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14.03/003 Micro Theory & Public Policy, Fall 2025

Lecture slides 10. Market equilibrium — A first application

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Market Equilibrium

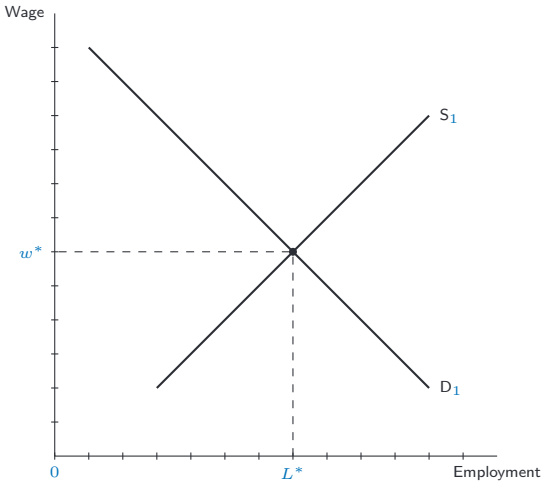
Consumer demand vs. market demand

- To develop consumer theory, we've analyzed the choices of **individuals** who take prices and income (or utility) as **given** (exogenous) when making optimizing decisions
- **But where do prices come from?**
- **Where does income come from?**
- We're going to answer those questions in two steps
  1. How do prices emerge in a market for a single good, taking incomes as given. This is *partial equilibrium applied competitive analysis*
  2. How are prices and incomes determined simultaneously. This is *general equilibrium competitive analysis*

Consumer demand and market demand

- The next two lectures will focus on **partial equilibrium competitive analysis**
- The following two lectures will take it to the next level: **general equilibrium competitive analysis**
- Material from both topics will appear on P-Set #3

Labor market equilibrium



$$w^* : L_s(w^*) = L_d(w^*)$$

Properties of the equilibrium wage

1. The wage is the market clearing *price* of labor
   - w^* is *not* the average product of the workers who are employed
   - w^* is also *not* the average reservation wage of the workers who are employed
   - The wage could *potentially* be as high as the y-intercept of the demand curve
   - The wage could *potentially* be as low as the y-intercept of the supply curve

2. The wage is the solution to two equivalent optimization problems
   - Constrained *maximization* (primal): maximize the wage subject to every worker who wants to work is able to find a job
   - Constrained *minimization* (dual): minimize the wage subject to the constraint that every firm that wants to find a worker at that wage can find one

3. The competitive, decentralized equilibrium in this (idealized) labor market is Pareto efficient

Where do prices come from?

Questions that have puzzled philosophers of Coke and gasoline for millennia

- Why does a gallon of water cost less than a gallon of gas—even though water is surely more essential?
- Why does a gallon of Coke (usually) cost more than a gallon of gas—even though Coke is mostly water?

The marginal revolution

- *Prices are set at the margin:* Prices reflect *marginal* willingness to pay (AKA, marginal value to consumer) not *average* willingness to pay
- The price for something that is essential to life can be very low if that thing is abundant, so marginal utility value is low
- The price for something that is inessential to life can be quite high if that thing is scarce, so marginal utility value is high

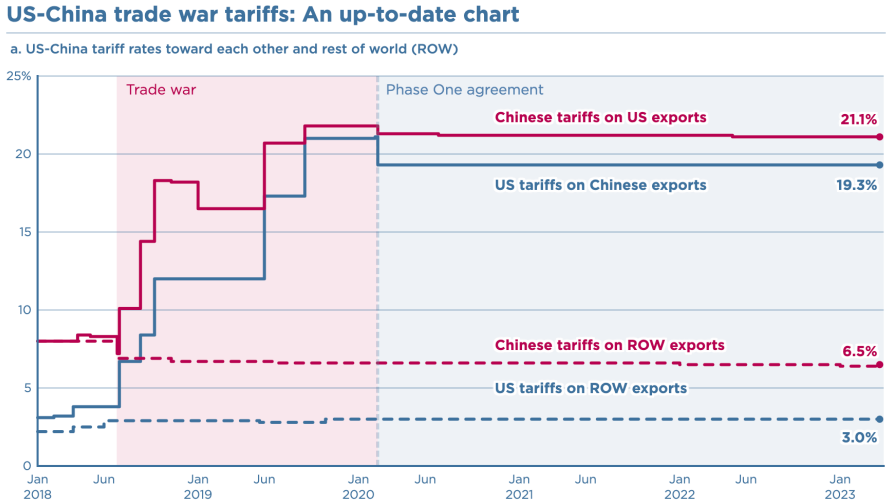
Topics today

1. The incidence of a tariff or tax
2. Taxation and salience: Experimental evidence on how taxation affects behavior in everyday life
3. Taxation and salience: Quasi-experimental evidence from comparing the effects of sales taxes versus excise taxes
4. Taxation, compensation, and the shaping of (distorting, correcting) consumer choice (theory)

Who really pays that tax or tariff?

