# Incidence and Efficiency Costs of Taxation

**Economía Pública: Impuestos**
Clase 6

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# Outline of this lecture

- Tax incidence: Partial equilibrium model
- Efficiency costs of taxation (DWL)
- Empirical applications
  1. The UK window tax (DWL)
  2. The Ramsey tax rule (optimal commodity taxation)
  3. Price pass-through of VAT changes
  4. Tax incidence with salience effects
- Tax incidence: General equilibrium
  1. Example: soda tax

# TAX INCIDENCE

Tax incidence is the study of the effects of tax policies on prices and the economic welfare of individuals

What happens to market prices when a tax is introduced or changed?

- Increase tax on cigarettes by $1 per pack
- Introduction of Earned Income Tax Credit (EITC)
- Temporary VAT cuts on foodstuffs in contexts of inflation

Effect on price $\Rightarrow$ distributional effects on smokers, profits of producers, shareholders, farmers, etc.

This is positive analysis: typically the first step in policy evaluation; it is an input to later thinking about what policy maximizes social welfare.

Tax incidence is not an accounting exercise but an analytical characterization of changes in economic equilibria when taxes change

Key point: Taxes can be shifted: taxes affect directly prices, which affect quantities because of behavioral responses, which affect indirectly the price of other goods

If prices are constant **economic incidence** would be the same as **legislative incidence** (read Bozio, 2008)

Example:

- Liberals favor capital income taxation because capital income is concentrated at the high end of the income distribution. Taxing capital means taxing disproportionately the rich
- Conservatives respond: if people save less because of capital taxes, capital stock may go down driving also the wages down and hurting workers. The capital tax might be shifted partly on workers

# Partial Equilibrium Model of Tax Incidence

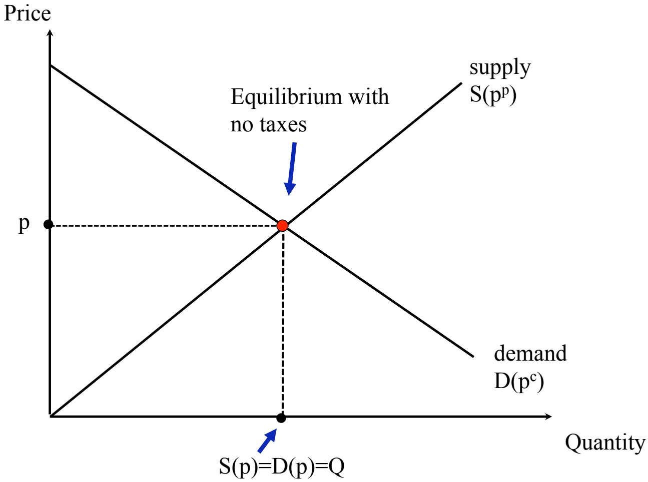
Simple model goes a long way to showing main results.

Government levies an excise tax on good $x$

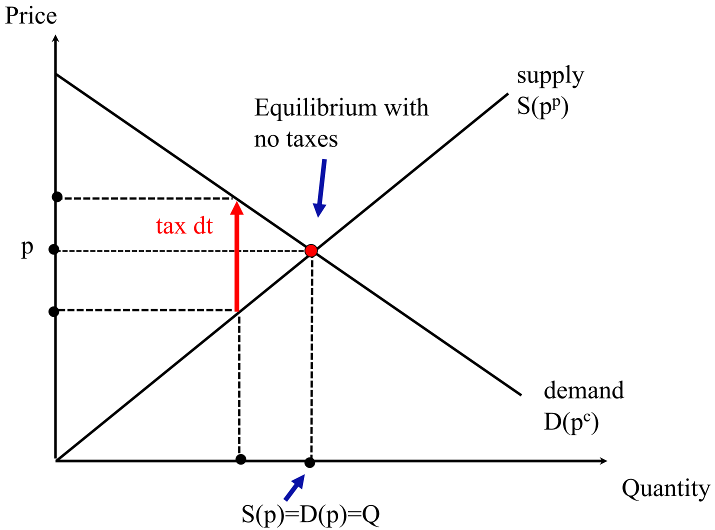
- **Excise tax** means it is levied on a quantity (gallon, pack, ton, ...). Typically fixed in nominal terms (e.g, \$1 per pack)
- **Ad-valorem tax** is a fraction of prices (e.g. 5% sales tax)

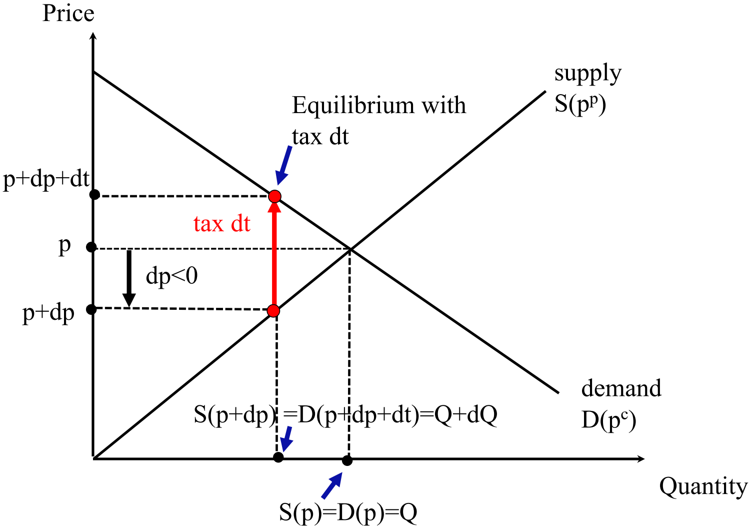
Let $p$ denote the pre-tax price of $x$ (producer price)

