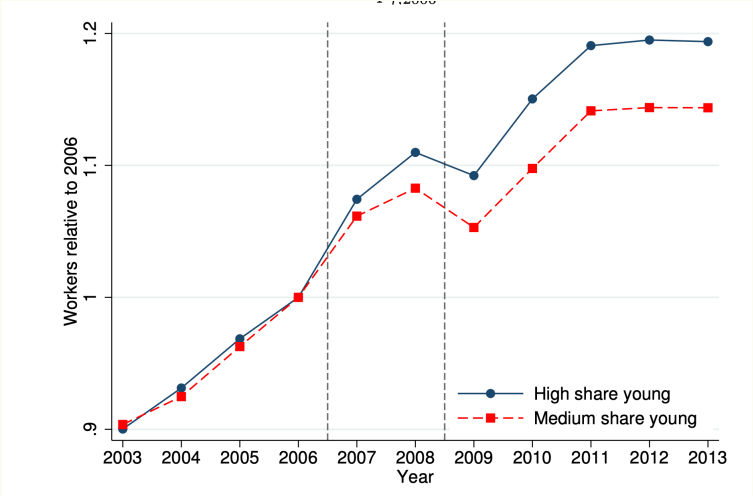
Saez, Schoefer and Seim (2019) - Firm sales



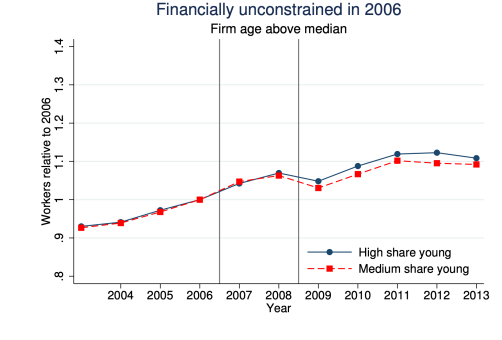
Saez, Schoefer and Seim (2019) - Firm value added

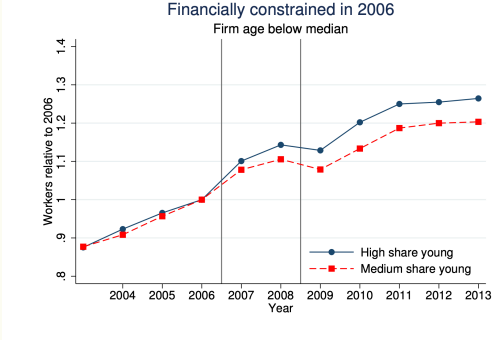


Saez, Schoefer and Seim (2019) - Firm employment

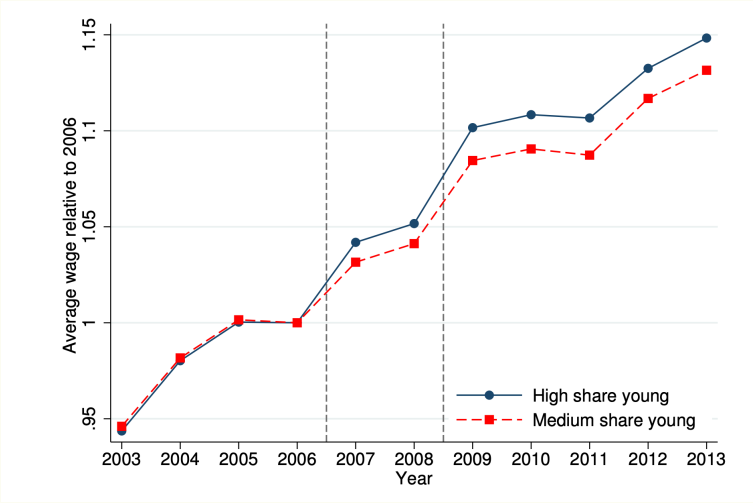


Saez et al. (2019) - Firm employment and financial constraints

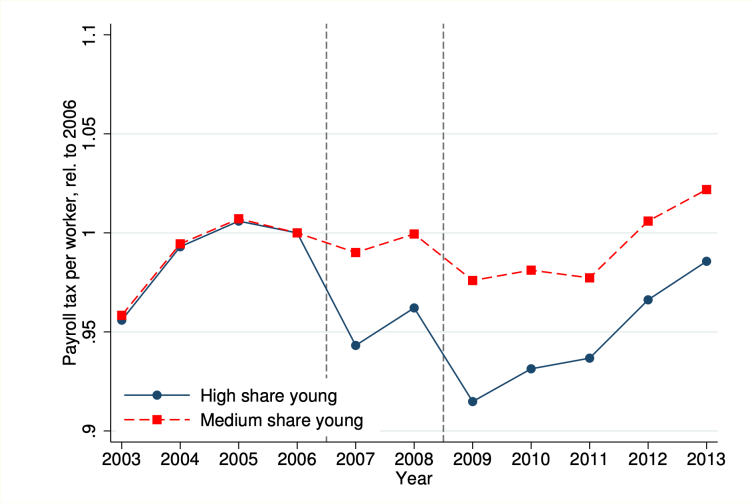




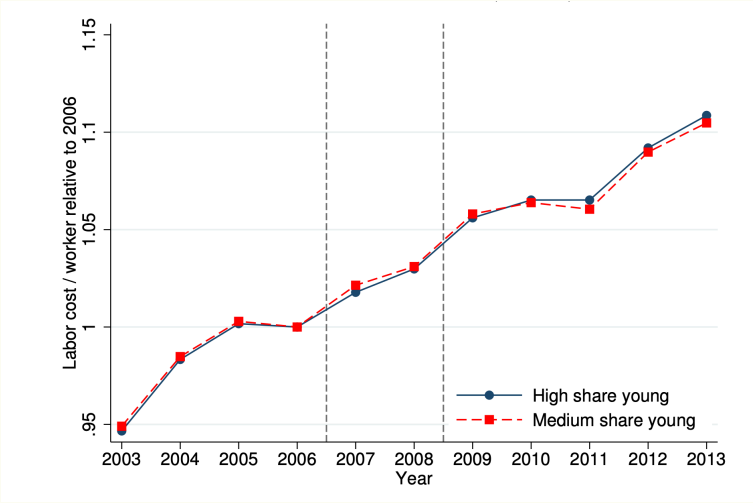
Saez, Schoefer and Seim (2019) - Net wage earnings per worker