The question of incidence

The US-China Trade War, 2018–2023



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Who should pay that tariff (tax)?

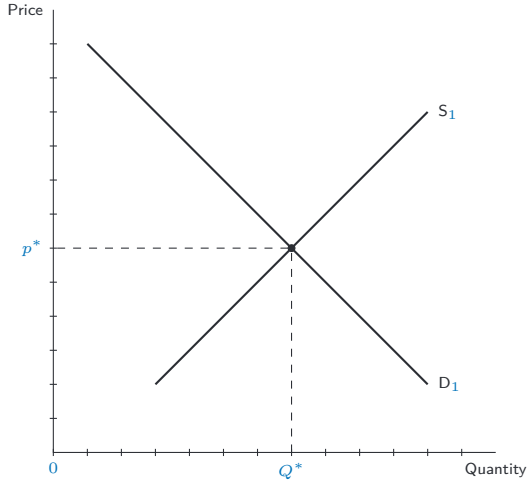
Is it unfair that some taxes are placed on consumers and others on producers?

- Shouldn't oil companies pay taxes on gas, not consumers?
- Doesn't taxing workers for their labor income penalize work? Why not tax employers instead?

To answer this question analytically, we need to ask who bears the *incidence* of a tax

- **Incidence**—the distribution of the economic burden of a tax
- On whom does the incidence of a tax fall, and why?

Product market equilibrium: No tariff



$$p^* : S(p^*) = D(p^*)$$

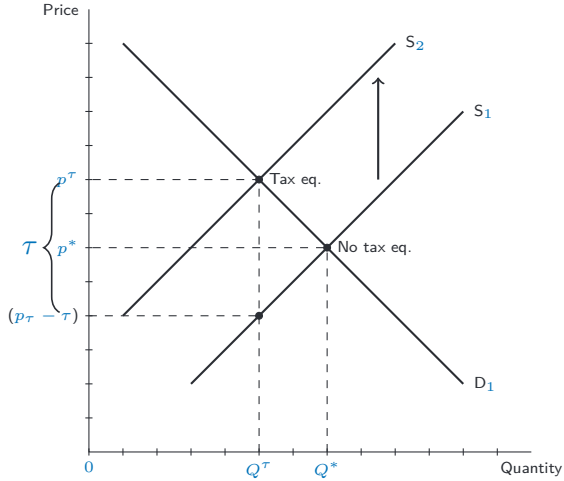
Imposing an income tax τ on importers (sellers)

- Importers must pay a tax of $\tau > 0$ to the government on unit imported
- We can solve for the new equilibrium with the tariff in place:

$$p^{\tau} : S(p^{\tau} - \tau) = D(p^{\tau})$$

- (It is more realistic to assume that importers pay a proportional tax, e.g., $\tau\%$ of the price. But this setup makes the figures and algebra messy—unless we transform everything into logs, which most people find confusing. So please go with this simplification.)

Product market equilibrium: Importers (sellers) pay tariff τ



$$p^\tau : S(p^\tau - \tau) = D(p^\tau)$$

Some questions

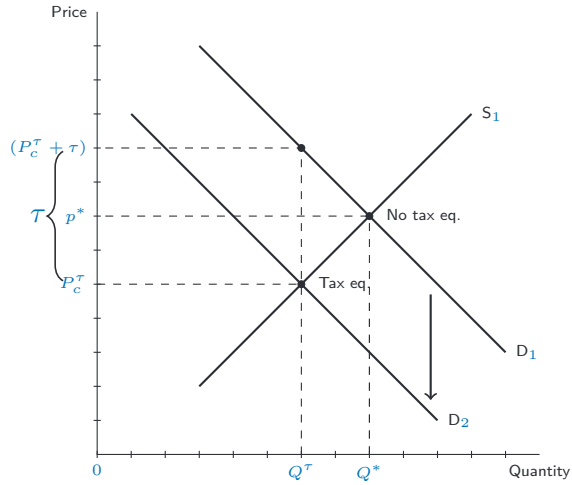
1. Will firm raise price from p^* to $p^* + \tau$?
2. Will consumer cost net of tariff fall from p^* to $p^* - \tau$?
3. Will equilibrium quantity consumed fall, rise, stay the same, or is this indeterminate?
4. What are the welfare consequences of the tariff?

