ECON 180

Introduction to Principles of Microeconomics and Financial Project Evaluation

Lecture 18: Who pays a soda tax?

October 19, 2021

Version 1

Required Reading and Viewing

- Sections 2.2 – 2.5 (pages 38-63) of Besanko/Brauetigam. Available online at http://bcs.wiley.com/he-bcs/Books?action=chapter&bcsId=2164&itemId=0471457698&chapterId=14997
  - (Click on 'Chapters 1-8' for PDF)
- Gordon, S. (2010). The economics of tax incidence: paying the tax is not the same as bearing the burden [Web Page]. Retrieved from http://worthwhile.typepad.com/worthwhile_canadian_initi/2010/08/incidence.html
- You Will Love Economics. (2018, October 5). Micro: Unit 1.5 – Excise Taxes and Tax Incidence [Video File]. Retrieved from https://youtu.be/L7rHOwkUD9A

Recommended Reading

- Topics 4.1 and 4.2 in Hutchinson, E. (n.d.). *Principles of Microeconomics*. https://pressbooks.bccampus.ca/uvicecon103/
- Stand-Up Economics: Chapters 12 and 14
- Stand-Up Microeconomics: http://standupeconomist.com/stand-up-economics-the-micro-textbook/ (Choose the version with calculus.)
  - **The above has plenty of *solved problems* for you to learn from.**
- Tax incidence [Web Page]. (n.d.). Retrieved from http://www.amosweb.com/cgi-bin/awb_nav.pl?s=wpd&c=dsp&k=tax+incidence
  - **A simple explanation of tax incidence, with mildly interactive graphics**

Sources

- Cawley, J., Frisvold, D., Hill, A. & Jones, D. (2019). The impact of the Philadelphia beverage tax on purchases and consumption by adults and children. *Journal of Health Economics*, *67*, 102225. Retrieved from https://doi-org.ezproxy.library.uvic.ca/10.1016/j.jhealeco.2019.102225
- Etile, F., Lecocq, S. & Boizot-Szantai, C. (2018). *The Incidence of Soft-Drink Taxes on Consumer Prices and Welfare: Evidence from the French "Soda Tax"* [Pre-print]. Retrieved from https://halshs.archives-ouvertes.fr/halshs-01808198/
- Zhong, Y., Auchincloss, A. H., Lee, B. K. & Kanter, G. P. (2018). The Short-Term Impacts of the Philadelphia Beverage Tax on Beverage Consumption. *American Journal of Preventive Medicine*, *55*(1), 26-34. Retrieved from https://doi-org.ezproxy.library.uvic.ca/10.1016/j.amepre.2018.02.017

Optional Readings on the Soda Tax

- Oksman, O. (2016, June 20). Philadelphia soda tax passed with help of a new sell: to raise funds for pre-K. *The Guardian*. Retrieved from https://www.theguardian.com/business/2016/jun/20/philadelphia-soda-tax-pre-k-funding-obesity-health (**Philadelphia Soda Tax**)
- Kell, J. (2016, March 29). Soda Consumption Falls to 30-Year Low in the U.S. *Fortune*. Retrieved from http://fortune.com/2016/03/29/soda-sales-drop-11th-year/ (**US average soda consumption**)
- McCrystal, L. (2018, March 1). Philly soda tax revenue falling short, city adjusts for pre-K and other programs. *The Inquirer*. Retrieved from http://www.philly.com/philly/news/pennsylvania/philadelphia-soda-tax-revenue-preschool-20180301.html (**Tax revenue less than expected**.)
- Sasko, C. (2018, April 13). The Soda Tax has Had a Huge Impact on Philly's Soda-Drinking Habits, Suggests New Study. *Philadelphia Magazine*. Retrieved from https://www.phillymag.com/news/2018/04/13/philadelphia-soda-tax-people-drinking-less-soda/ (**Soda tax successfully affected consumption habits**.)

Learning objectives

- Understand the concept of tax/cost incidence/burden.
- Understand that incidence is independent of who pays the tax.
- Understand how incidence depends on the elasticities of supply and demand.
- Be able to use a supply and demand diagram to derive tax incidence.
- Be able to use algebra to calculate tax incidence.
- Be able to use elasticities and calculus to calculate tax incidence.

Relevant Solved Problems

- From Stand-Up Economics: http://standupeconomist.com/stand-up-economics-the-micro-textbook/ (Choose the version with calculus.)
- Burdens: 12.2(b), 12.3(f), 12.8, 14.3(e), 14.5(c)

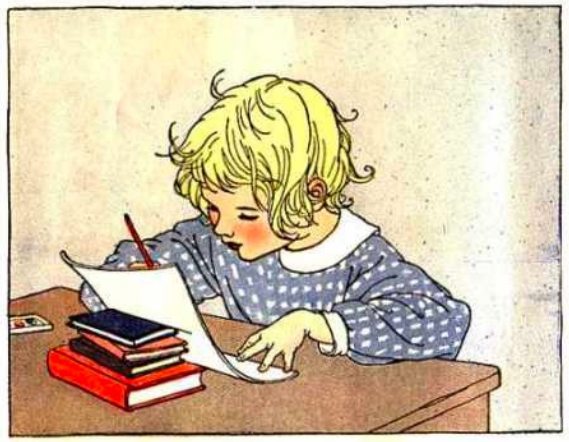
ESSENTIALS (20 slides)

Philadelphia's Soda Tax

- Philadelphia has a problem with childhood obesity.
- Philadelphia also lacks funding for pre-K education.
- In 2017, the city placed a 1.5 cent/ounce sales tax on soda.
- This tax is paid by consumers at the register (like any other sales tax).
- It's hoped the tax will help with both problems.

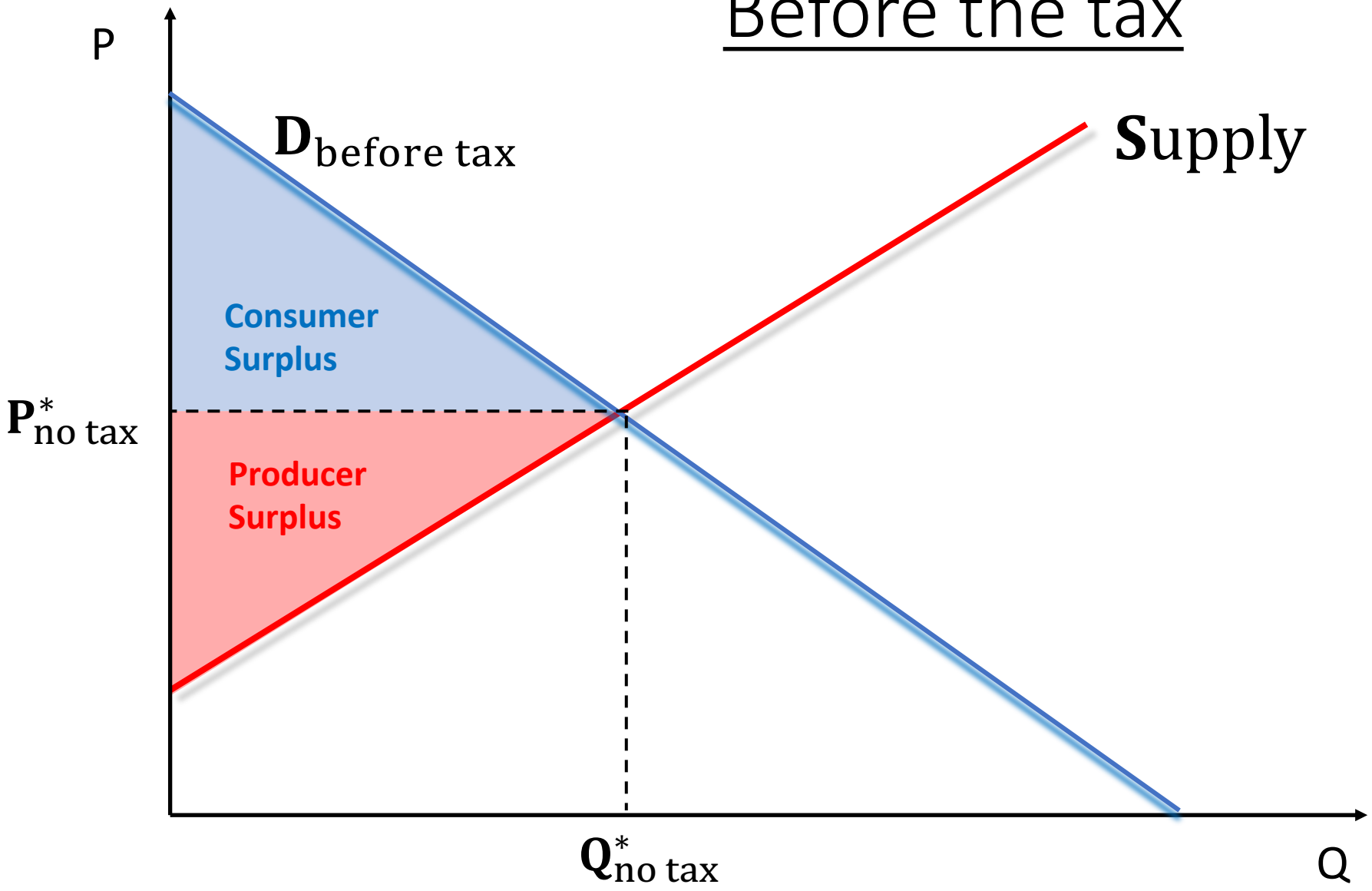
- This recent-ish development is a perfect test-bed for our supply and demand techniques.
- (They also apply to more traditional engineering problems: if the government raises taxes, how will this affect your costs/revenues?)