Let $p^c = p + t$ denote the tax-inclusive price of $x$ (consumer price)



Price
supply
S(p^p)
Equilibrium with
no taxes
p
demand
D(p^c)
Quantity
S(p)=D(p)=Q


Price
supply
S(p^p)
Equilibrium with
no taxes
tax dt
p
demand
D(p^c)
Quantity
S(p)=D(p)=Q



Price
supply
S(pᵖ)
Equilibrium with
tax dt
p+dp+dt
tax dt
p
dp<0
p+dp
demand
D(pᶜ)
S(p+dp) =D(p+dp+dt)=Q+dQ
Quantity
S(p)=D(p)=Q

# TAX INCIDENCE

Demand for good $x$ is $D(p^c)$ decreases with $p^c = p + t$

Supply for good $x$ is $S(p)$ increases with $p$

Equilibrium condition with tax $t$: $Q = S(p) = D(p + t)$

Start from $t = 0$ and $S(p) = D(p)$

We want the effect of a small tax $dt$ on price $p$: $dp/dt$:

Change $dt$ generates change $dp$ so that equilibrium holds:

$$S(p + dp) = D(p + dp + dt) \Rightarrow$$

$$S(p) + S'(p)dp = D(p) + D'(p)(dp + dt) \Rightarrow$$

$$S'(p)dp = D'(p)(dp + dt) \Rightarrow$$

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

## TAX INCIDENCE FOR SMALL TAX $dt$

Elasticities are useful in economics because they are unit free

**Elasticity:** % change in quantity when price changes by 1%

$\varepsilon_D = \frac{p^c}{D}\frac{dD}{dp^c} = \frac{p^c D'(p^c)}{D(p^c)} < 0$ denotes the price elasticity of demand

$\varepsilon_S = \frac{p}{S}\frac{dS}{dp} = \frac{pS'(p)}{S(p)} > 0$ denotes the price elasticity of supply

$$\frac{dp}{dt} = \frac{D'(p)}{S'(p) - D'(p)} = \frac{pD'(p)/D(p)}{pS'(p)/S(p) - pD'(p)/D(p)} = \frac{\varepsilon_D}{\varepsilon_S - \varepsilon_D}$$

$$-1 \leq \frac{dp}{dt} \leq 0 \quad \text{and} \quad 0 \leq \frac{dp^c}{dt} = 1 + \frac{dp}{dt} \leq 1$$

## Tax Incidence Formula: $\frac{dp}{dt} = \frac{\varepsilon_D}{\varepsilon_S - \varepsilon_D}$

When do **consumers** bear the entire burden of the tax?
($dp/dt = 0$ and $dp^c/dt = 1$)

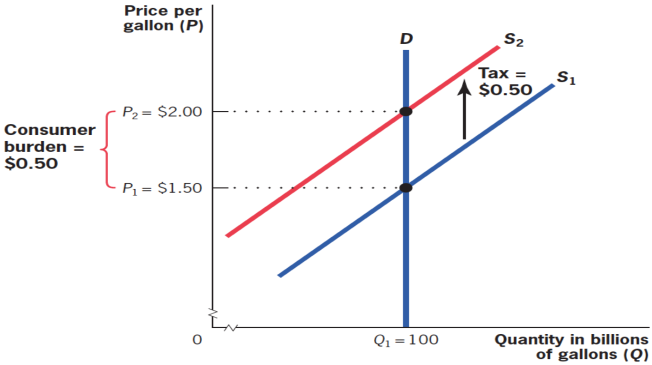
1) $\varepsilon_D = 0$ [inelastic demand]
   Example: short-run demand for gasoline inelastic (need to drive to work)
2) $\varepsilon_S = \infty$ [perfectly elastic supply]
   Example: perfectly competitive industry

When do **producers** bear the entire burden of the tax?
($dp/dt = -1$ and $dp^c/dt = 0$)

1) $\varepsilon_S = 0$ [inelastic supply]
   Example: fixed quantity supplied
2) $\varepsilon_D = -\infty$ [perfectly elastic demand]
   Example: demand shifts to a a close substitute if price changes

19.1

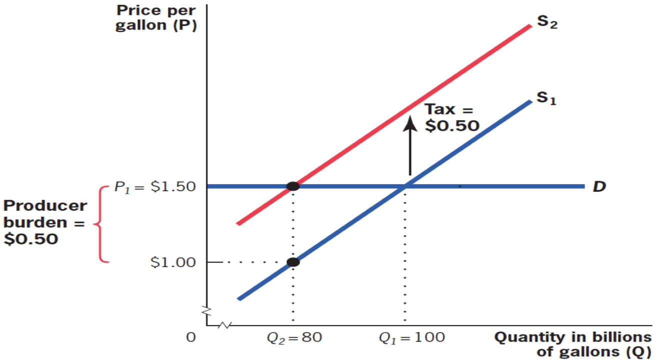
# Perfectly Inelastic Demand



19.1

# Perfectly Elastic Demand



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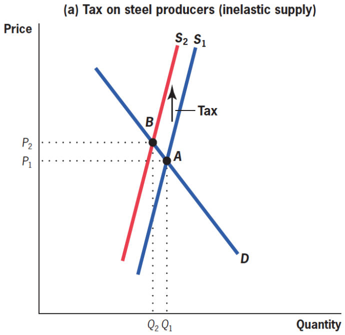
## Supply Elasticities



## TAX INCIDENCE: KEY RESULTS

1) Statutory incidence not equal to economic incidence
2) Equilibrium is independent of who nominally pays the tax (producer or consumer)
3) More inelastic factor bears more of the tax

These are robust conclusions of the **standard economic model** with **perfect competition** where consumer and producers are price takers (extends to case with many goods)