Imposing tariff tax τ on consumers

- **Instead of firms**, consumers (buyers) must pay a tariff of $\tau > 0$ in addition to price
- We can solve for the new equilibrium with the buyer-side tariff in place:

$$p_c^\tau : S(p_c^\tau) = D(p_c^\tau + \tau)$$

Product market equilibrium: Consumers pay the tariff



$$p^\tau : S(p_c^\tau) = D(p_c^\tau + \tau)$$

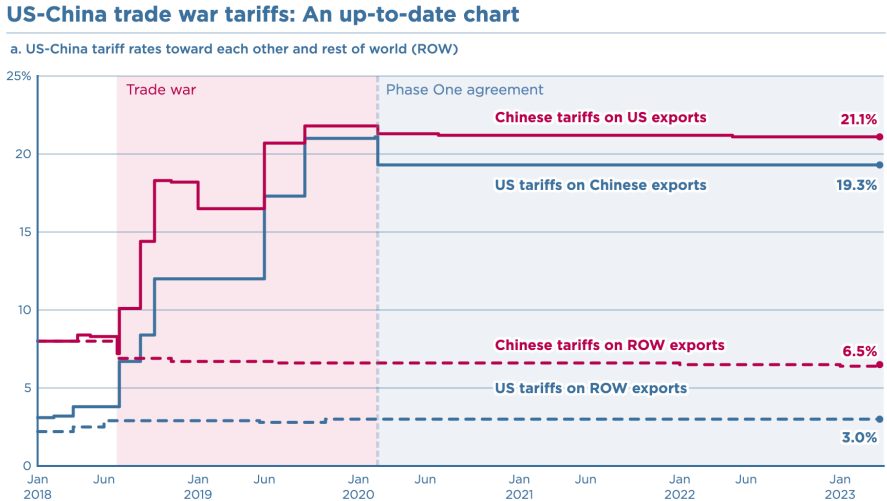
Equivalence between placing tariffs on sellers versus buyers

- It must be the case that

$$p_c^\tau + \tau = p^\tau$$
$$p^\tau - \tau = p_c^\tau$$

- Whether the tax is placed on buyers or sellers, the equilibrium price is the same
- The gap between what the buyer pays what the seller receives is τ, no matter who nominally pays the tax
- Who ultimately pays the tax—the incidence of τ on buyers versus sellers—depends on the interaction between the supply and demand curves

Reminder: The US-China Trade War, 2018–2023



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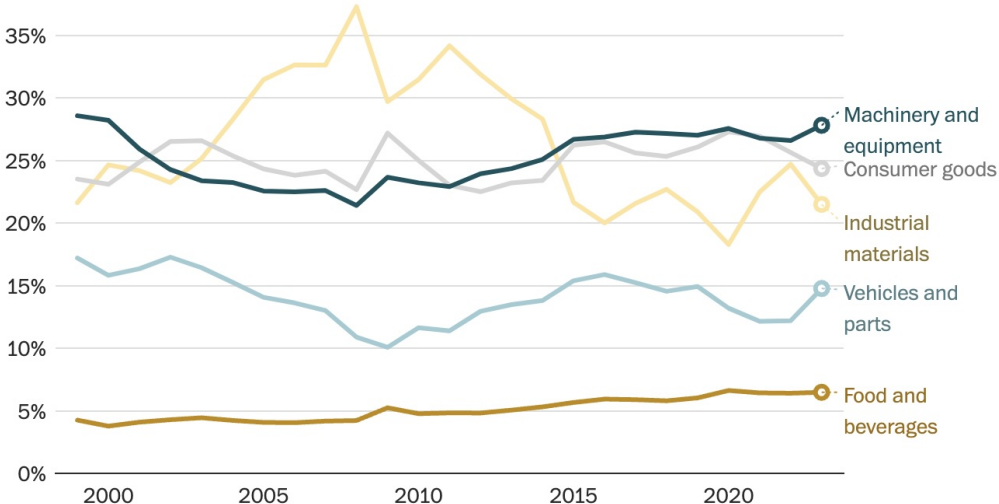
American industry relies on imported supplies

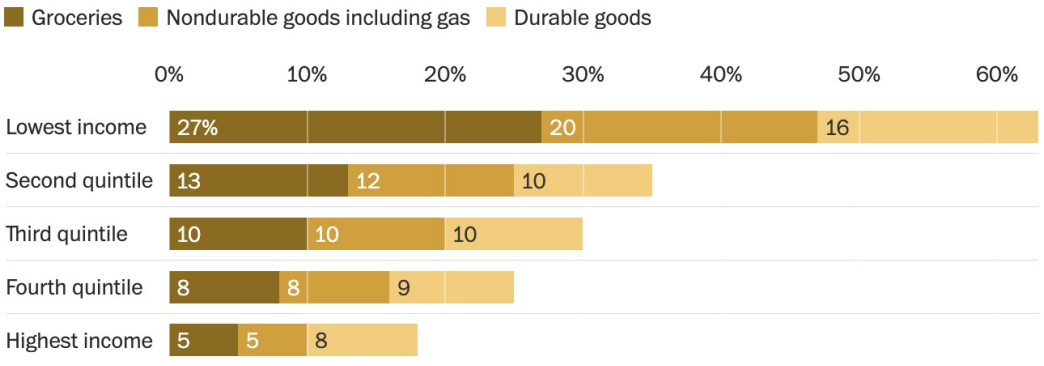
Share of imported materials and supplies by category