Saez, Schoefer and Seim (2019) - Payroll taxes per worker



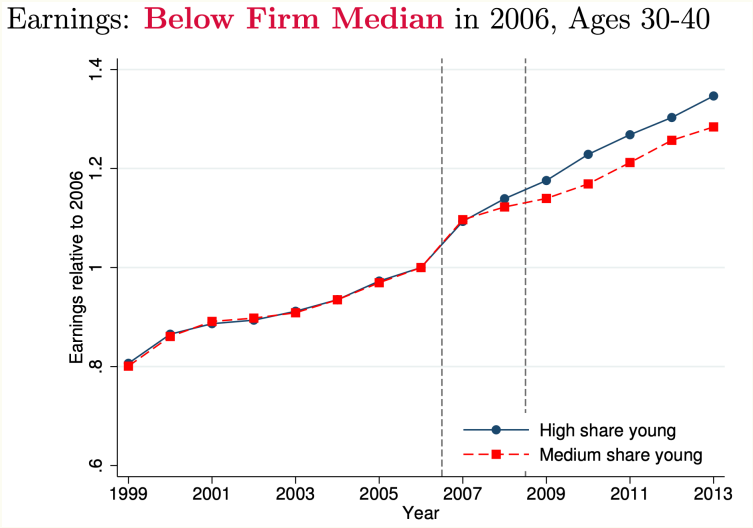
Saez, Schoefer and Seim (2019) - Labor cost per worker



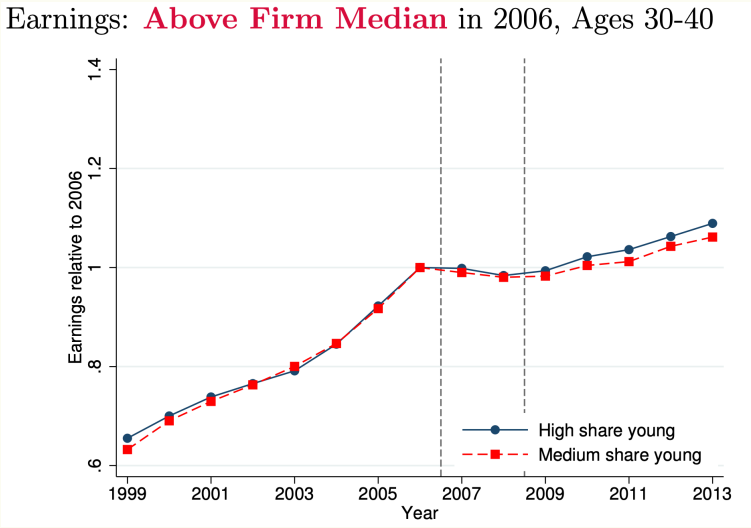
Saez et al (2019) - Individual VS Collective wage incidence

- Frictionless benchmark: 100% incidence on directly affected worker beneficiary group
- Evidence shows that workers benefit from the payroll tax cut
  - but collectively in specific firms, not only the treated workers.
- Evidence consistent with part of the incidence falling on workers
  - young and old workers in the “treated firms”.
- What about distributional effects?

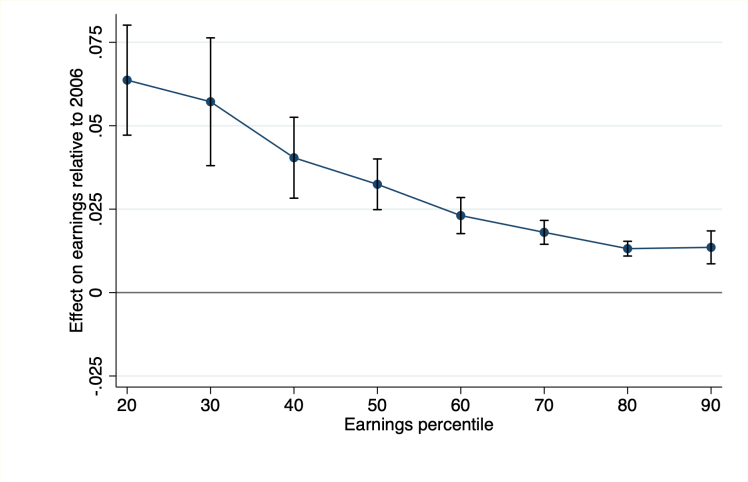
Saez et al (2019) - Wage below firm median



Saez et al (2019) - Wage above firm median



Saez et al (2019) - Wage across percentiles



Saez et al (2019) - Conclusions

- Standard view: Payroll tax split between market-level wage of directly treated workers and employers' profits.
- Findings: Transmission of payroll tax wage incidence may work through firm-level rent-sharing.
  - "Collective" incidence on all workers' wages – including "untreated" ones.
  - Less of a "give-away" to firm owners than aggregate evidence suggests.
- Rent-sharing is consistent with "macro incidence" falling on workers' wages.
- Related evidence:
  - Rent sharing and "firm fixed effects".
  - Wage-setting norms may shield targeted workers from incidence.

When Statutory Incidence Matters

When statutory incidence matters

- Basic theory suggests that statutory incidence of tax should be irrelevent
  - But does this hold in the world?