# Efficiency Costs of Taxation

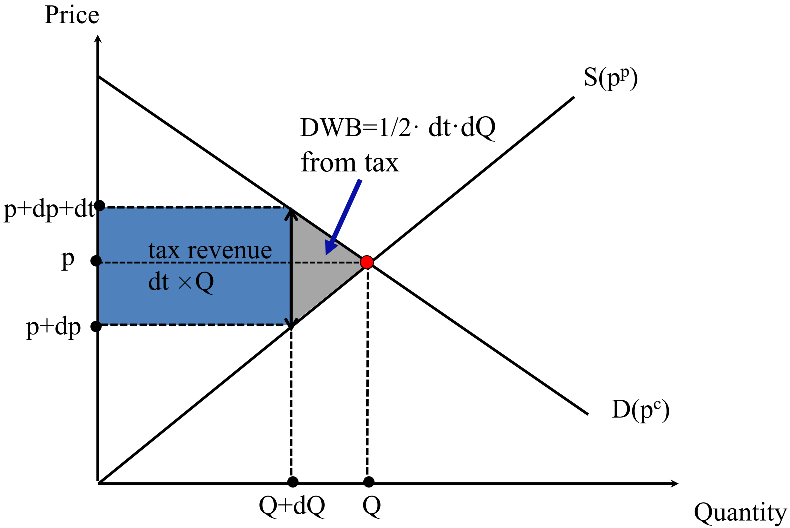
**Deadweight burden** (also called **excess burden**) of taxation is defined as the welfare loss (measured in dollars) created by a tax over and above the tax revenue generated by the tax

In the simple supply and demand diagram, welfare is measured by the sum of the consumer surplus and producer surplus

The welfare loss of taxation is measured as change in consumer+producer surplus minus tax collected: it is the triangle on the figure

The inefficiency of any tax is determined by the extent to which consumers and producers change their behavior to avoid the tax; deadweight loss is caused by individuals and firms making inefficient consumption and production choices in order to avoid taxation.

If there is no change in quantities consumed, the tax has no efficiency costs



Price
S(p^p)
DWB=1/2· dt·dQ
from tax
p+dp+dt
p
tax revenue
dt ×Q
p+dp
D(p^c)
Q+dQ
Q
Quantity

## Efficiency Costs of Taxation

Deadweight burden (or deadweight loss) of small tax $dt$ (starting from zero tax) is measured by the **Harberger Triangle**:

$$DWB = \frac{1}{2}dQ \cdot dt = \frac{1}{2}S'(p) \cdot dp \cdot dt = \frac{1}{2}\frac{pS'(p)}{S(p)} \cdot \frac{Q}{p} \cdot dp \cdot dt$$

[recall that $Q = S(p)$ and hence $dQ = S'(p)dp$]

Recall that $dp/dt = \varepsilon_D/(\varepsilon_S - \varepsilon_D)$, hence:

$$DWB = \frac{1}{2} \cdot \frac{\varepsilon_S \cdot \varepsilon_D}{\varepsilon_S - \varepsilon_D} \cdot \frac{Q}{p}(dt)^2$$

## Efficiency Costs of Taxation Formula: $DWB = \frac{1}{2} \cdot \frac{\varepsilon_S \cdot \varepsilon_D}{\varepsilon_S - \varepsilon_D} \cdot \frac{Q}{p} (dt)^2$

1) *DWB* increases with the absolute size of elasticities $\varepsilon_S > 0$ and $-\varepsilon_D > 0$

$\Rightarrow$ More efficient to tax relatively inelastic goods

2) *DWB* increases with the square of the tax rate $t$: small taxes have relatively small efficiency costs, large taxes have relatively large efficiency costs

$\Rightarrow$ Better to spread taxes across all goods to keep each tax rate low

$\Rightarrow$ Better to fund large one time govt expense (such as a war) with debt and repay slowly afterwards than have very high taxes only during war

3) Pre-existing distortions (such as an existing tax) makes the cost of taxation higher: move from the triangle to trapezoid

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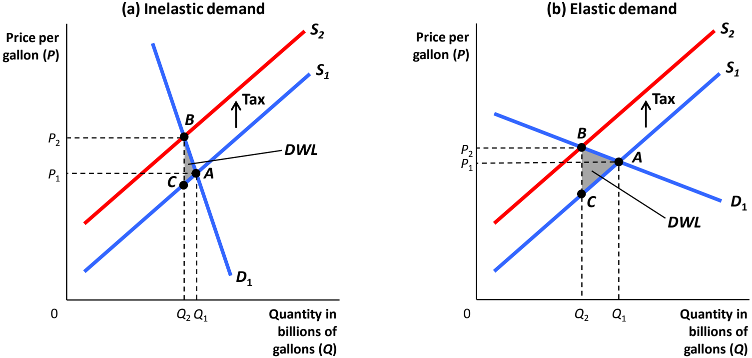
# Elasticities Determine Tax Inefficiency



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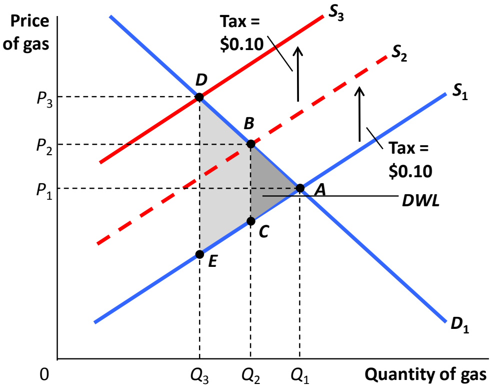
# Marginal DWL Rises with Tax Rate



## Illustration: Efficiency Costs of Taxation

Britain had a window tax on buildings from 1700 to 1850
$\Rightarrow$ Inefficiently dark buildings