Source: Bureau of Economic Analysis

Poorer Americans spend more on goods

Percentage of earnings spent in each category



Source: Consumer Expenditure Survey, Bureau of Labor Statistics

The Trump Administration's 2018 washing machine tariffs

MESSAGE

FROM

THE PRESIDENT OF THE UNITED STATES

TRANSMITTING

DOCUMENTS TO THE CONGRESS THAT DESCRIBE THE SAFEGUARD ACTIONS PROCLAIMED ON IMPORTS OF LARGE RESIDENTIAL WASHERS AND CERTAIN CRYSTALLINE SILICON PHOTOVOLTAIC CELLS (WHETHER OR NOT PARTIALLY OR FULLY ASSEMBLED INTO OTHER PRODUCTS), PURSUANT TO 19 U.S.C. 2253(b); PUBLIC LAW 93–618, SEC. 203(b); (88 STAT. 2015)

JANUARY 25, 2018.—Message and accompanying papers referred to the Committee on Ways and Means and ordered to be printed

U.S. GOVERNMENT PUBLISHING OFFICE

79–011 WASHINGTON : 2018

RELIEF COMPONENTS

Finished washers. Imports will be subject to a tariff-rate quota (TRQ). The in-quota volume will be set at 1.2 million units, which will be subject to a 20 percent additional duty. The out-of-quota duty will be 50 percent. The quota level and out-of-quota tariff rate are set at levels recommended by the ITC. The in-quota duty is at the level recommended by a plurality of the Commissioners. This duty will provide an impetus for importers to increase their prices, thereby relieving the downward pressure on prices that has led to a decline in domestic washer producers' financial performance. This action will facilitate the efforts of U.S. producers to adjust to import competition without placing an undue burden on U.S. consumers.

Substitution towards Chinese washers just before tariffs took effect

More imports of Vietnamese, Korean, and Thai washers during the tariffs

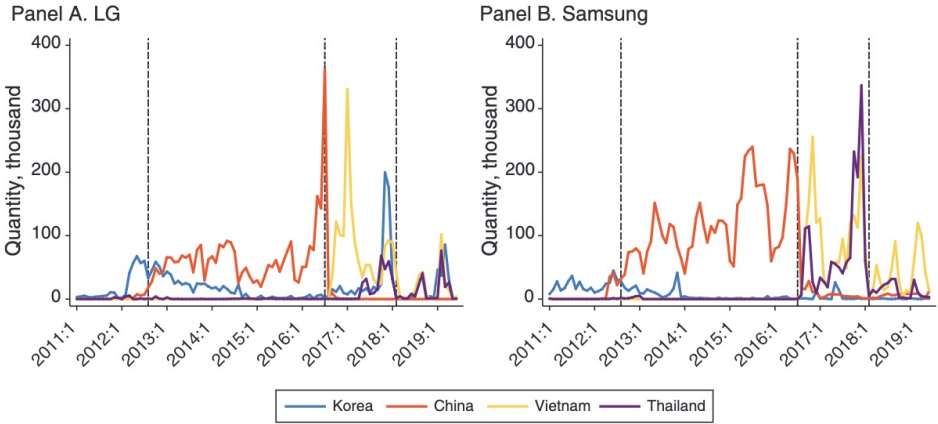
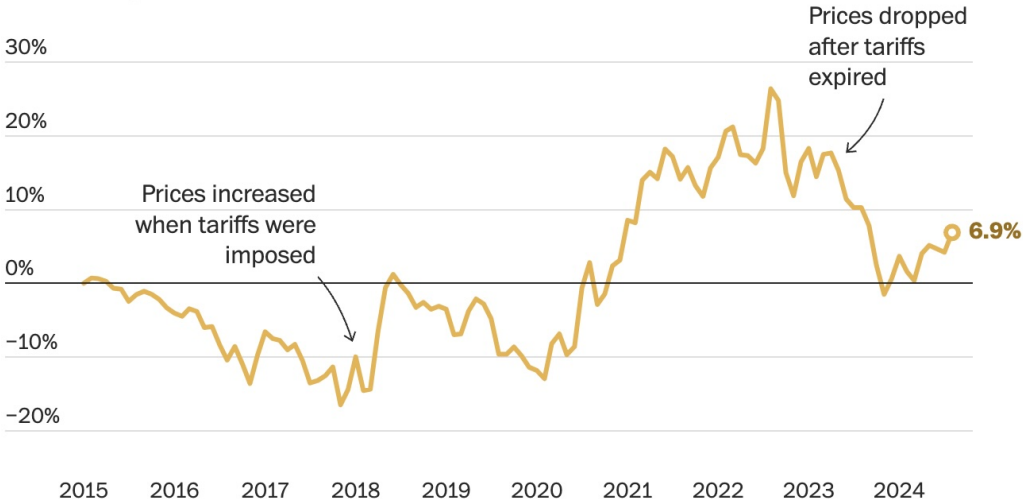