- Three examples where this does not hold:

  1. Compliance Issues
     - E.g., Kopczuk, Marion, Muehlegger, and Slemrod (2013): Diesel taxes
  2. Consumer/Market Issues
     - E.g., Benzarti, Carloni, Harju, and Kosonen (2019): VAT in Europe
  3. Behavioral Issues
     - E.g., Gallagher and Muehlegger (2011): Incentives to buy green cars
     - E.g., Chetty, Looney, and Kroft (2009): Sales vs. excise taxes

Kopczuk, Marion, Muehlegger, and Slemrod (2013)

- **Question:** Does it matter who pays diesel taxes?
- **Design:** exploit variation across states of tax rate and point of remittance

$$p_{it} = \beta_0 + \beta_1 \tau_{it} + \beta_2 \text{regime}_{it} + \beta_3 \tau_{it} \times \text{regime}_{it} + BX_{it} + \varepsilon_{it}$$

  - regime_{it} measures the point of collection (supplier/distributor vs retailer)
  - if point of collection does not matter $\beta_2 = \beta_3 = 0$

Kopczuk, Marion, Muehlegger, and Slemrod (2013)

Dependent variable: net-of-tax price. Full pass-through when remittance on distributor

TABLE 5—POINT OF TAX COLLECTION AND INCIDENCE

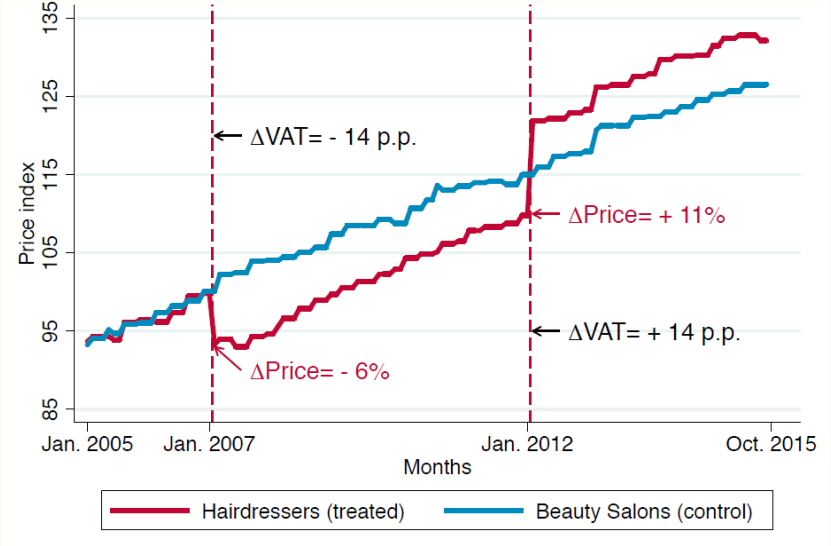
	(1)	(2)	(3)	(4)
Real diesel tax	−0.086***	−0.025	−0.120**	
	(0.021)	(0.022)	(0.055)	
Collect tax from supplier		2.875***	0.445	0.824
		(0.268)	(0.604)	(0.658)
Collect tax from distributor		1.378***	0.192	−0.308
		(0.188)	(0.626)	(0.656)
Real tax × collect from supplier			0.209***	0.162***
			(0.052)	(0.057)
Real tax × collect from distributor			0.100*	0.139**
			(0.056)	(0.057)
Real minimum neighbor's tax	0.080*	0.275***	0.276***	0.249***
	(0.046)	(0.051)	(0.050)	(0.051)
Degree days	0.087	0.094	0.095	0.078
	(0.066)	(0.063)	(0.062)	(0.061)
Degree days × HH fuel oil frac	0.468***	0.460***	0.460***	0.459***
	(0.085)	(0.080)	(0.079)	(0.078)
Unemp. rate	−0.064	−0.128**	−0.135**	−0.132**
	(0.061)	(0.062)	(0.063)	(0.062)
Real diesel tax × year dummies				X
Observations	5,435	5,435	5,435	5,435
R^2	0.98	0.98	0.98	0.98

Notes: The dependent variable is the real tax-exclusive retail price of No. 2 diesel. Each specification includes state fixed effects and year × month effects. Standard errors clustered by year × month are in parentheses.

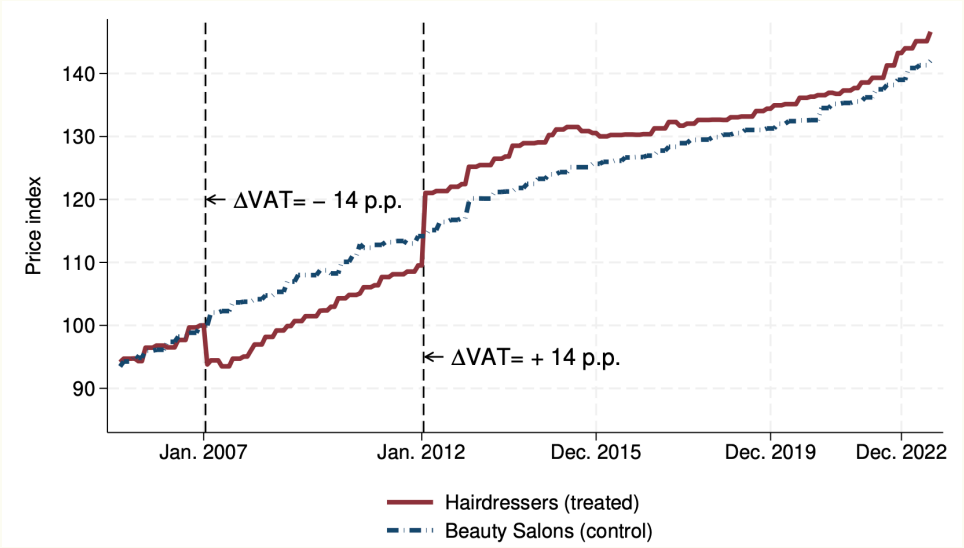
Benzarti, Carloni, Harju, and Kosonen (2019)

- Question: How does the VAT affect consumer prices?
- Design: Two complementary event-study designs:
  - Specific Finnish reforms (excellent data, good sense of institutions)
  - All VAT changes in the EU, 1996-2015 (representativeness)