# The Window Tax: A Case Study in Excess Burden

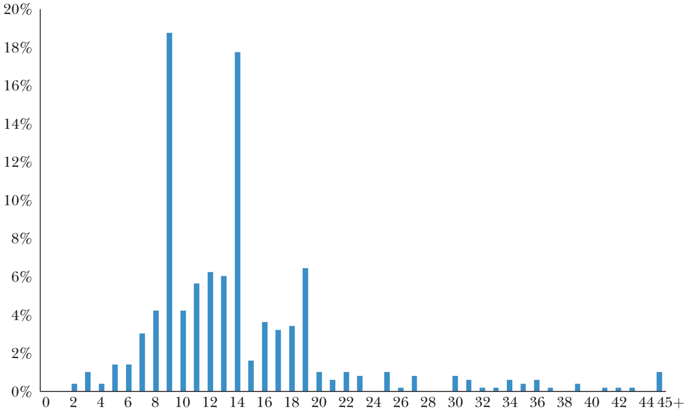
Oates and Schwab (2015)

- Data from microfilms of local tax records to document DWB
- Tax levied on dwellings based on the number of windows
  1. **Originally:** flat rate of 2 shillings per house + 4 shillings if 10-20 windows and 8 shillings if 20+ windows
  2. **Reform in 1747:** 6 pence p/window if house 10-14 windows; 9 pence if 15-19 windows; 1 shilling p/window if 20+ windows
  3. **Reform in 1761:** 1 shilling p/window if 8 or 9 windows; higher for 10+ windows

  Aside: are these *kinks* or *notches*?
- Why? Intended to be a visible indicator of ability to pay (tax assessors could count windows from the outside)

# How the Window Tax Distorted Decisions

*Figure 2*
**Distribution of Number of Windows, 1747–1757 Sample**

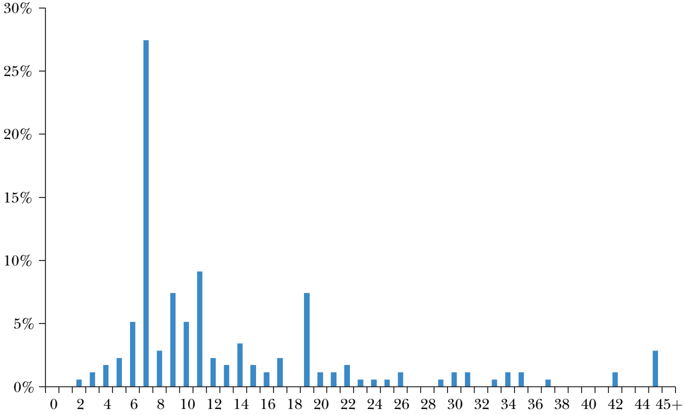



Distortion: "Too many" homes with 9, 14, and 19 windows in 1747-1757 and with 7 windows beginning in 1761 (but not before)

# How the Window Tax Distorted Decisions

*Figure 3*

**Distribution of Number of Windows, 1761–65 Sample**




Distortion: "Too many" homes with 9, 14, and 19 windows in 1747-1757 and with 7 windows beginning in 1761 (but not before)

## Application: Optimal Commodity Taxation

Ramsey (1927) asked by Pigou to solve the following problem:

Consider one consumer who consumes $K$ different goods

What are the tax rates $t_1, .., t_K$ of each good that raise a given amount of revenue while minimizing the welfare loss to the individual?

Uniform tax rates $t = t_1 = .. = t_K$ is not optimal if the individual has more elastic demand for some goods than for others

Optimum is called the **Ramsey tax rule**: optimal tax rates are such that the marginal DWB for last dollar of tax collected is the same across all goods

$\Rightarrow$ Tax more the goods that have inelastic demands [and tax less the goods that have elastic demands]

Note: this abstracts from redistribution and focuses solely on efficiency

# Tax Incidence: Empirical Applications (VAT)

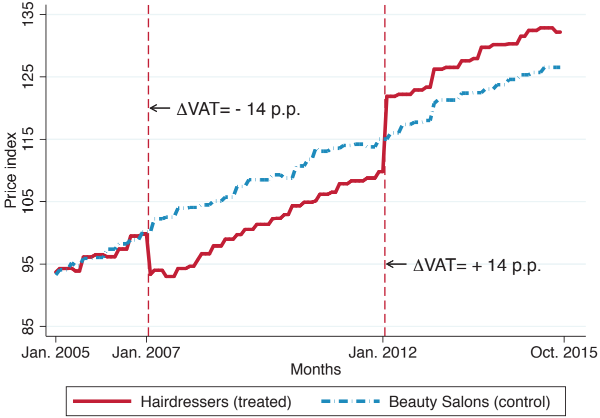
- European countries have large taxes on consumption: Value Added Tax (VAT)
- Normal VAT rates are high (15-25%) but some goods/services have lower rates (or are exempt)
- Benzarti et al. (2020) study the effects of VAT rates ↑ and ↓
- Nice illustrative case study: hairdressers in Finland got a VAT cut of 14 points in Jan 2007 that was repealed in Jan 2012
- Provide a basic graphical **difference-in-difference** analysis of prices of hairdressers (treatment) with beauty salons (control)

⇒ Find that tax decreases are only 50% passed on consumers while tax increases are almost fully passed on consumers.

Most likely explanation: producers pocket tax cut bc consumers are inattentive to taxes. Producers pass tax increase because they can justify the price increase to consumers.

⇒ Price determination does not work like basic competitive model

Figure 1: Finnish Hairdressing Sector VAT Reforms
Source: Benzarti et al. (2017)




*Notes:* This figure shows the price of hairdressing services and beauty salons before and after the 14 percentage point hairdressing services VAT cut in January 2007 and the 14 percentage point VAT hairdressing services hike in January 2012.