FIGURE 2. FIRM-LEVEL IMPORTS OF WASHING MACHINES

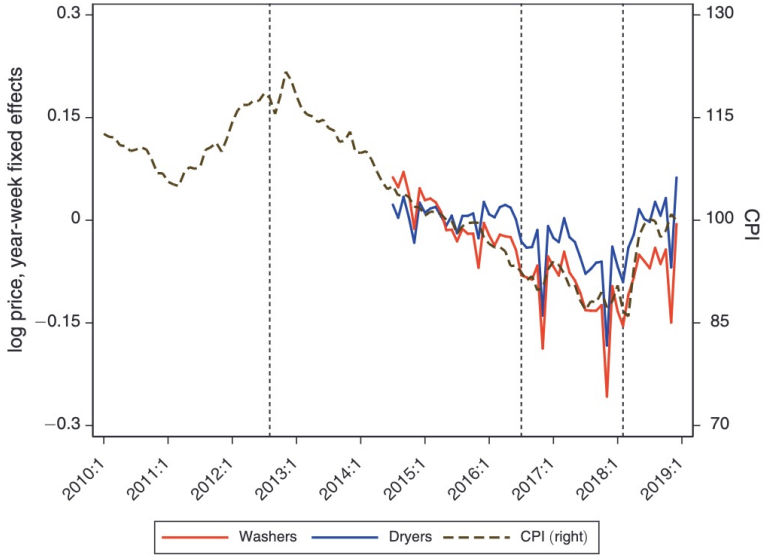
Prices of washers and dryers spiked after tariffs took effect

Price changes from Jan. 2015



Source: Bureau of Labor Statistics

Comparing price index for all consumer prices, washers, and dryers



Tariff 'spillovers' affected dryers, but not most household appliances

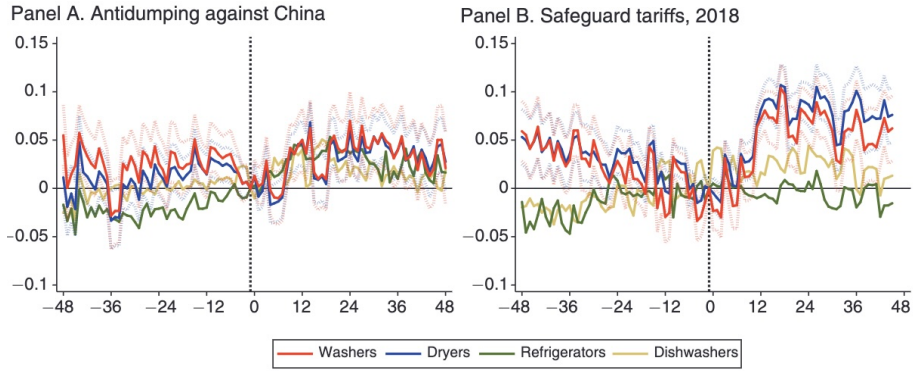


FIGURE 5. PRICE EFFECTS OF SAFEGUARD TARIFFS AND ANTIDUMPING DUTIES AGAINST CHINA

Notes: These figures report the regression coefficients $\lambda_{C(i)t}$ from equation (2). In panel A the estimates are relative to the week of July 17, 2016, and in panel B the estimates are relative to the week of January 28, 2018. The dotted lines denote 95 percent confidence intervals for the coefficient estimates for washers and dryers, based on standard errors clustered by model.

"Salience and Taxation: Theory and Evidence"
Chetty, Looney, and Kroft (2009)

Part I: The salience experiment

Adding post-tax prices to shelved items

Are Harvard students aware of sales taxes?

"We showed the students a photograph of taxable products on the shelf at the grocery store similar to that in Exhibit 1. We distributed surveys asking each student to choose two goods and write down "the total bill due at the register for these two items." We first showed the photograph with the regular tags displaying only the pretax prices. After collecting the survey responses, we showed a second photograph of products with our tax-inclusive price tags and asked students to repeat the exercise."