Some questions



- The tax is 1.5 cents/ounce.
- Does this mean the price of soda will go up by 1.5 cents?
- If not, by how much will the price go up? Why?
- A rise in price will lead to a fall in quantity demanded (Law of Demand)
- This is good, since lower soda pop consumption is a goal.
- By how much will consumption fall?
- How much money will be raised for schooling by the tax?
- We can get a rough idea by looking at a similar French tax.
- (Details in After Hours.)

Before the tax



How does the tax work in our model?

- It's the time before the tax. Annie Consumer buys 12 oz of cola if it costs 5 cents/oz, and 11 oz if it costs 6.5 cents/oz.
- Now suppose the government passes a sales tax of 1.5 cents per oz on cola. If cola costs 5 cents/oz, Annie must now pay 5 + 1.5 = 6.5 cents *after tax*.
- Instead of buying 12 oz, Annie will buy 11 oz – exactly what she would have bought, in a world without tax, if the price were 1.5 cents higher.
- "If you want me to buy the same amount I bought before, you're gonna have to pay me back for the tax!"
- Annie's demand curve, which plots *inverse demand* $P(Q_d)$, shifts *down* by the amount of the tax. Before tax, P(12) = 5. Now, P(12) = 5 – 1.5 = 3.5, since Annie must pay not only P, but also the tax.

Introducing our supply and demand equations

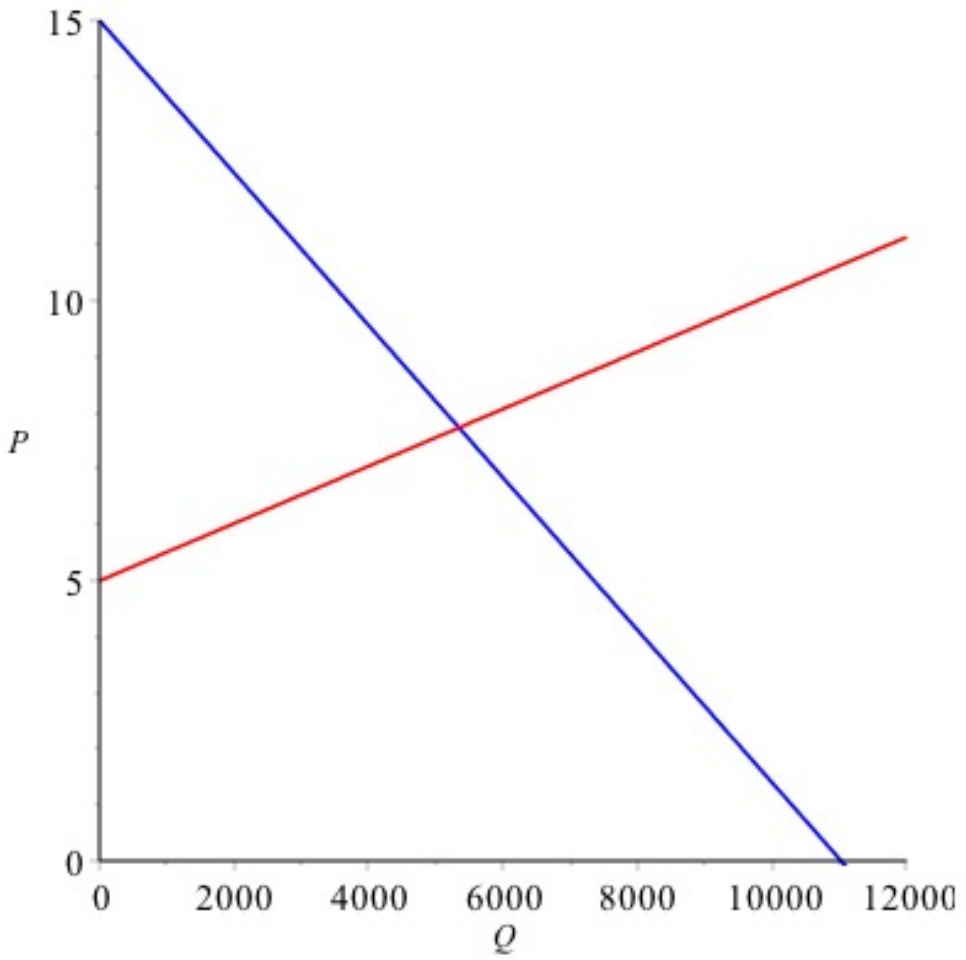
- Just for fun, I used public data to come up with Supply and Demand curves that (very roughly) approximate the real world.
- **P is in cents, and Q is in ounces of soda per person per year.**

Demand and Supply Equations

$$Q_d = 11{,}025 - 735P \qquad Q_s = -9{,}780 + 1956P$$

Inverse Demand and Supply Equations (Graphing Form)

$$P = 15 - \frac{Q_d}{735} \qquad P = 5 + \frac{Q_s}{1956}$$



Tax Impact on Demand: Algebra

- It's easiest to work with inverse demand. Let the tax be T.
- From our intuition, we know that P(Q_d) goes down by T after the tax: to keep Q_d the same as before, a consumer needs to be compensated.
- Algebraically, this means the entire right-hand-side of our inverse demand curve goes down by T → the intercept of the demand curve goes down by T.