# VAT cuts have gained ground amidst rising inflation

- VAT has become a common policy tool used to affect the economy
- EU Parliament amended the EU VAT Directive in April 2022
  $\rightarrow$ grants EU countries flexibility to $\Delta$ VAT rates
- The IMF called for govts to avoid temporary VAT cuts on fuels, elect or food as an attempt to $\downarrow$ the impact of fast-rising inflation

# VAT 'inflation' cuts are on the rise

## Several countries ↓ VAT rates on a scale not seen before

E.g., for food:

1. **Poland:** 0% on basic food
2. **Bulgaria:** 0% on basic food
3. **Lithuania:** 0% on food from August
4. **North Macedonia:** 0% on basic foodstuff
5. **Romania:** considers cutting foodstuff VAT to 0%
6. **Belgium:** considers cutting fruit and vegetables VAT to 0%
7. **Bosnia:** cut foodstuff VAT from 17% to 5%
8. **Croatia:** cut foodstuff VAT from 13% to 5%
9. **Latvia:** cut foodstuff VAT from 21% to 5%
10. **Turkey:** cut foodstuff VAT from 8% to 1%
11. **Greece:** cut foodstuff VAT from 24% to 13%
12. **Others:** Spain, Italy, Germany, Ireland, Austria, Slovakia

- Governments often state **specific goals** when cutting VAT rates:
  - (i) $\downarrow P$ and $\uparrow$ *demand*, (ii) $\uparrow$ cash flow/profits, (iii) $\uparrow$ wages

  E.g., EU Parliament:

  "*overall, the deal struck by the Council (...) maintains the flexibility for Member States to lower VAT on essential products to benefit low-income households and, as such, tackle the regressiveness of the VAT system*"

- Implicitly assume that **govts can affect tax incidence**.
  Yet little is done to achieve these policy goals

# VAT incidence is complicated

**Standard model:** pass-through of VAT changes to prices

- No role for the government!
- Determined by the relative magnitude of demand/supply elast

In practice, it's much more complicated:

- **Limited vs full pass-through** (Benzarti & Carloni, 2019; Kosonen, 2015; Gaarder, 2018; Buettner & Madzharova, 2021; Fuest et al, 2021)
- **Asymmetry** and **price hysteresis** (Benzarti et al., 2020)
- **Heterogeneity** (e.g., large vs small restaurants) (Harju et al., 2018)

⇒ These issues substantially complicate using temporary VAT cuts as a policy tool. **Can governments do something about it?**

# Can governments affect tax incidence? Yes. But...

Benzarti, Garriga, and Tortarolo (2022) show that:

- Tax incidence can be affected by govts in spite of the relative elasticities
- But may miss target population due to unexpected incidence effects

⇒ They exploit a **large and temporary VAT cut** on basic food in Argentine supermarkets along with a variety of govt "mandates"

⇒ **Goal:** contain the impact of a ~24% currency devaluation on prices following a surprising presidential primary election

→ Ensuring that the VAT cut was passed on to prices was essential

# **Reform:** a 4.5-month long VAT holiday on basic food

- **VAT cut**: unanticipated, large, salient, and temporary

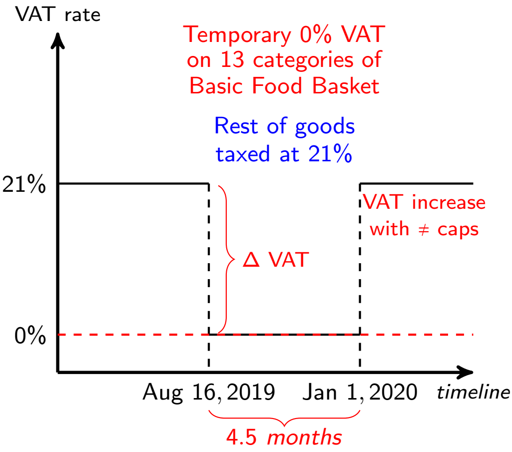
→ Govt urged *full* pass-through to P

- **VAT increase**: back to 21%

→ Govt imposed caps on how much P could increase (0%, 7%, or no cap)

- **Price monitoring system**:

→ In chain supermarkets only



# Barcode-level **scanner data** with P and Q

## Treatment

Temporary 0% VAT

| **Categories** |
|---|
| Cooking oils (sunflower, corn, mix) |
| Rice |
| Dried pasta |
| Tea, Yerba Mate, and Mate Cocido |
| Sugar |
| Canned vegetables and beans |
| Canned fruits |
| Corn flour (*polenta*) |
| Wheat flour |
| Fluid milk (whole/skim) |
| Yogurt (whole or skim) |
| Eggs |
| Bread |
| Breadcrumbs and/or batter |

## Control

Standard 21% VAT

| **Categories** |
|---|
| Other cooking oils (olive, soy, canola) |
| Rice-based meals |
| Breakfast cereal |
| Coffee |
| Salt |
| Herbs, Spices, & Seasonings |
| Dulce de leche (caramel) |
| Jam and Jelly |
| Other flours |
| Crackers, Biscuits, Toasts, Puddings |
| Chocolate |
| Mayonnaise |
| Vinegar |
| Dried legumes and beans |