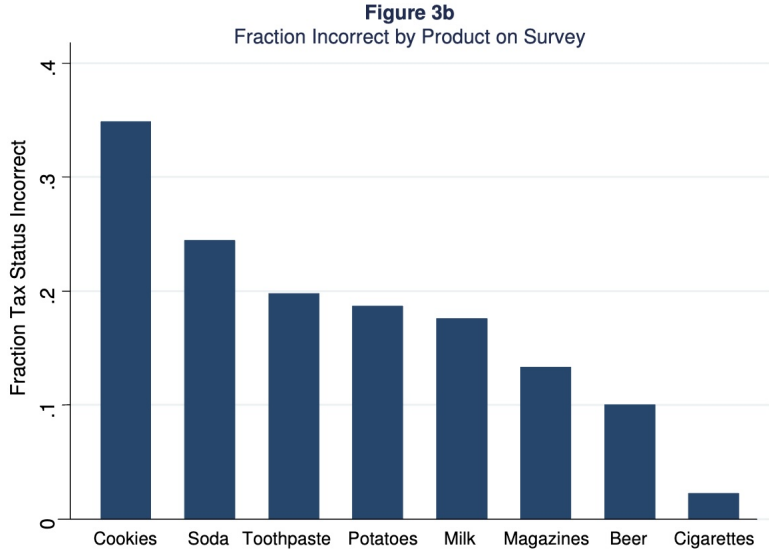
Are Harvard students aware of sales taxes?

TABLE 1— SURVEY EVIDENCE: SUMMARY STATISTICS

	Mean	Median	Standard deviation
Panel A. Classroom survey			
Original price tags:			
Correct tax-inclusive price w/in $0.25	0.18	0.00	0.39
Experimental price tags:			
Correct tax-inclusive price w/in $0.25	0.75	1.00	0.43
t-test for equality of means: $p < 0.001$			
$N = 49$			

Notes: Panel A reports summary statistics for a survey of 49 students who were shown regular (non-tax-inclusive) price tax and the experimental (tax-inclusive) price tags. Statistics shown are for an indicator for whether individual reported total bill within 25 cents of total tax-inclusive price. See Web Appendix Exhibit 1 for survey instrument. Panel B reports summary statistics for a survey of 91 customers at the treatment grocery store. See Web Appendix Exhibit 2 for survey instrument.

Are grocery store customers aware of sales taxes? Survey evidence



Descriptive statistics: Tax salience experiment

TABLE 2— GROCERY EXPERIMENT: SUMMARY STATISTICS

	Treatment store		Control stores		Total
	Treatment products (1)	Control products (2)	Treatment products (3)	Control products (4)	All stores and products (5)
Panel A. Category-level statistics					
Weekly quantity sold per category	25.08 (24.1)	26.63 (38.1)	27.84 (27.4)	30.64 (47.0)	29.01 (42.5)
Weekly revenue per category	$97.85 (81.9)	$136.05 (169.9)	$107.04 (92.3)	$154.66 (207.7)	$143.10 (187.1)
Number of categories	13	95	13	95	108
Panel B. Product-level statistics					
Pre-tax product price	$4.46 (1.8)	$6.26 (4.3)	$4.52 (1.7)	$6.31 (4.2)	$6.05 (4.1)
Pre-tax product price (weighted by quantity sold)	$4.27 (1.7)	$5.61 (3.9)	$4.29 (1.6)	$5.59 (3.8)	$5.45 (3.7)
Weekly quantity sold per product (conditional > 0)	1.47 (0.9)	1.82 (1.6)	1.61 (1.1)	1.98 (1.9)	1.88 (1.7)

Notes: Statistics reported are means with standard deviations in parentheses. Statistics are based on sales between 2005 week 1 and 2006 week 15. Data source is scanner data obtained from a grocery chain. The "treatment store" is the store where the intervention took place; the "control stores" are two nearby stores in the same chain. "Treatment products" are cosmetics, hair care accessories, and deodorants. "Control products" are other toiletries located in the same aisles; see Web Appendix Table 2 for complete list. Product price reflects actual price paid, including any discount if product is on sale. See Web Appendix A for data sources and sample definition.

Diff-in-Diff and Diff-in-Diff-in-Diff ('Triple-Diff') estimates

TABLE 3— EFFECT OF POSTING TAX-INCLUSIVE PRICES: *DDD* ANALYSIS OF MEAN QUANTITY SOLD

Period	Control categories	Treated categories	Difference
Panel A. Treatment store			
Baseline (2005:1–2006:6)	26.48 (0.22) [5,510]	25.17 (0.37) [754]	−1.31 (0.43) [6,264]
Experiment (2006:8–2006:10)	27.32 (0.87) [285]	23.87 (1.02) [39]	−3.45 (0.64) [324]
Difference over time	0.84 (0.75) [5,795]	−1.30 (0.92) [793]	$DD_{TS} = -2.14$ (0.68) [6,588]
Panel B. Control stores			
Baseline (2005:1–2006:6)	30.57 (0.24) [11,020]	27.94 (0.30) [1,508]	-2.63 (0.32) [12,528]
Experiment (2006:8–2006:10)	30.76 (0.72) [570]	28.19 (1.06) [78]	−2.57 (1.09) [648]
Difference over time	0.19 (0.64) [11,590]	0.25 (0.92) [1,586]	$DD_{CS} = 0.06$ (0.95) [13,176]
DDD Estimate			−2.20 (0.59) [19,764]

Notes: Each cell shows mean quantity sold per category per week, for various subsets of the sample. Standard errors (clustered by week) in parentheses, number of observations in square brackets. Experimental period spans week 8 in 2006 to week 10 in 2006. Baseline period spans week 1 in 2005 to week 6 in 2006. Lower panel reflects averages across the two control stores.