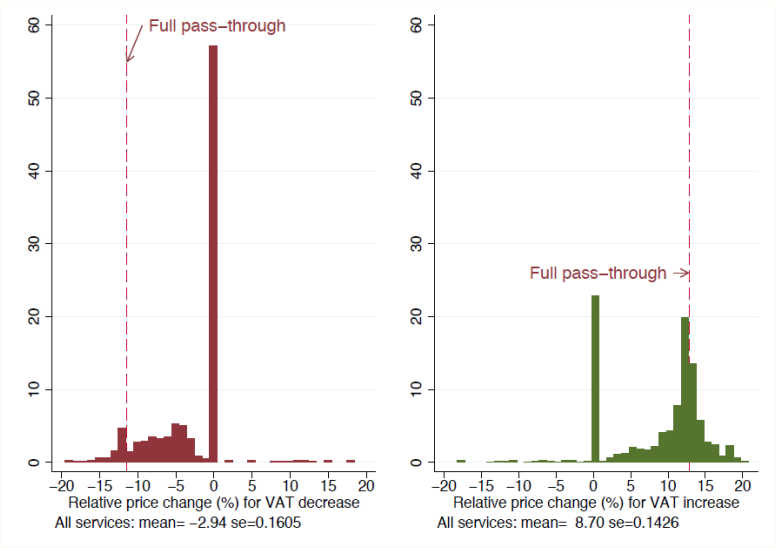
VAT increase and decrease: Finnish hairdressers



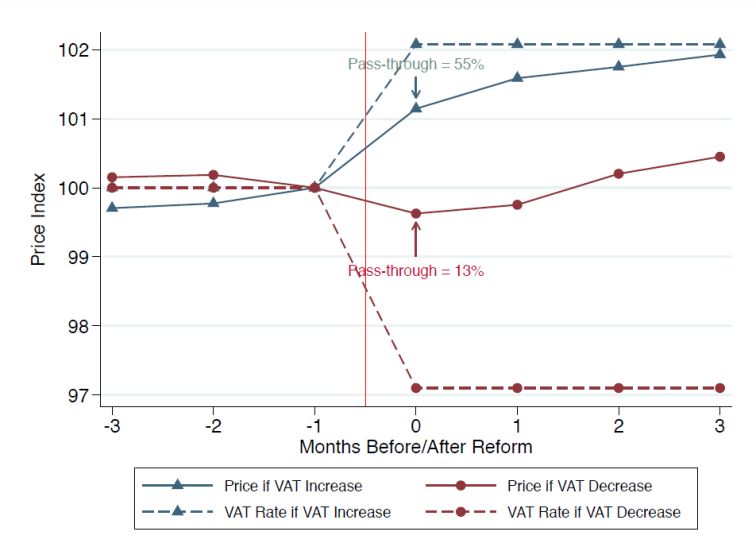
VAT increase and decrease: Finnish hairdressers, long-run hysteresis



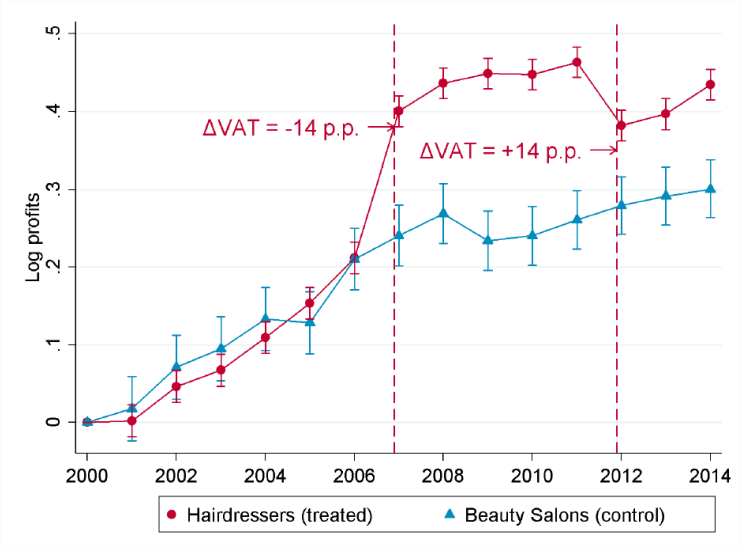
VAT increase and decrease: Distribution of price changes



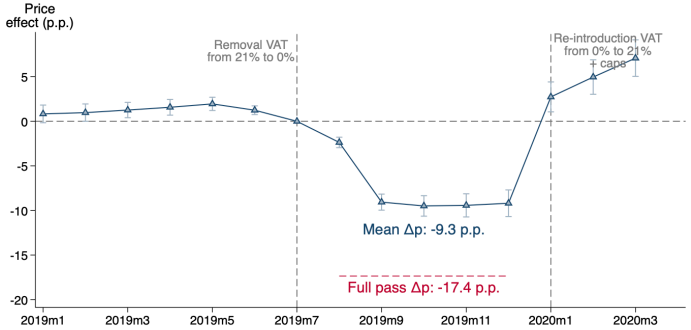
VAT increase and decrease: All EU changes, 1996-2015