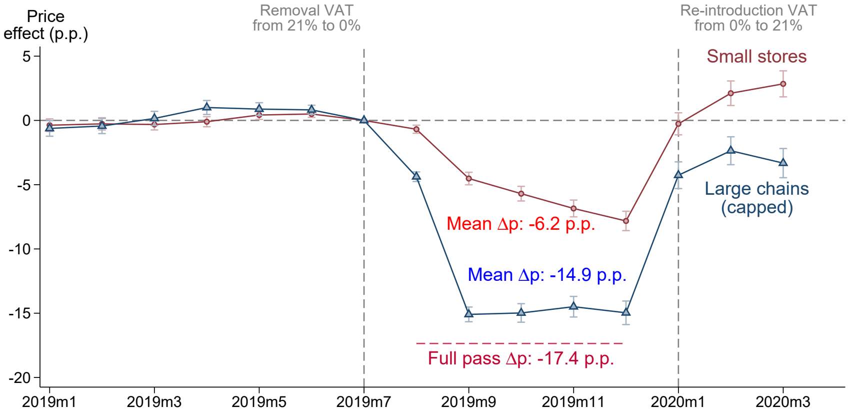
Notes: Wheat flour and bread are taxed at the reduced rate of 10.5%.
Source: Decree 567/2019 - Annex (IF–2019 – 73155740-APN-SCI#MPYT).

# Findings

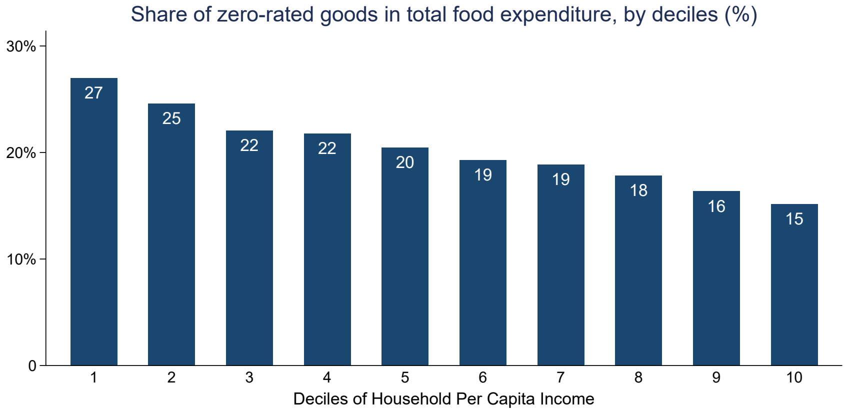
- A large portion of the VAT cut, ≈60%, is passed on to lower prices
- Price mandates were successful at ensuring gradual price increases (in chain supermarkets) when the VAT cut was repealed
- Pass-through rate of the VAT cut in chain supermarkets is 2x that of small stores where, they show, low-income households are more likely to shop at

⇒ While the govt was successful at engineering a price decrease using the VAT cut, it partially failed to reach the target population due to unexpected incidence effects

# Average pass-through of the VAT cut is 35% for indep stores and 85% for supermarket chains

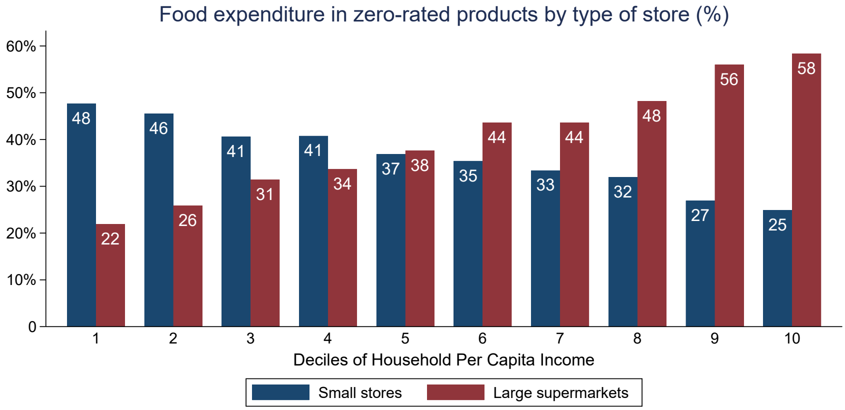


# Policy goal was to ensure that *low-income* households could still afford basic food in a context of inflation



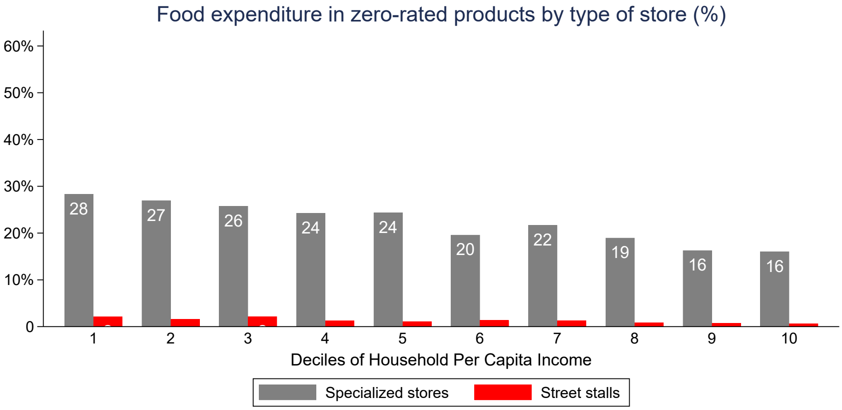

- Targeted goods (T) more heavily consumed by the lowest deciles
- But average expenditure on T increases with income

# But low-income people tend to shop at small supermarkets where price pass-through was limited (!)




- VAT cut likely benefited richer households more
- Important policy implication when designing VAT cuts

# But low-income people tend to shop at small supermarkets where price pass-through was limited (!)




- VAT cut likely benefited richer households more
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# Tax Incidence with Salience Effects

Canonical model assumes that all individuals are fully aware of taxes that they pay ($\frac{dx}{dt} = \frac{dx}{dp}$)

Is this true in practice? May be not. Many taxes are not fully salient

- Do you know your exact marginal income tax rate? Do you think about it when choosing a job?
- Do you know the sales tax you have to pay in addition to posted prices at cash register? Do you know which goods have 0% VAT?