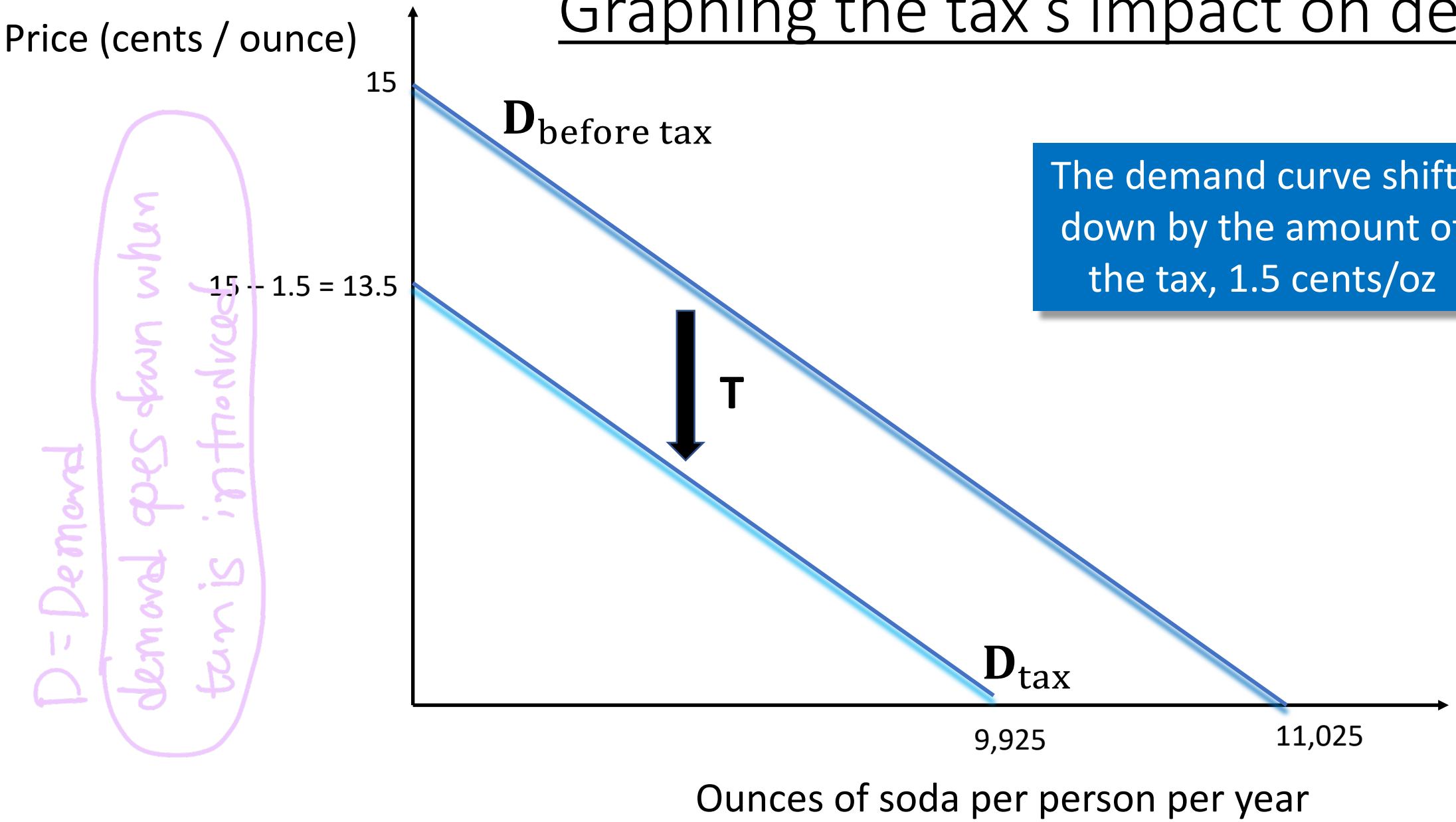
$$\mathrm{P} = 15 - \frac{\mathrm{Q_d}}{735}$$

Before the tax

$$\mathrm{P} = 15 - \frac{\mathrm{Q_d}}{735} - 1.5 = 13.5 - \frac{\mathrm{Q_d}}{735}$$