VAT increase and decrease: Profits

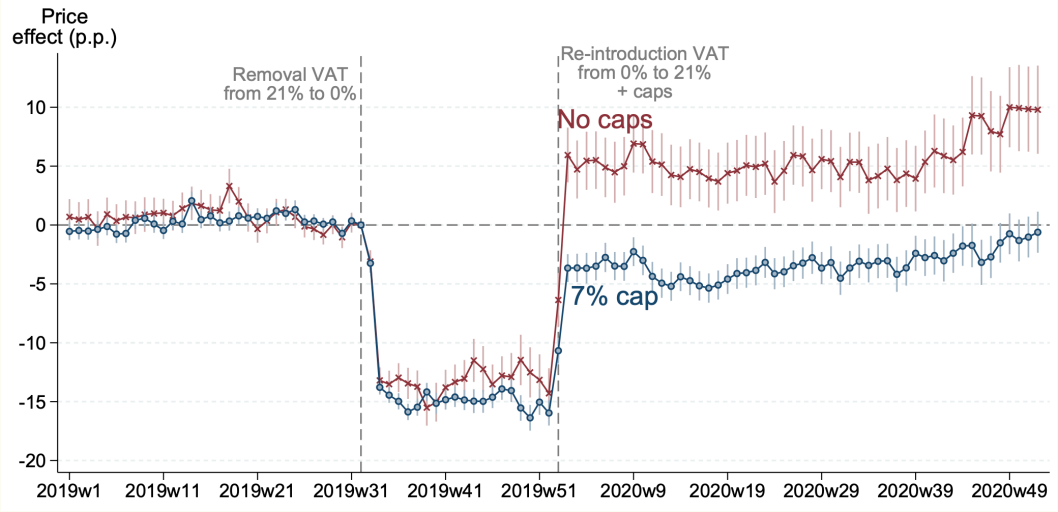


Another example: VAT Holiday



Notes: This figure shows the price pass-through of the VAT holiday for both chain and independent supermarkets using the goods that were not subject to the price caps. We group barcodes into treatment and control as shown in Table 1. The top panel plots the unconditional mean of the average price level for control and treatment food products separately before and after the VAT cut and its subsequent repeal. In each case, we normalize every barcode series to 100 in the month before the VAT cut was implemented (July 2019). The bottom panel shows the results of estimating the dynamic difference-in-differences specification (1). The first vertical dashed line indicates the time when the VAT was decreased to 0% for goods in the treatment group. The second vertical dashed line indicates the time when the VAT was reinstated at 21% for goods in the treatment group with differential caps in the allowed price increase. The red dashed line indicates the hypothetical situation with full pass-through to prices [(1-1.21)/1.21 x 100 = -17.4%].

Another example: VAT Holiday



VAT increase and decrease: Mechanisms

- Three Stylized Facts:
  1. Asymmetric pass-through, even in competitive industries
  2. Asymmetric pass-through distributions, and substantial price dispersion
  3. Long-term persistence of the asymmetric passthrough

- Question: Why does the VAT have asymmetric effects on consumer prices?

- Cannot explain in the standard incidence framework, even including (symmetric) costly price adjustment.
  - No difference in asymmetry for large vs. small reforms, high vs. low growth settings, non-linear demand, etc...

- Potential Mechanisms:
  1. Behavioral Consumers: perceive p increase bc of higher markup unfair, but bc of higher tax fair (short-run)
  2. Lack of Exit/Entry (long-run)

Benzarti, Carloni, Harju, and Kosonen (2019)

- Clear stylized fact that is policy relevant
  - Important implication: Prices are tax-history-dependent
  - Policy Implication: Short-run tax holidays mostly accrue to producers
- Convincingly rules out standard tax incidence model / mechanisms
- Key Question: What is actually going on?
  - So what is the real underlying constraint?
  - And how should policy take account?

Tax incidence with salience effects

- Central assumption of neoclassical model: taxes equivalent to prices

$$\frac{dx}{dt} = \frac{dx}{dp}$$

  - In practice, are people fully aware of marginal tax rates, or other taxes?

- Chetty, Looney, and Kroft (2009) test this assumption and generalize theory to allow for salience effects

- Part 1: Test whether "salience" (visibility of tax-inclusive price) affects behavioral responses to commodity taxation

  - Does effect of a tax on demand depend on whether it is included in posted price?

- Part 2: New formulas for incidence and efficiency costs

Chetty et al.: Conceptual framework

- Economy with two goods, x and y
- Prices: Normalize the price of y to 1 and let p denote the (fixed) pretax price of x.
- Taxes: y untaxed, x subject to an ad valorem sales tax τ (not included in posted price)
  - Tax-inclusive price of x is $q = (1 + \tau)p$
- Let demand for good x be denoted by $x(p, \tau)$

Chetty et al.: Conceptual framework

- If agents optimize fully, demand only depends on tax-inclusive price:

$$\mathbf{x}(\mathbf{p}, \tau) = \mathbf{x}((1+\tau)\mathbf{p}, 0)$$

- Full optimization implies price elasticity equals gross-of-tax elasticity:

$$\varepsilon_{\mathbf{x},\mathbf{p}} \equiv -\frac{\partial \log \mathbf{x}}{\partial \log \mathbf{p}} = \varepsilon_{\mathbf{x},1+\tau^S} \equiv -\frac{\partial \log \mathbf{x}}{\partial \log(1+\tau)}$$

- To test this hypothesis, log-linearize demand fn. $\mathbf{x}(\mathbf{p}, \tau)$ to obtain estimating equation:

$$\log \mathbf{x}(\mathbf{p}, \tau) = \alpha + \beta \log \mathbf{p} + \theta\beta \log(1+\tau)$$

- θ measures degree to which agents under-react to the tax:

$$\theta = \frac{\partial \log \mathbf{x}}{\partial \log(1+\tau)} \Big/ \frac{\partial \log \mathbf{x}}{\partial \log \mathbf{p}} = \frac{\varepsilon_{\mathbf{x},1+\tau}}{\varepsilon_{\mathbf{x},\mathbf{p}}}$$

Chetty et al.: Two empirical strategies

Two strategies to estimate θ:

1. Manipulate tax salience: make sales tax as visible as pre-tax price
   - Effect of intervention on demand:
   $$\mathbf{v} = \log \mathbf{x}((1+\tau)\mathbf{p}, \mathbf{0}) - \log \mathbf{x}(\mathbf{p}, \tau)$$
   - Compare to effect of equivalent price increase to estimate θ:
   $$(1-\theta) = -\frac{\mathbf{v}}{\varepsilon_{\mathbf{x},\mathbf{p}} \log(1+\tau)}$$
2. Manipulate tax rate: compare $\varepsilon_{\mathbf{x},\mathbf{p}}$ and $\varepsilon_{\mathbf{x},1+\tau}$
   $$\theta = \varepsilon_{\mathbf{x},1+\tau} / \varepsilon_{\mathbf{x},\mathbf{p}}$$