Effect of tax salience on consumption: Regression estimates

TABLE 4—EFFECT OF POSTING TAX-INCLUSIVE PRICES: REGRESSION ESTIMATES

Dependent variable	Quantity per category (1)	Revenue per category ($) (2)	Log quantity per category (3)	Quantity per category (4)	Quantity (treat. categories only) (5)
Treatment	−2.20	−13.12	−0.101	−2.27	−1.55
	(0.60)	(4.89)	(0.03)	(0.60)	(0.35)
Average price	−3.15	−3.24		−3.04	−15.06
	(0.26)	(1.74)		(0.25)	(3.55)
Average price squared	0.05	0.06		0.05	1.24
	(0.00)	(0.03)		(0.00)	(0.34)
Log average price			−1.59		
			(0.11)		
Before treatment				−0.21	
				(1.07)	
After treatment				0.20	
				(0.78)	
Category, store, week FEs	x	x	x	x	x
Sample size	19,764	19,764	18,827	21,060	2,379

Notes: Standard errors, clustered by week, reported in parentheses. All columns report estimates of the linear regression model specified in equation (4). Quantity and revenue reflect total sales of products within a given category per week in each store. Average price is a weighted average of the prices of the products for sale in each category using a fixed basket of products (weighted by total quantity sold) over time. In column 3, observations are weighted by total revenue by category-store. Specification 4 includes "placebo" treatment variables (and their interactions) for the three-week period before the experiment and the three-week period after the experiment. Specification 5 reports DD estimates restricting the sample to treatment product categories only (at both treatment and control stores). In this specification, the "treatment" variable is defined as the interaction between the treatment store dummy and treatment time dummy.

"Salience and Taxation: Theory and Evidence"
Chetty, Looney, and Kroft (2009)

Part II: Sales taxes versus excise taxes

Sales taxes versus excise taxes

- **Sales tax:** Paid at the point of sale. Not listed on the price tag
- **Excise tax:** Charged ahead of time to the seller and hence implicitly included in the price (and hence on the price tag)

Summary statistics: Beer consumption, excise taxes, and sales taxes

TABLE 5— SUMMARY STATISTICS FOR STATE BEER CONSUMPTION, TAXES, AND REGULATION

Per capita beer consumption (cans)	243.2
	(46.1)
State beer excise tax ($/case)	0.51
	(0.50)
State beer excise tax (percent)	6.5
	(8.2)
Sales tax (percent)	4.3
	(1.9)
Drinking age is 21	0.73
	(0.44)
Drunk driving standard	0.65
	(0.47)
Any alcohol regulation change	0.19
	(0.39)
N (number of state-year pairs)	1,666

Notes: Statistics reported are means with standard deviations in parentheses. Observations are by state for each year from 1970 to 2003. "Drinking age is 21" is an indicator for whether the state-year has a legal drinking age of 21. "Drunk driving standard" indicates state-year has a threshold blood alcohol content level above which one is automatically guilty of drunk driving. "Any alcohol regulation change" is a dummy variable equal to one in any year where a state has raised the drinking age or implemented a stricter drunk driving standard, an administrative license revocation law, or a zero tolerance youth drunk driving law. See Web Appendix A for data sources and sample definition.

Regression estimates: Beer consumption, excise taxes, and sales taxes

TABLE 6— EFFECT OF EXCISE AND SALES TAXES ON BEER CONSUMPTION

	Baseline (1)	Business cycle (2)	Alcohol regulations (3)	Region trends (4)
Dependent variable: Change in log (per capita beer consumption)				
$\Delta \log(1 + \text{excise tax rate})$	−0.88	−0.91	−0.89	−0.71
	(0.17)	(0.17)	(0.17)	(0.18)
$\Delta \log(1 + \text{sales tax rate})$	−0.20	−0.01	−0.02	−0.05
	(0.30)	(0.30)	(0.30)	(0.30)
$\Delta \log(\text{population})$	0.03	−0.07	−0.07	−0.09
	(0.06)	(0.07)	(0.07)	(0.08)
$\Delta \log(\text{income per capita})$		0.22	0.22	0.22
		(0.05)	(0.05)	(0.05)
$\Delta \log(\text{unemployment rate})$		−0.01	−0.01	−0.01
		(0.01)	(0.01)	(0.01)
Alcohol regulation controls			x	x
Year fixed effects	x	x	x	x
Region fixed effects				x
F-test for equality of tax elasticities (prob $> F$)	0.05	0.01	0.01	0.06
Sample size	1,607	1,487	1,487	1,487

Notes: Standard errors, clustered by state, in parentheses. All specifications are estimated on full sample for which data are available (state unemployment rate data are unavailable in early years). Column 3 includes three indicators for whether the state implemented per se drunk driving standards, administrative license revocation laws, or zero tolerance youth drunk driving laws, and the change in the minimum drinking age (measured in years). Column 4 includes fixed effects for each of nine census regions. F-test tests null hypothesis that coefficients on excise and sales tax rate variables are equal.