After a tax of 1.5 per unit

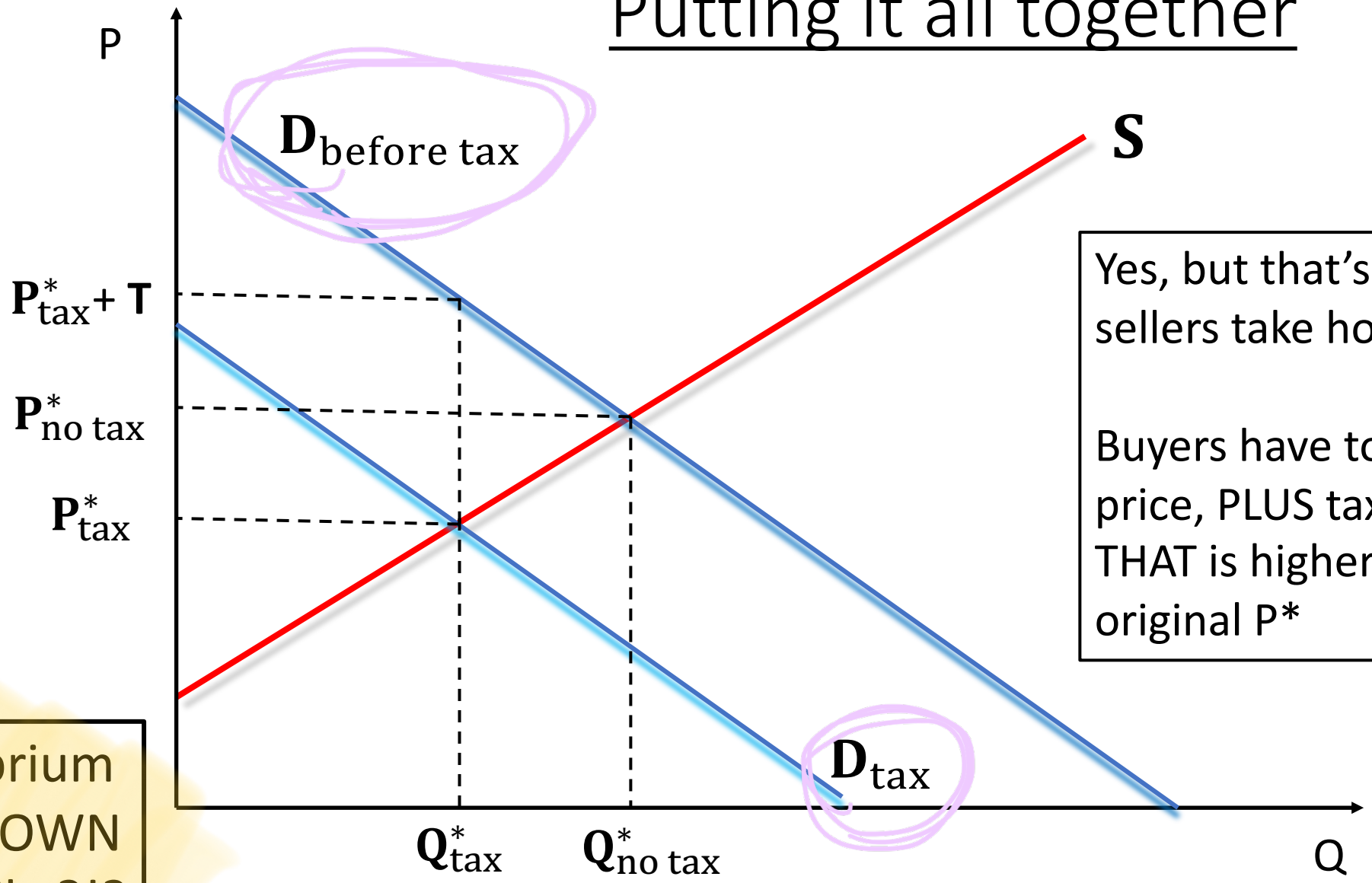
Graphing the tax's impact on demand



The demand curve shifts down by the amount of the tax, 1.5 cents/oz

D = Demand
demand goes down when
tax is introduced

Putting it all together

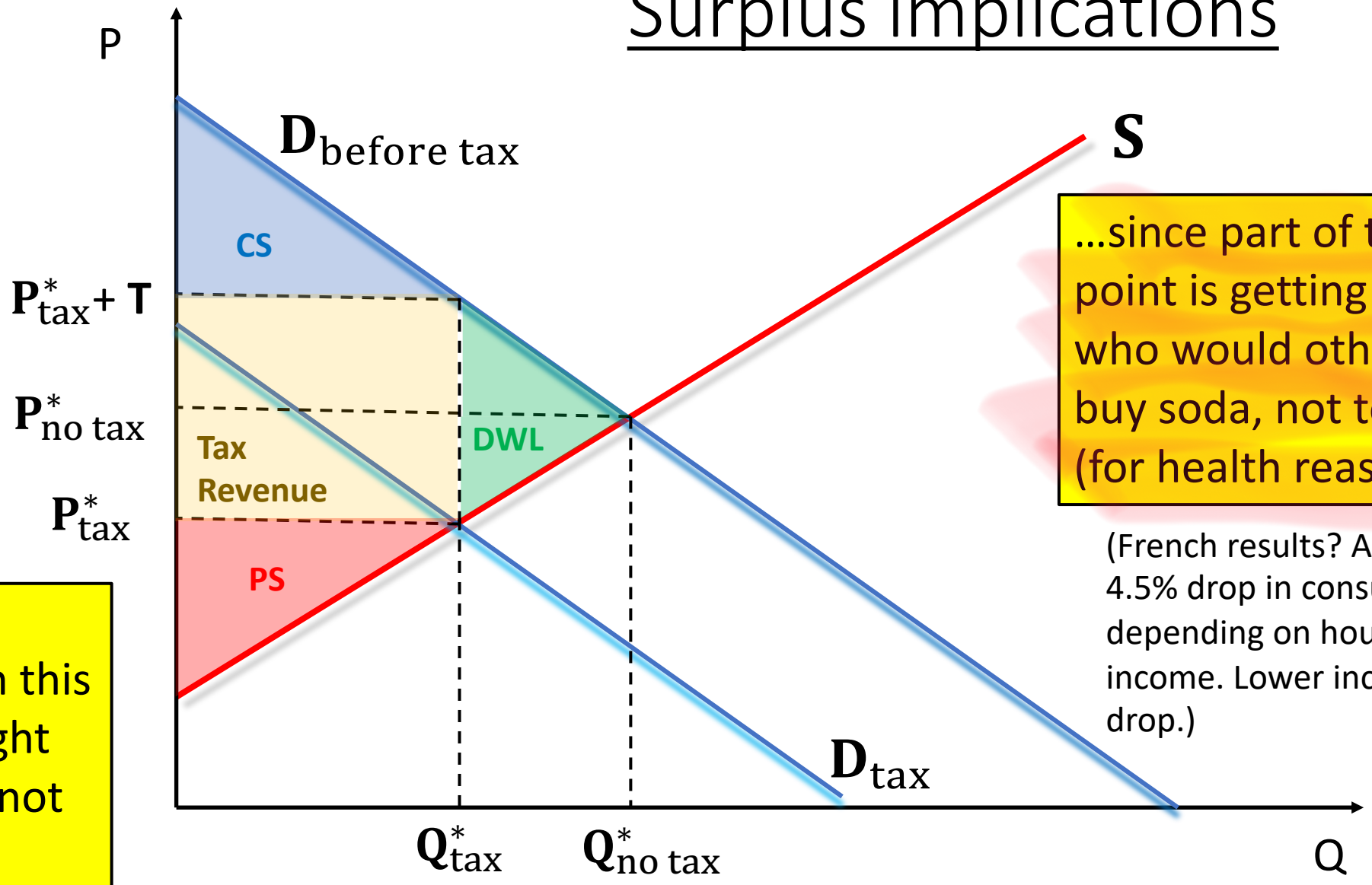


Yes, but that's what the sellers take home.

Buyers have to pay the price, PLUS tax, and THAT is higher than the original P*

Wait, equilibrium price goes DOWN after a tax hike?!?

Surplus implications



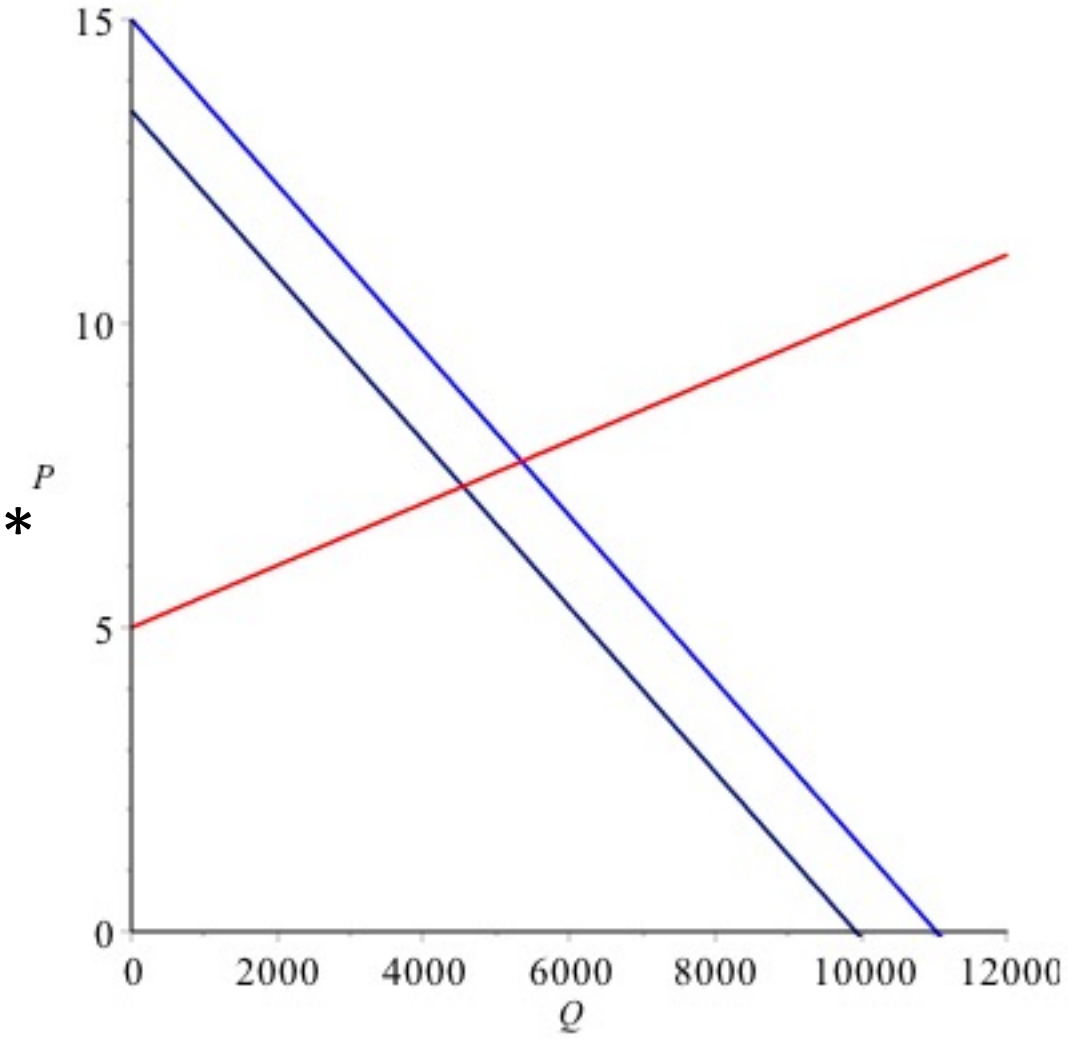
…since part of the point is getting people who would otherwise buy soda, not to buy it (for health reasons)

(French results? About 3.3-4.5% drop in consumption, depending on household income. Lower income, higher drop.)

Yes, there's a 'DWL'… but in this case, that might be a feature, not a bug…

Solving for the equilibria

- Two equations, two unknowns.
- Inverse Demand = Inverse Supply → Q*
- Plug Q* into either Supply or Demand → P*



By how much does price go up, exactly?

- Before the Tax:
- $15 - Q^*/735 = 5 + Q^*/1956 \rightarrow Q^* = 5{,}342.5$
- $P^* = 15 - (5{,}342.5)/735 = 7.7$

- After the Tax:
- $13.5 - Q^*/735 = 5 + Q^*/1956 \rightarrow Q^* = 4{,}541.1$
- $P^* = 13.5 - (4{,}541.1)/735 = 7.3$

- Producers take home 7.3/ounce
- Consumers pay (7.3 + 1.5)/ounce = 8.8/ounce
- The price they pay has gone up by (8.8 – 7.7) = 1.1 < 1.5