Chetty, Looney, Kroft AER '09: test this assumption in the context of commodity taxes and develop a theory of taxation with inattentive consumers

# Tax Incidence with Salience Effects: Formula

Chetty et al. '09 show that incidence on producers of increasing $t$ is

$$\frac{dp}{dt} = -\theta \cdot \frac{\varepsilon_D}{\varepsilon_S - \varepsilon_D}$$

where $\theta$ measures the degree to which agents under-react to the tax

1. Incidence on producers attenuated by $\theta$

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

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

# Chetty, Looney, Kroft AER'09

US sales tax is paid at the cash register and not displayed on price tags in stores (opposite of VAT in supermarkets)

2 empirical strategies to test whether salience matters for sales tax incidence:

1) **Randomized field experiment** with supermarket stores
   - Treatment store: they display new price tags showing level of sales tax and total price on a **subset** of products
   - Compare shopping behavior for treated products vs. control products in treated store, before and after new tags are implemented (Diff-in-Diffs)
   - Repeat the analysis in control stores as a placebo DD strategy
2) **Policy experiment:** $\Delta$ in beer excise and sales taxes across states
   - Excise tax included in posted price (salient) while sales tax is added at register (not salient)


Orig. Tag

Exp. Tag

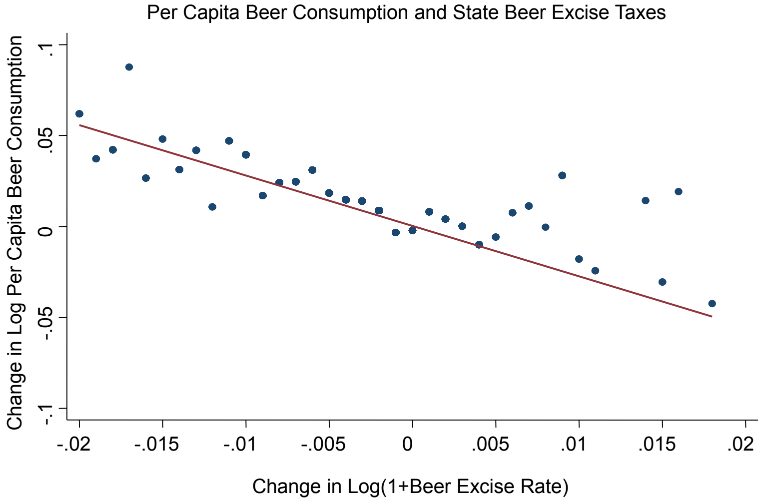
Source: Chetty, Looney, Kroft (2009)

## Effect of Posting Tax-Inclusive Prices: Mean Quantity Sold

| | **TREATMENT STORE** | | |
|---|---|---|---|
| Period | Control Categories | Treated Categories | Difference |
| Baseline | 26.48<br>(0.22) | 25.17<br>(0.37) | -1.31<br>(0.43) |
| Experiment | 27.32<br>(0.87) | 23.87<br>(1.02) | -3.45<br>(0.64) |
| Difference over time | 0.84<br>(0.75) | -1.30<br>(0.92) | **$DD_{TS}$ = -2.14**<br>(0.64) |
| | **CONTROL STORES** | | |
| Period | Control Categories | Treated Categories | Difference |
| Baseline | 30.57<br>(0.24) | 27.94<br>(0.30) | -2.63<br>(0.32) |
| Experiment | 30.76<br>(0.72) | 28.19<br>(1.06) | -2.57<br>(1.09) |
| Difference over time | 0.19<br>(0.64) | 0.25<br>(0.92) | **$DD_{CS}$ = 0.06**<br>(0.90) |
| | | DDD Estimate | ***-2.20***<br>(0.58) |

Source: Chetty, Looney, Kroft (2009)

## Figure 2a

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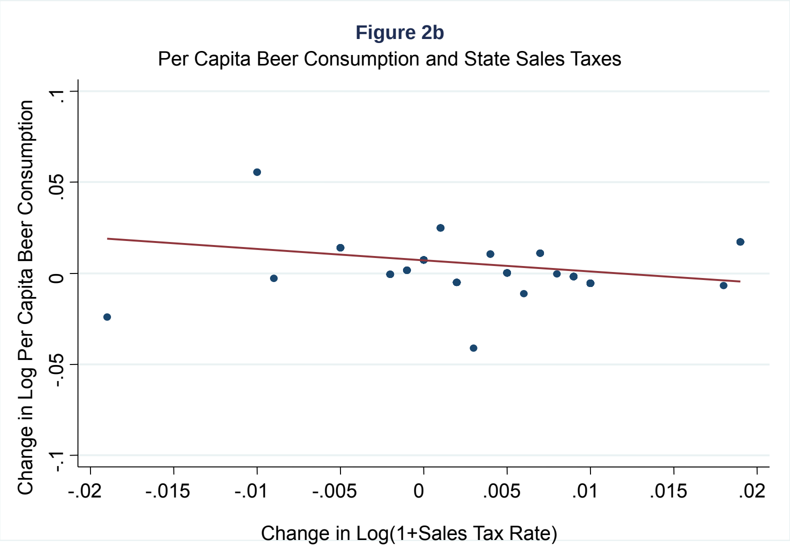



Source: Chetty, Looney, Kroft (2009)

## Tax Incidence with Salience Effects

Key Empirical Result: **Salience matters**

1) Posting sales taxes reduces demand for those goods
2) Beer consumption is elastic to excise tax rate (built in posted price) but not to the sales tax rate (not built in the posted price)

⇒ If tax is not salient to consumers, they are less elastic, and hence more likely to bear the tax burden (and less DWL!)