- Run fixed-effect panel regression of beer price on excise tax (price-inclusive) and sales tax (price-exclusive) changes.
- Find significantly larger response to excise tax changes ($\varepsilon = 0.9$) than sales tax changes ($\varepsilon = 0.2$)

Chetty et al.: Strategy 1

- Experiment manipulating salience of sales tax implemented at a supermarket that belongs to a major grocery chain
  - 30% of products sold in store are subject to sales tax
  - Posted tax-inclusive prices on shelf for subset of products subject to sales tax (7.375% in this city)
- Data: Scanner data on price and weekly quantity sold by product

Chetty et al.: Strategy 1

Source: Chetty, Looney, and Kroft (2009)

Chetty et al.: Strategy 1

Quasi-experimental difference-in-differences

- Treatment group:
  - Products: Cosmetics, Deodorants, and Hair Care Accessories
  - Store: One large store in Northern California
  - Time period: 3 weeks (February 22, 2006 – March 15, 2006)
- Control groups:
  - Products: Other prods. in same aisle (toothpaste, skin care, shave)
  - Stores: Two nearby stores similar in demographic characteristics
  - Time period: Calendar year 2005 and first 6 weeks of 2006

Chetty et al.: Strategy 1 - DID

Effect of Posting Tax-Inclusive Prices: Mean Quantity Sold

	TREATMENT STORE		
Period	Control Categories	Treated Categories	Difference
Baseline	26.48 (0.22)	25.17 (0.37)	-1.31 (0.43)
Experiment	27.32 (0.87)	23.87 (1.02)	-3.45 (0.64)
Difference over time	0.84 (0.75)	-1.30 (0.92)	**DD_{TS} = -2.14** (0.64)

Chetty et al.: Strategy 1 - DID

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Difference over time	0.84 (0.75)	-1.30 (0.92)	**DD_{TS} = -2.14** (0.64)

CONTROL STORES

Period	Control Categories	Treated Categories	Difference
Baseline	30.57 (0.24)	27.94 (0.30)	-2.63 (0.32)
Experiment	30.76 (0.72)	28.19 (1.06)	-2.57 (1.09)
Difference over time	0.19 (0.64)	0.25 (0.92)	**DD_{CS} = 0.06** (0.90)

Chetty et al.: Strategy 1 - Triple Difference

Effect of Posting Tax-Inclusive Prices: Mean Quantity Sold

TREATMENT STORE

Period	Control Categories	Treated Categories	Difference
Baseline	26.48 (0.22)	25.17 (0.37)	-1.31 (0.43)
Experiment	27.32 (0.87)	23.87 (1.02)	-3.45 (0.64)
Difference over time	0.84 (0.75)	-1.30 (0.92)	**DD_{TS} = -2.14** (0.64)

CONTROL STORES

Period	Control Categories	Treated Categories	Difference
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Experiment	**30.76** **(0.72)**	**28.19** **(1.06)**	**-2.57** **(1.09)**
Difference over time	**0.19** **(0.64)**	**0.25** **(0.92)**	**DD_{CS} = 0.06** **(0.90)**
		DDD Estimate	***-2.20*** (0.58)

Tax incidence with salience effects: Theory

- Let $\{x(p, t, Z), y(p, t, Z)\}$ denote empirically observed demands
- Place no structure on these demand functions except for feasibility:

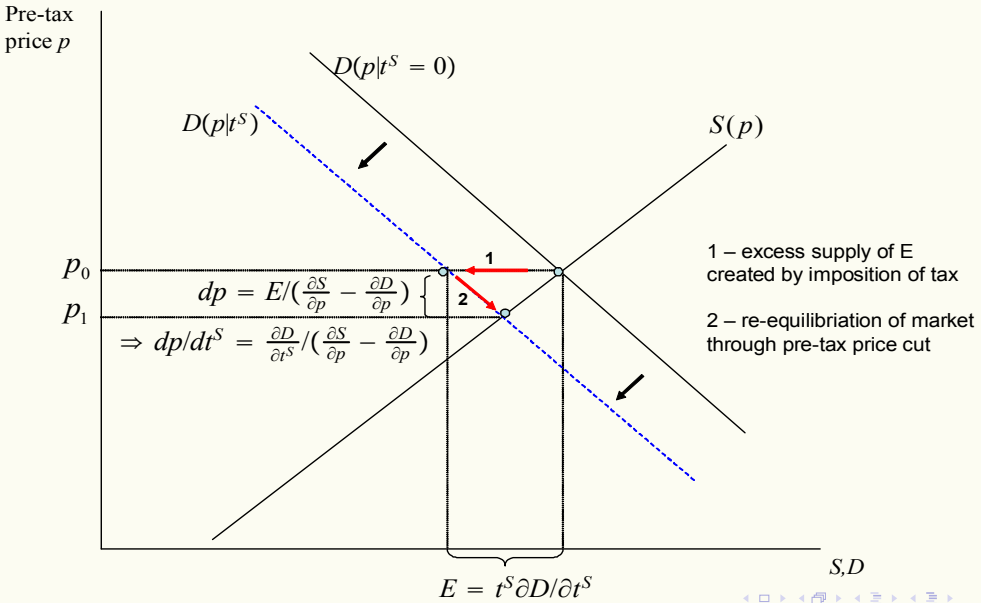
$$(p + t)x(p, t, Z) + y(p, t, Z) = Z$$

- Demand functions taken as empirically estimated objects
- Supply side model same as above
- Market clearing price p satisfies

$$D(p, t, Z) = S(p)$$

where $D(p, t, z) = x(p, t, z)$ is market demand for x.