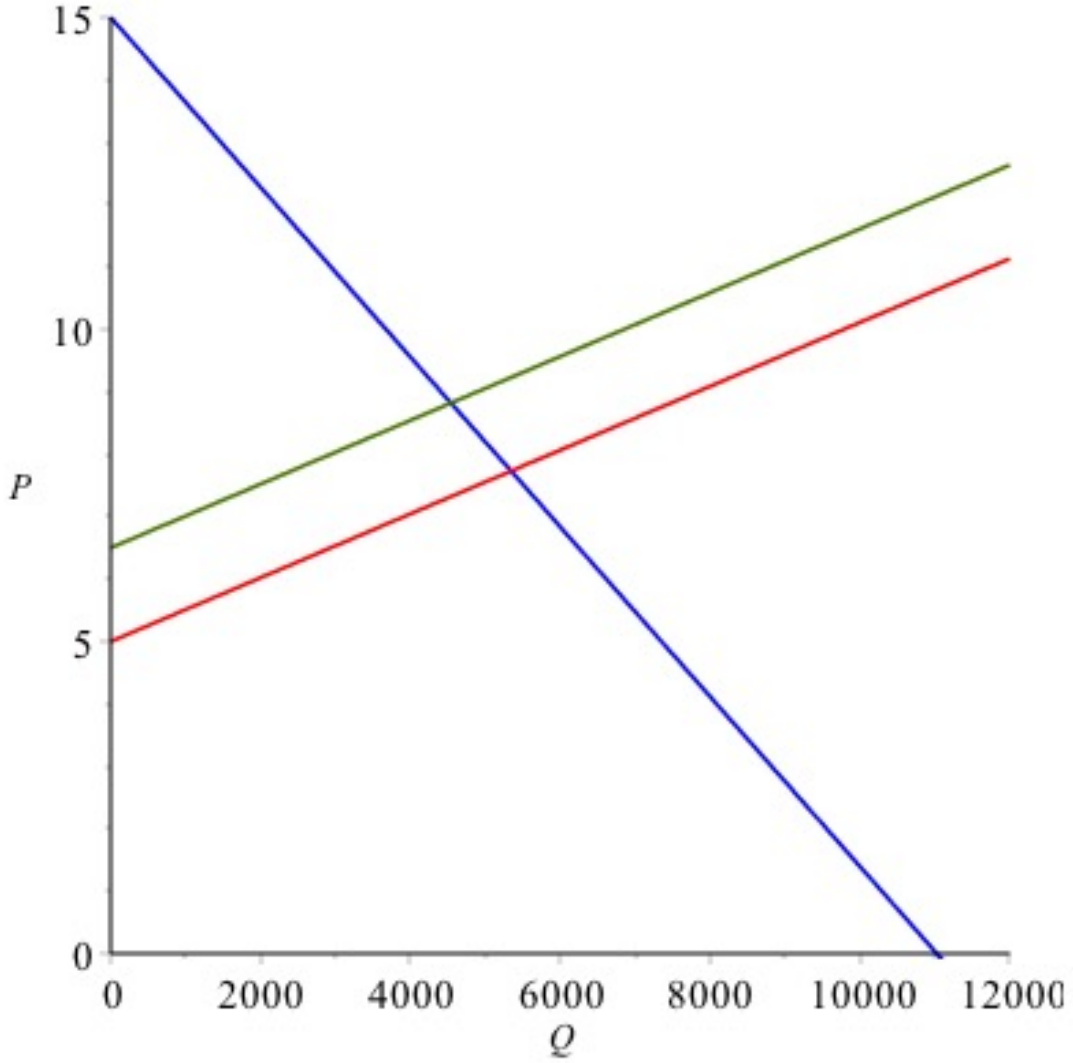
Tax Incidence (or burden)

- The tax is 1.5 cents, but buyers only see prices rise by 1.1 cents.
- The rest of the tax is paid by the sellers, in the form of lower prices.
- The burden (or incidence) of the tax on consumers is:
- Increase in costs / Total Tax = $[(\mathbf{P}^*_{\text{tax}} + \mathbf{T}) - \mathbf{P}^*_{\text{no tax}}] / \mathbf{T}$
- 1.1 cents price rise / 1.5 cents tax = 73% burden on consumers
- The burden (or incidence) of the tax on sellers is:
- Fall in price / Total Tax = $[\mathbf{P}^*_{\text{no tax}} - \mathbf{P}^*_{\text{tax}}] / \mathbf{T}$
- (7.7 – 7.3)/1.5 = 0.4/1.5 = 27%
- Burden on Consumers + Burden on Sellers = 100%

What if the tax was paid by producers?

- We had our consumers pay the tax, T, at the till.
- What if the producers paid it before consumers ever saw it?
- If before, they needed a price P to provide quantity Q…
- NOW they'll need a price (P + T) to provide quantity Q.
- The supply curve will shift UP by T. For our values,
- $\mathrm{P} = 5 + \frac{\mathrm{Q_S}}{1956} \rightarrow \mathrm{P} = 6.5 + \frac{\mathrm{Q_S}}{1956}$
- Demand would remain unchanged.

Graphing the situation (using Maple)



Looks pretty similar, right?

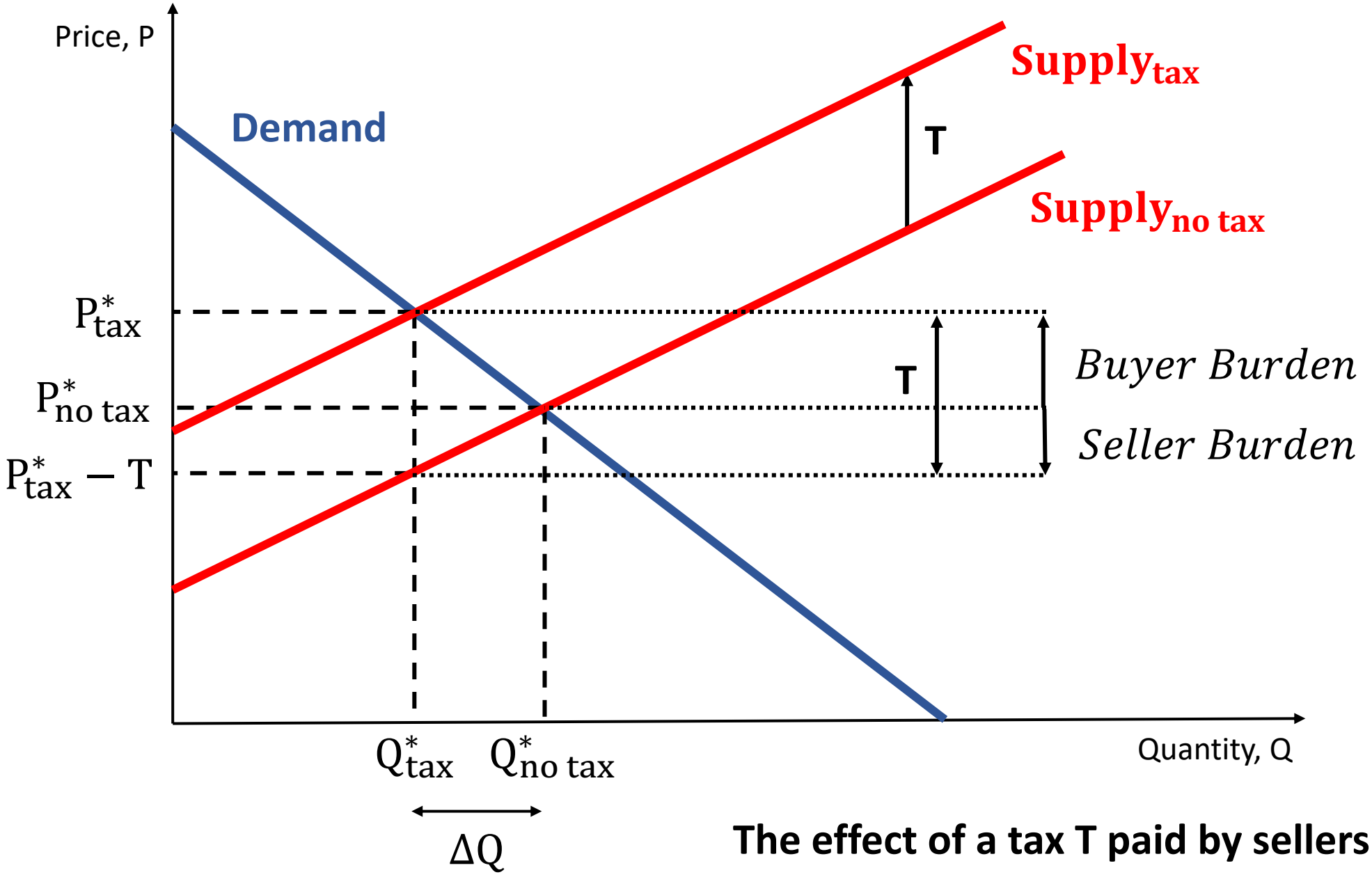
There's a reason for that…

"Whether the rock hits the laptop or the laptop hits the rock, it's bad for the laptop."