Consumption responses to sales taxes – Visual evidence

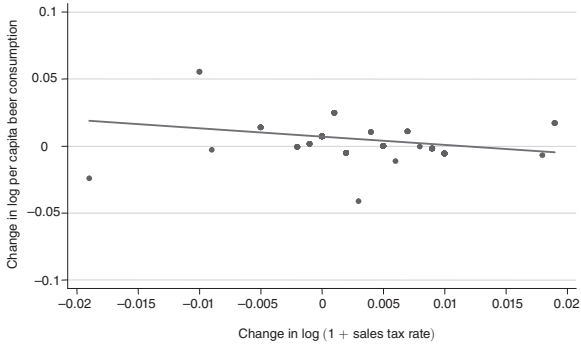


FIGURE 2B. PER CAPITA BEER CONSUMPTION AND STATE SALES TAXES

Notes: These figures plot within-state annual changes in beer consumption against within-state changes in gross-of-tax-prices ($1 + t^E$ and $1 + t^S$). To construct Figure 2A, we round each state excise tax change to the nearest tenth of a percent (0.1 percent), and compute the mean change in log beer consumption for observations with the same rounded excise tax change. Figure 2A plots the mean consumption change against the rounded excise tax rates. Figure 2B is constructed analogously, rounding sales tax changes to the nearest 0.1 percent. See Web Appendix A for data sources and sample definition.

Consumption responses to excise taxes – Visual evidence

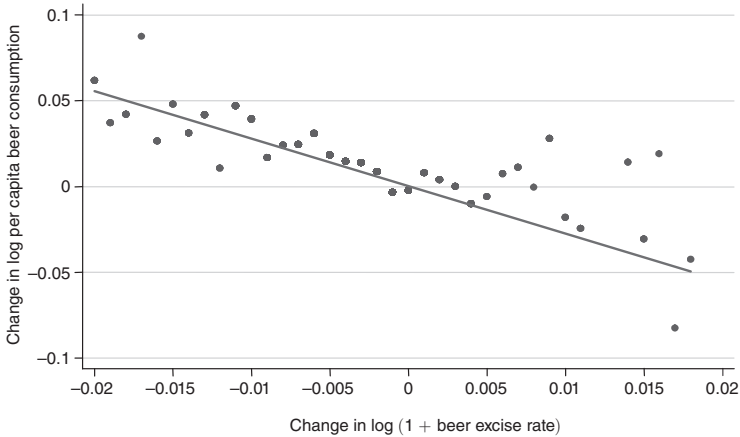


FIGURE 2A. PER CAPITA BEER CONSUMPTION AND STATE BEER EXCISE TAXES

Taxation, compensation, and shaping (distorting, correcting) consumer choice

Using taxes to change behavior without making people poorer

- Taxes are often used *intentionally* to change behavior — e.g., burn less fossil fuel, drink fewer sugar-sweetened beverages (SSBs), not drive during rush hour, or run their energy-intensive appliances at non-peak hours
- E.g., gas taxes, SSB taxes, time-varying road tolls, time-of-day energy pricing
- But this creates a conundrum: Lower income individuals and households spend a larger share of their budgets on these necessities. So these taxes are regressive—they take a larger share of income of the poor than the wealthy
- A natural solution to this conundrum is to impose a tax while making a transfer to low-income households to offset the income loss.
- If the policy simply *rebates* the tax to low-income households, then it's not a tax at all.
- So, the rebate needs to be decoupled from the tax paid

What is the effect on consumer welfare of pairing a tax with a rebate to hold income constant?

- Consider a tax τ on each unit of good X that is *fully rebated* to the consumer:

$$\tau \times d_x(P_x + \tau, P_y, I + R) = R. \tag{1}$$

- This tax is revenue neutral for consumer; rebated exactly the amount paid in taxes ($R = \tau d_x(\cdot)$)
- This tax alters the *price ratio* faced by the consumer but intersects the original budget set at the newly chosen bundle.
- We assume that the consumer is ***not*** choosing X with the expectation that all tax paid will be refunded
- (Perhaps the rebate is equal to the average tax paid, and this consumer happens to purchase the average amount of X.)

What is the effect of $\tau + R$ on consumer welfare?