Tax incidence with salience effects: Theory



Tax incidence with salience effects: Theory

Incidence on producers of increasing t is

$$\frac{dp}{dt} = \frac{\partial D/\partial t}{\partial S/\partial p - \partial D/\partial p} = \theta \frac{\varepsilon_D}{\varepsilon_S - \varepsilon_D}$$

1. Incidence on producers attenuated by θ

2. No tax neutrality: taxes on producers have greater incidence on producers than non-salient taxes levied on consumers

    - Intuition: Producers need to cut pretax price less when consumers are less responsive to tax

Tax Incidence: General Equilibrium

General equilibrium analysis

- Now move beyond two-good partial equilibrium model to analyze impacts on all prices
- Typical goal: trace out full incidence of taxes back to original owners of factors
  - Partial equilibrium: "producer" vs. consumer
  - General equilibrium: capital owners vs. labor vs. landlords, etc.

General equilibrium analysis

Two types of GE models:

1. Static: many sectors or many factors of production
   - Workhorse analytical model: Harberger (1962): 2 sector and 2 factors of production
   - Computational General Equilibrium: many sectors, many factors of production model
2. Dynamic:
   - Characterize impacts over time or across generations
   - Asset price effects: capitalization

Harberger 1962 two sector model

1. Fixed total supply of labor L and capital K (short-run, closed economy)
2. Constant returns to scale in both production sectors
3. Full employment of L and K
4. Firms are perfectly competitive

   Implicit assumption: no adjustment costs for capital and labor

   - Note: Can model open-economy setting as flexible capital with inflexible labor, sectors = countries

Harberger model: Setup

- Production in sectors 1 (bikes) and 2 (cars):

$$X_1 = F_1(K_1, L_1)$$
$$X_2 = F_2(K_2, L_2)$$

  with full employment conditions $K_1 + K_2 = K$ and $L_1 + L_2 = L$

- Factors K and L fully mobile $\rightarrow$ in eq., returns must be equal:

$$w = p_1 F_{1L} = p_2 F_{2L}$$
$$r = p_1 F_{1K} = p_2 F_{2K}$$

- Demand functions for goods 1 and 2:

$$X_1 = X_1(p_1/p_2) \text{ and } X_2 = X_2(p_1/p_2)$$

- System of ten eq'ns and ten unknowns: K_i, L_i, p_i, X_i, w, r

Harberger Model: effect of tax increase

- Introduce small tax $d\tau$ on rental of capital in sector 2 (K_2)
- All eqns the same as above except $r = (1 - d\tau)p_2F_{2K}$
- Labor income = wL with L fixed, rK = capital income with K fixed
- $dw/d\tau$ and $dr/d\tau$ capture how tax is shifted from capital to labor
- $dp_1/d\tau$ and $dp_2/d\tau$ capture how tax is shifted from sector 2 to sector 1

Harberger model: main effects

Substitution effects: capital bears incidence

- Tax on K_2 shifts production in Sector 2 away from K so aggregate demand for K goes down
- Because total K is fixed, r falls $\rightarrow$ K bears some of the burden

Harberger model: main effects

Output effects: capital may not bear incidence

- Tax on K_2 implies that sector 2 output becomes more expensive relative to sector one
- Therefore demand shifts toward sector 1
- Case 1: $K_1/L_1 < K_2/L_2$ (1: bikes, 2: cars)
  - Sector 1 is less capital intensive so aggregate demand for K goes down
  - Output effect reinforces subst effect: K bears the burden of the tax
- Case 2: $K_1/L_1 > K_2/L_2$ (1: cars, 2: bikes)
  - Sector 1 is more capital intensive, aggregate demand for K increases
  - Subst. and output effects have opposite signs; labor may bear some or all the tax

Harberger model: main effects

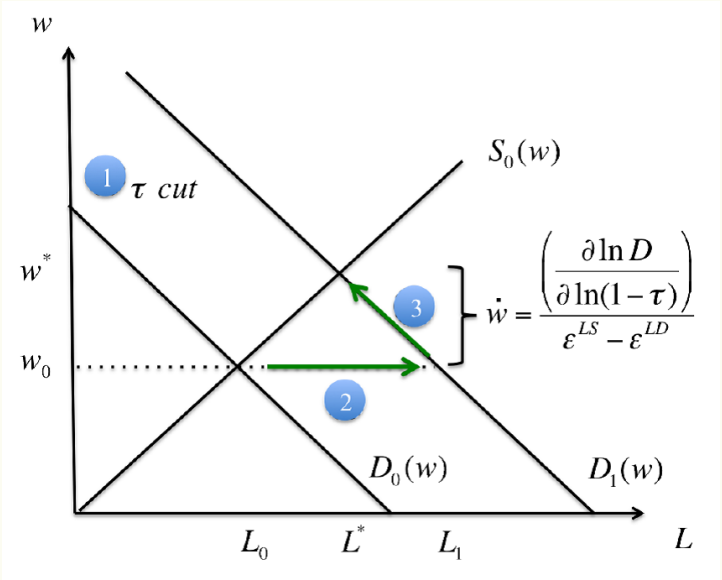
Substitution + Output = Overshifting effects

- Case 2: $K_1/L_1 > K_2/L_2$
  - Possible that capital is made better off by capital tax
  - Labor can be forced to bear more than 100% of tax
  - Tax on capital in bike sector $\rightarrow$ demand for bikes falls, demand for cars rises
  - Capital in greater demand than it was before $\rightarrow$ price of labor falls substantially, capital owners actually gain
- Bottom line: taxed factor may bear less than 0 or more than 100% of tax

Empirical application: Suarez Serrato and Zidar AER 2016

- General equilibrium incidence of state corporate taxes
  - Nice combination of theory and reduced form empirics
- Model includes three sets of actors:
  - Workers/households:
    - Inelasticly supply labor
    - Imperfectly elastic across cities (key parameter)
  - Firms:
    - Monopolistic and heterogeneously productive
    - Inelasticly mobile across cities (key parameter)
  - Land owners:
    - Imperfectly elastic housing supply (key parameter)