– Miguel de Cervantes (updated)

The end result:

- **It *doesn't matter* whether the tax is paid by the producer, or the consumer. The burden is distributed EXACTLY the same.**
- What DOES the burden depend on? THAT'S what we'll be looking at next lecture.
- After tax P* = what the consumer pays = 8.8 cents/ounce
- After tax P* - T = what the producer keeps = 7.3 cents/ounce
- Burden on seller = fall in *take-home* income = (7.3 – 7.7)/1.5 = 27% of tax
- Burden on buyer = rise in cost = (8.8 – 7.7)/1.5 = 73% of tax

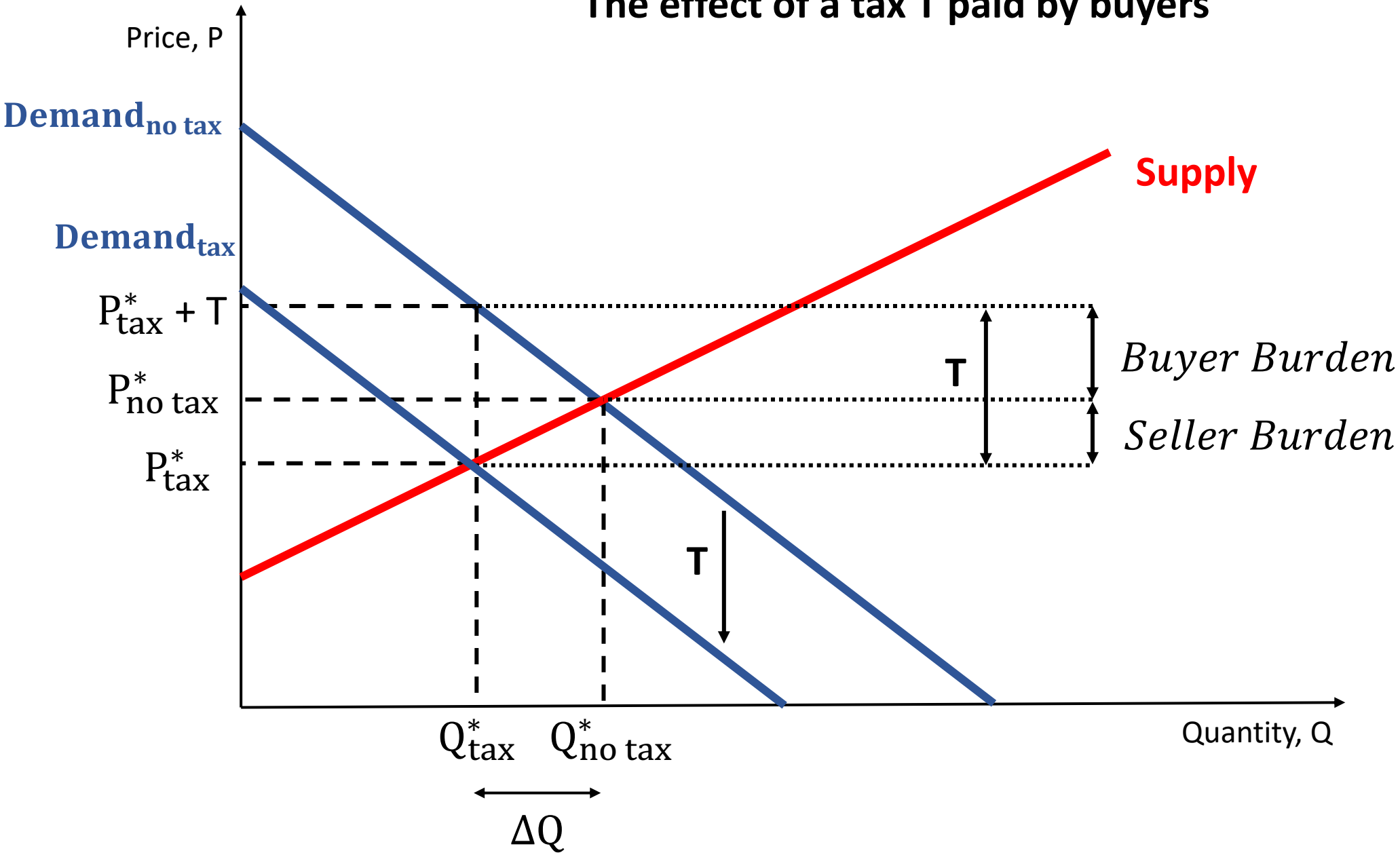


The effect of a tax T paid by sellers

Incidence is the same no matter who pays T

- Incidence depends only on T, $\mathrm{P}^*_{\mathrm{no\ tax}}$and $\mathrm{P}^*_{\mathrm{tax}}$.
- T is a given value, and $\mathrm{P}^*_{\mathrm{no\ tax}}$ is found before taxes are paid, so is independent of whether buyers or sellers pay the tax.
- We solved for $\mathrm{P}^*_{\mathrm{tax}}$ by solving
- $\mathrm{Inverse\ Supply}_{\mathrm{tax}}$ = Inverse Demand
- Since $\mathrm{Inverse\ Supply}_{\mathrm{tax}} = \mathrm{Inverse\ Supply}_{\mathrm{no\ tax}} + \mathrm{T}$, we solved
- $\mathrm{Inverse\ Supply}_{\mathrm{no\ tax}} + \mathrm{T}$ = Inverse Demand
- What would change if buyers paid the tax?

The effect of a tax T paid by buyers



A tax paid by buyers

- Suppose buyers have to pay a tax of $T per unit purchased.
- If before the tax, they were willing to buy Q units at a price of P, now they'll require a price of (P – T) to be willing to buy that same quantity:
- When the selling price is (P – T), the amount consumers have to pay out of pocket is P: (P – T) to the seller, and T to government.
- This is true no matter what value of Q we're looking at…
- →A tax of $T paid by buyers causes the demand curve to shift down by $T. That is, Demand *falls*.
- More importantly, inverse demand becomes
- $\text{Inverse Demand}_{\text{tax}} = \text{Inverse Demand}_{\text{no tax}} - \text{T}$

Back to incidence

- Incidence depends only on T, $P^*_{\text{no tax}}$and P^*_{tax}.
- When sellers paid the tax, we solved for P^*_{tax} by solving
- $\text{Inverse Supply}_{\text{tax}} = \text{Inverse Demand}_{\text{no tax}}$
- $\text{Inverse Supply}_{\text{no tax}} + T = \text{Inverse Demand}_{\text{no tax}}$
- When buyers paid the tax, we solve for P^*_{tax} by solving
- $\text{Inverse Demand}_{\text{tax}} = \text{Inverse Supply}_{\text{no tax}}$
- $\text{Inverse Demand}_{\text{no tax}} - T = \text{Inverse Supply}_{\text{no tax}}$
- $\text{Inverse Demand}_{\text{no tax}} = \text{Inverse Supply}_{\text{no tax}} + T$
- → P^*_{tax} will be the same in both cases.
- Since T and $P^*_{\text{no tax}}$ are, as well, the burden of taxation (or an added cost of production) is independent of who actually pays the cost/tax.

AFTER HOURS

- A French soda tax (1 slides)
- What happened to soda consumption? (7 slides)
- Historical note (1 slide)

Table 8: Tax incidence: pass-throughs at the UPC level (% points)

(Etile et al., 2018)

	SSB		NCSB	
	#UPC	Pass-through (%)	#UPC	Pass-through (%)
All	400	36.4	127	32.0
Top national	136	19.2	86	23.9
Other national	113	48.5	17	66.0
Retailer	108	47.4	18	38.8
Hard discount	43	33.5	6	35.4
Standard Coca-Cola	31	38.5		
Diet Coke/Coke Light			28	35.3
Coca-Cola Zero			17	12.4

- In 2012, France passed a tax of 0.0716 Euro/litre on Sugar-Sweetened Beverages (SSB) and Non-Calorically Sweetened Beverages (NCSB).
- Former for health reasons (fight obesity), latter for political reasons (industry image, raise money for social security).
- Prices went up by only 19.2% to 66%, according to one study (about 40% overall).

By how much does quantity go down?

- One goal of the tax was to lower consumption of soda.
- How well does it achieve this?