A number of recent empirical studies show that individuals are not fully informed and fully rational and this has large consequences for policy (e.g., see Garriga and Tortarolo (2022) for wage effects of means-tested transfers)

# Property tax incidence: owners vs tenants

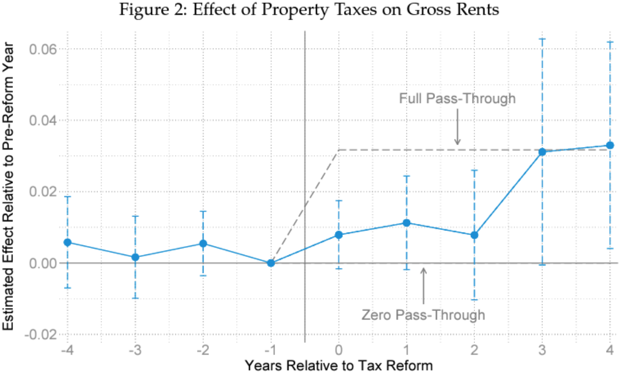
Who bears the economic burden of a tax levied on a rental property? The owner or the tenant? Statutory incidence is on owners (landlords)

- Longstanding question in economics with no convincing answers [England, 2016; Loffler & Siegloch, 2021]

  '*Our understanding of the incidence of local property taxes is in a sad state*" (Oates & Fischel, 2016, p.415)

- Empirically challenging: limited identifying variation & data (monthly rent and property tax payments)

# Example (German municipalities): property tax fully shifted to tenants by year 3




**Source:** Loffler & Siegloch (2021). 'Welfare Effects of Property Taxation'

# Property tax compliance is far from perfect

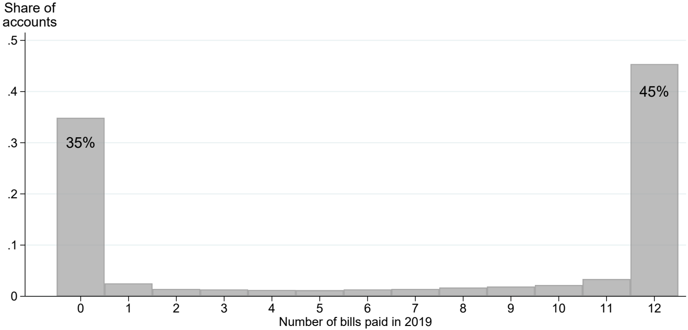
Tres de Febrero: only 45% pay their bills regularly

- Ex-ante **tax compliance/enforcement** matter for ex-post **incidence**

  ⟶ Worth considering in L&MICs with limited tax capacity

Figure A.5: Distribution of bill payments in 2019 for individuals and blocks

(a) **Number of monthly bills paid in 2019 (by individuals)**




Source: Cruces, Tortarolo, Vazquez-Bare (2023)

# General Equilibrium Tax Incidence

Examples so far have focused on **partial equilibrium** incidence which considers impact of a tax on one market in isolation

**General equilibrium** models consider the effects on related markets of a tax imposed on one market

E.g. imposition of a tax on cars may reduce demand for steel $\Rightarrow$ additional effects on prices in equilibrium beyond car market.

## General Equilibrium Tax Incidence
## Example: Soda Tax

Consider the market for Soda beverages in Berkeley CA

Berkeley imposes a Soda tax since 2015: \$0.01 per ounce (=\$0.12/can)

Goal was to reduce soda consumption for better health (people overdrink). See Allcott et al. '18 for merits of soda tax.

Here narrower question: Who bears the incidence?

If soda demand in Berkeley is inelastic, consumers bear burden

Demand for Soda in Berkeley is likely to be elastic: if price of Soda in Berkeley goes up, you consume less Soda [intention of the tax] or you buy Soda elsewhere [unintended effect]

Consider extreme case of perfectly elastic demand

# General Equilibrium Tax Incidence
# Example: Soda Tax

If Soda demand perfectly elastic then:

**1)** Berkeley Soda sellers (supermarkets, restaurants) cannot charge more and hence bear the full burden of the tax.

**2)** But Soda sellers are not self-contained entities

Companies are just a technology for combining capital and labor to produce an output.

Capital: land, physical inputs like building, kitchen equipment, etc.

Labor: cashier staff, cooks, waitstaff, etc.

**3)** Ultimately, these two factors (capital or labor) must bear the loss in profits due to the tax [if consumer demand is perfectly elastic]

## General Equilibrium Tax Incidence
## Example: Soda Tax

Incidence is "shifted backward" to capital and labor.

Assume that labor supply is perfectly elastic because Berkeley restaurant/supermarket workers can always go and work in Oakland if they get paid less in Berkeley

Capital, in contrast, is perfectly inelastic in short-run: you cannot pick up the shop and move it in the short run

Short run: capital bears the tax because it is completely inelastic $\Rightarrow$ Soda business owners lose (not consumers or workers)

Longer-run: the supply of capital likely to be highly elastic: Investors can close/sell the shop, take their money, and invest it elsewhere

## General Equilibrium Tax Incidence: Long-run effects

If both labor and capital are highly elastic in the long run, who bears the tax?

The one additional inelastic factor is land.

The supply is clearly fixed.

When both labor and capital can avoid the tax, the only way Soda sellers will remain in Berleley is if they pay a lower rent on their land.

$\Rightarrow$ Soda tax ends up hurting Berkeley landowners in general equilibrium [if Soda demand, labor and capital are fully elastic]

This is of course an idealized example, in practice, demand, labor, and capital are not fully elastic so that incidence is shared

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