Equilibrium in the local labor market



Key equations: Labor supply elasticity to w

- Workers:

$$\varepsilon_{LS} = \frac{1 + \eta_c - \alpha}{\sigma^W (1 + \eta_c) + \alpha}$$

where α is the housing share of spending, η_c is the local housing supply elasticity, and σ^W is the dispersion of place-specific taste parameters

- Elasticity of local labor supply driven by:
  - Greater flexibility of workers across space
  - Greater elasticity in housing supply

Key equations: Labor demand elasticity to w

- Firms:

$$\varepsilon_{LD} = \gamma \left(\epsilon_{PD} + 1 - \frac{1}{\sigma^F} \right) + 1$$

  where γ is the labor Cobb-Douglas parameter, ϵ^{PD} is the product demand elasticity, and σ^F is the dispersion of place-specific productivity parameters

- Elasticity of local labor demand driven by:
  - Greater output elasticity of labor
  - Greater product demand elasticity
  - Greater mobility in firm location (generated through lower heterogeity in productivity)

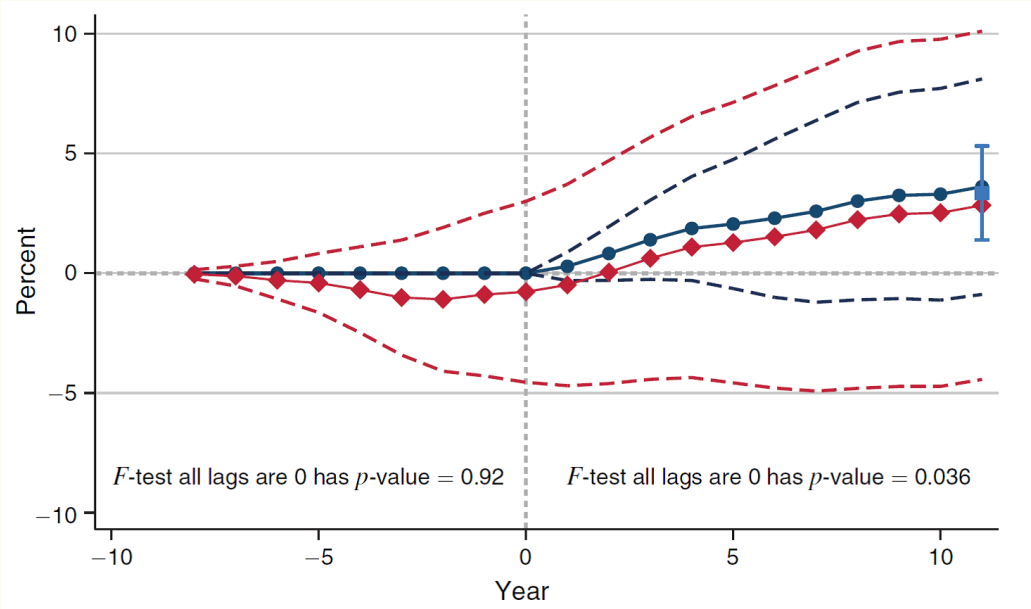
Key equations: Corporate tax incidence

- Incidence on wages is

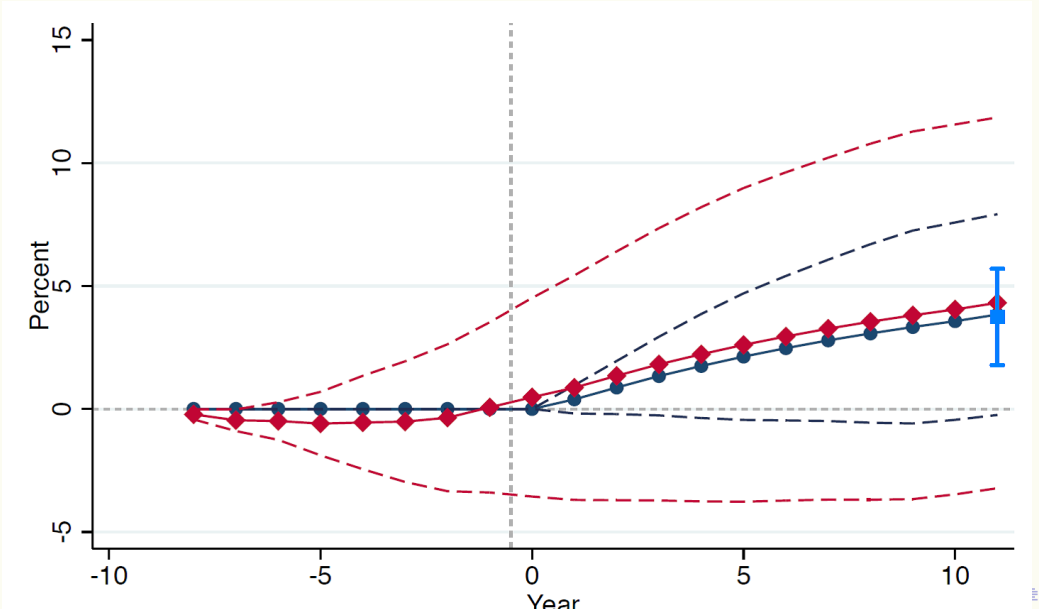
$$\frac{\partial \ln w_c}{\partial \ln (1 - \tau_s)} = \frac{-\frac{1}{(\epsilon_{PD}+1)\sigma^F}}{\varepsilon_{LS} - \varepsilon_{LD}}$$

- Workers bear less burden from corporate tax increase when:
  - Labor supply is elastic
  - Firms are less mobile

Effect of corporate tax cut on establishments



Effect of corporate tax cut on population



Incidence of State-level corporate tax

- Estimates suggest that firms bear 35-45% of the incidence
  - Landowners and workers roughly split the rest
- Sharply at odds with traditional logic
  - Intuition: Firms are not much more mobile than workers due to place-specific productivity (e.g., Silicon Valley).
- So why are state corporate tax rates so low?
  - Authors argue due to fiscal externalities
  - Higher corporate taxes means lower personal income and sales tax revenue