- Before the tax, Q* = 5,342.5 ounces/person/year
- After the tax, Q* = 4,541.1 ounces/person/year

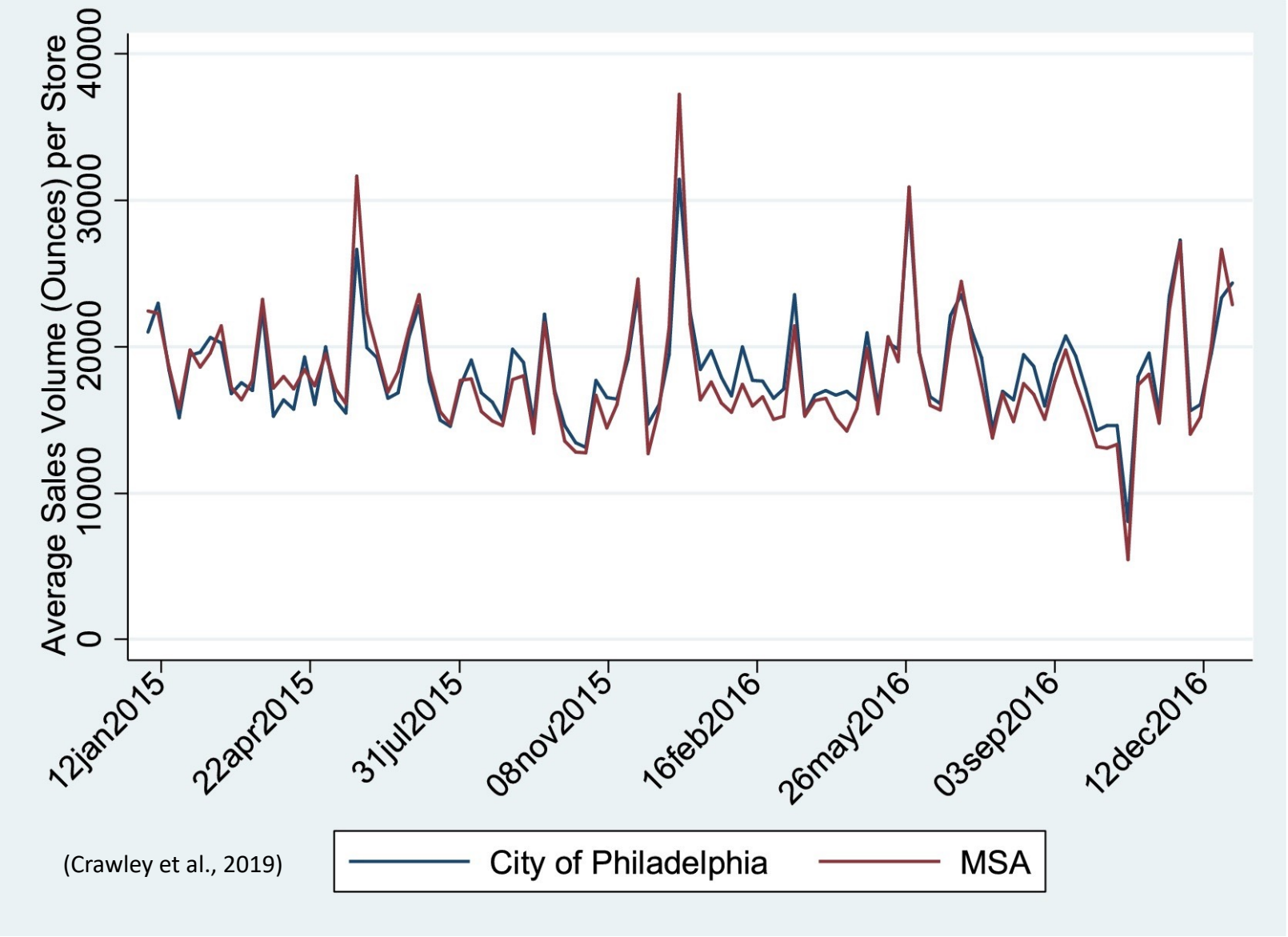
- Q* falls by 15% of its original value – not bad!
- But… what actually happened?

How much revenue is raised by government?

- In our model, yearly tax revenue = **T** x $\mathbf{Q}^*_{\mathbf{tax}}$ x Population of Philadelphia (units!)
- Population of Philadelphia: 6.06 million, $\mathbf{Q}^*_{\mathbf{tax}}$=4,541.1 ounces/person/year
- → 27,519,066,000 ounces, or about 326 Olympic swimming pools!
- **T** = $0.015/ounce

- → **Total tax revenue = $412,785,990** (assuming no cost of collection)
- Philadelphia School Budget (total): $2.6 billion
- → This tax could raise 16% of the current total school funding.
- Not a bad amount of money with which to fund pre-K!
- What actually happened? It brought in about $80 million in one year, according to (Crystal, 2018). This is much lower than what we calculated, probably because consumption fell by far more than expected.

Soda Consumption before the Tax (Average volume/store)



(Crawley et al., 2019)

MSA = Philadelphia metropolitan area (not just city)

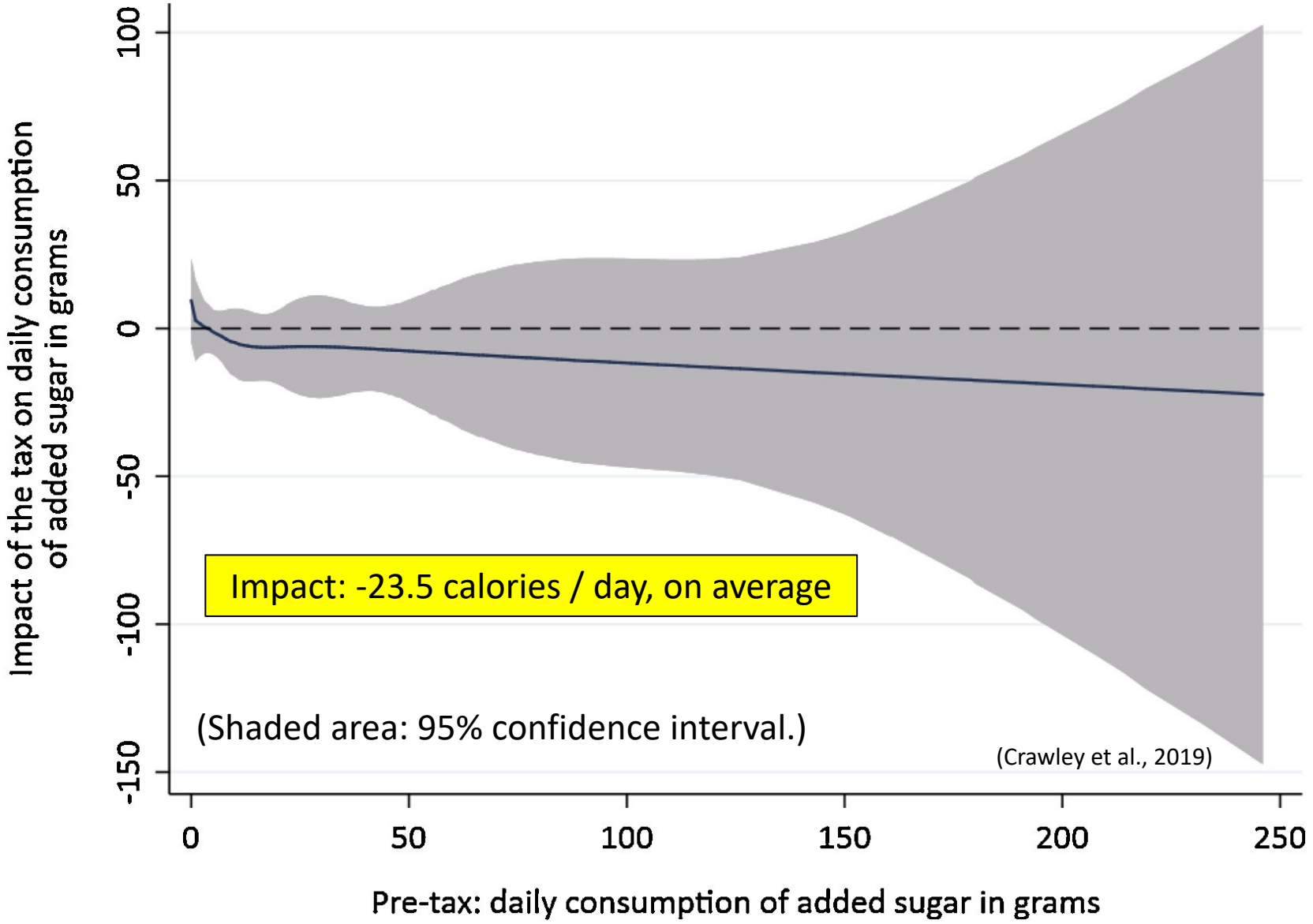
And after the tax?

- “Within the first 2 months of tax implementation, relative to the comparison cities, in Philadelphia the odds of daily consumption of regular soda was 40% lower […]; energy drink was 64% lower […]; bottled water was 58% higher […]; and the 30-day regular soda consumption frequency was 38% lower”. (Zhong et al., 2018)
- →Consumers substituted *away* from soda and TO water.
- BUT… one tiny problem. It’s a PHILADELPHIA soda tax.
- “We find that the tax reduced purchases in Philadelphia stores and that Philadelphia residents increased purchases of taxed beverages outside of the city.” (Cawley et al., 2019)

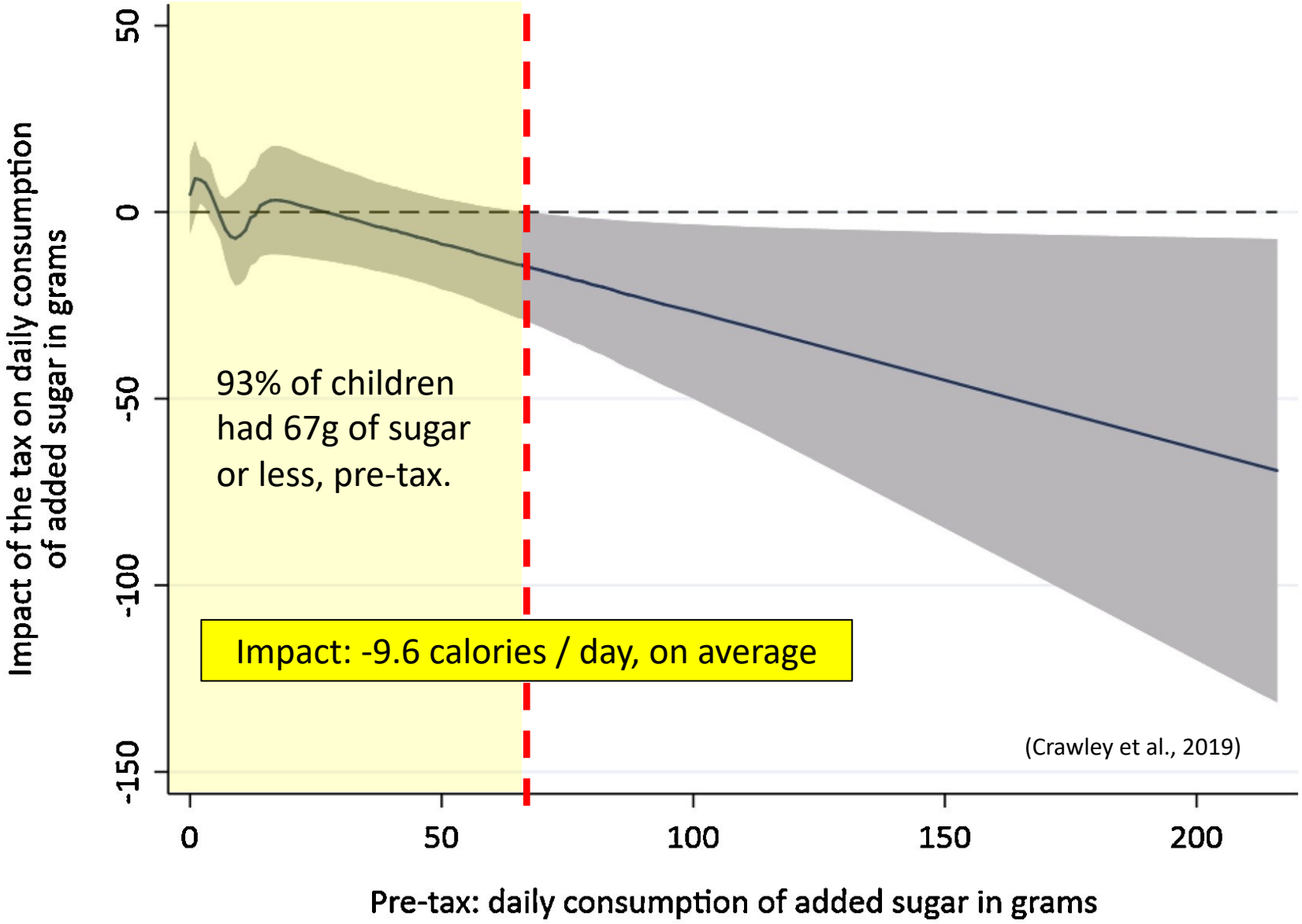
The thing about taxes…

- This was a *money* tax, aimed in part at reducing childhood obesity.
- Adults typically do the buying. If they were the decision makers? Sure.
- “The tax reduced the frequency of adults’ soda consumption by 31 percent, but had no detectable impacts on adults’ consumption of other beverages.” (Cawley et al., 2019)
- What if *children* were the decisionmakers, either buying on their own or insisting on getting soda until adults caved in?
- “The tax had no detectable impact on children’s consumption of soda or all taxed beverages, although children who were frequent consumers prior to the tax reduced their consumption after the tax.”

Impact on Adults

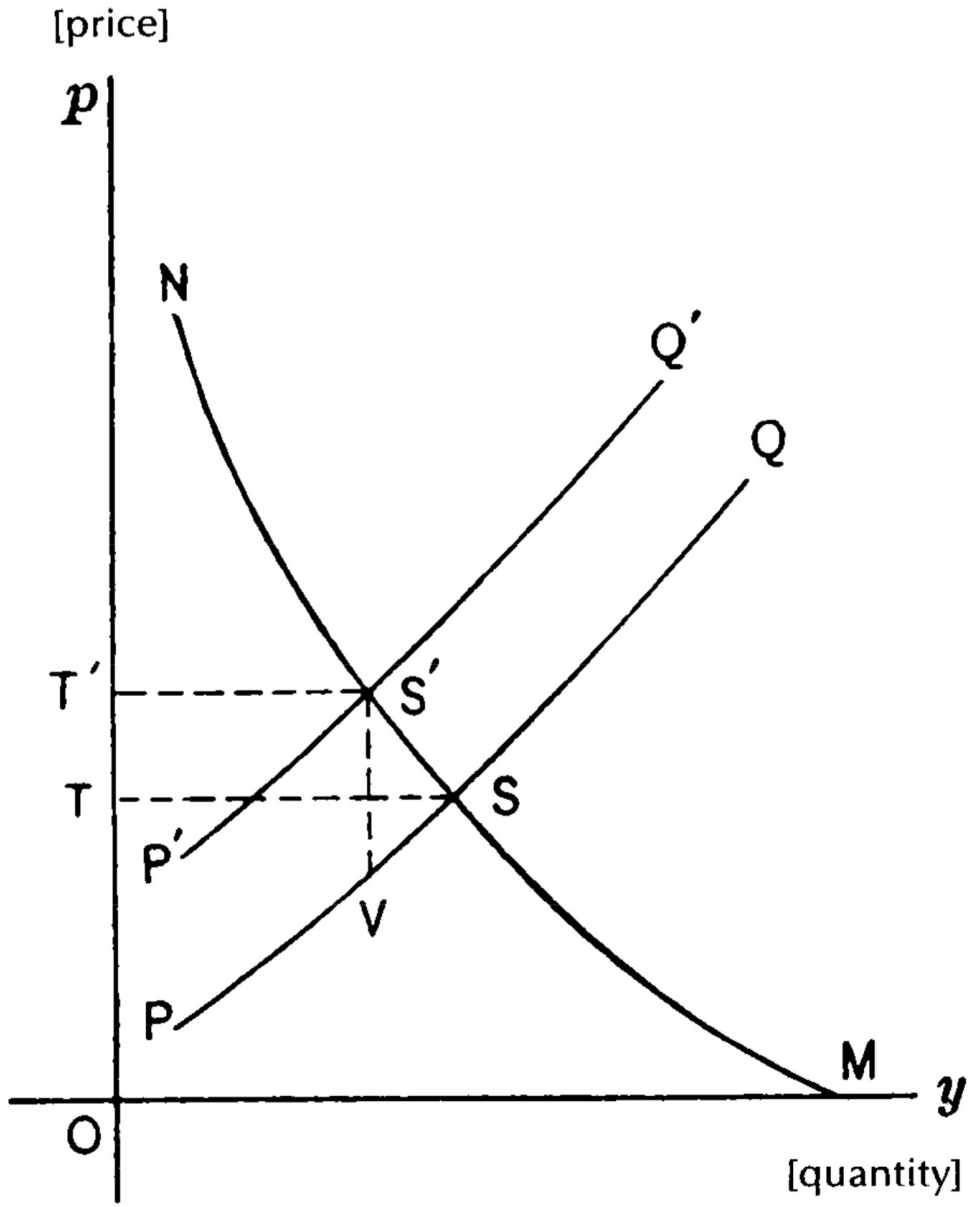


Impact on Children



Historical Note

- On the right is the first EVER supply and demand diagram.
- It was created by Augustine Cournot in 1838…
- …for the problem we (well, you) just solved: incidence of a unit tax paid by producers.



Source: Cournot ([1838] 1971: Fig. 6 at end of book).