Lecture 2: Tax avoidance and excess burden

Economics 336/337

In Lecture 1, we saw how interventions that distort prices induce departures from the Pareto frontier. Questions:

- How do we measure the welfare loss (“excess burden”) from such distortions in a way that is economically meaningful?
- How do we estimate the effects of taxes and tax avoidance on the economy?
- Can we design a tax system to minimize welfare losses from avoidance?

Consider a single consumer with demand for a single good $x(p)$. We want a monetary measure of the change in consumer welfare resulting from a price change from q to $q+t$. Recall the Harberger triangle:

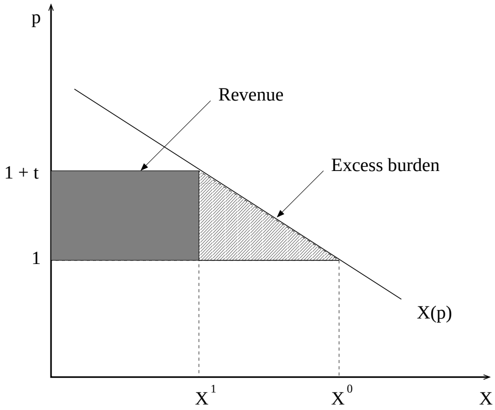


Figure: Excess burden of an excise tax

Why is the Harberger triangle the "right" measure of welfare loss?

- marginal willingness to pay is inverse demand curve: $x^{-1}(X)$
- consumer surplus at initial price q is: $\int_q^\infty x(p)dp$
- change in consumer surplus is: $\Delta CS = \int_q^{q+t} x(p)dp$

Note: ΔCS includes the tax revenue, which is a transfer from taxpayer to government. The excess burden of the tax nets out revenue:

So Harberger triangle measures

- consumer surplus lost when demand falls due to tax
- minus the opportunity cost of producing those units
- minus the tax revenue

In January, the TTC increased the token price of a trip from \$2.25 to \$2.50 (and Metropasses commensurately).

What was the cost of this to TTC passengers/taxpayers? Was the change socially desirable?

- Naive answer: Because TTC handles 250 million equivalent-to-cash trips per year, the cost of the increase was $\$0.25 \times 250\text{mn} = \$62.5\text{mn}$.
- But this is too high because the \$62.5 million is revenue gained by TTC – costs that would have to covered through some taxes.
- On the other hand, this is too low, because it ignores the economic value of TTC trips not taken at the higher price.

A better approach: Calculate excess burden.

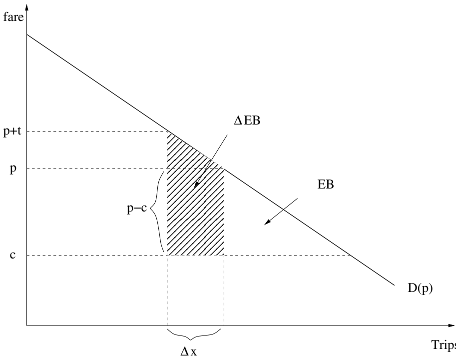


Figure: Excess burden of a fare increase

What do you think is the marginal cost of a TTC ride? Why?

Solving for EB

From TTC 2009 Budget document:

FARE INCREASE SCENARIO	ANNUAL REVENUE IMPACT ($M)	ANNUAL RIDERSHIP IMPACT (M)
$0.25 Standard Pro-Rata	$50.4	(11.5)
0.25 Standard Pro-Rata, Metropass + 1 trip	$57.5	(12.1)
$0.25 Standard Pro-Rata, Metropass + 2 trips*	$62.5	(12.5)

In another document, TTC calculates marginal cost to be about $1 per ride.

Exercise: Calculate the marginal EB of the fare increase

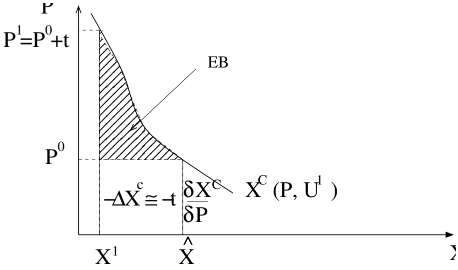


Figure: Measuring excess burden from the demand curve

Using formula for area of a triangle,

$$EB \approx -\frac{1}{2}t\Delta X \approx -\frac{1}{2}t^2\frac{\partial X}{\partial p} = \frac{1}{2}\left(\frac{t}{p}\right)^2(pX)\,\varepsilon$$

(where $\Delta X \approx t\partial X/\partial p$) (where $\varepsilon = -(p/X)\partial X/\partial p$ is demand elasticity)

Implications of the formula

$$EB \approx \frac{1}{2}\left(\frac{t}{p}\right)^2 (pX)\,\varepsilon$$

- EB increases with the *square* of the tax rate
- marginal EB changes when there are preexisting distortions
- EB increases with elasticity of demand (or supply)

Application: The window tax

- levied in England 1696-1851 (other countries too)
- tax liability increased with number of windows in a house
- people could avoid tax by blocking up windows

Credit: Gary Burt (Wikimedia)

In plain language, what is source of excess burden here?

Oates and Schwab (2015) look for evidence on window tax avoidance:

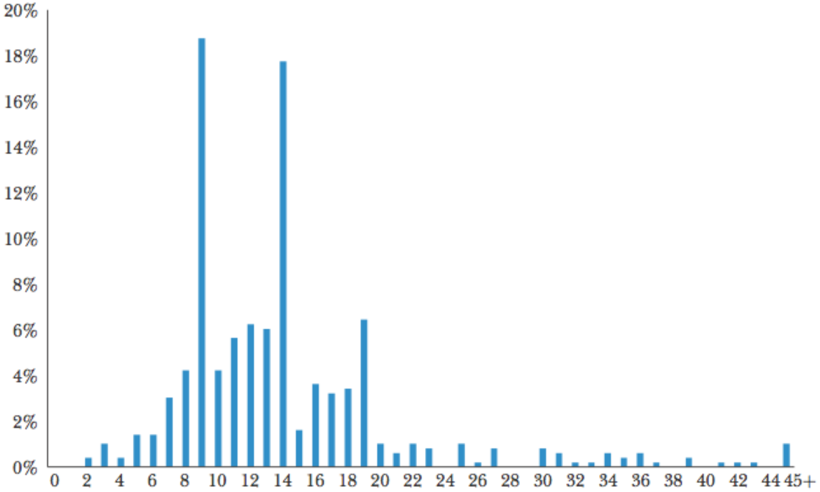
- after 1747, there were "notches" in the tax schedule:

  > *"a tax of 6 pence on every window in a house with 10 to 14 windows, of 9 pence per window in houses with 15 to 19 windows, and of 1 shilling for every window in houses with more than 20"*

  - so tax jumped when number of windows reached 10, 15, 20
- as expected there was "bunching" at 9, 14, 19 windows (see graph)
- at least 30% of houses appear to have changed number of windows to beat the tax
- based on our approximation formula, excess burden is estimated at 13% of tax revenues

Figure 2

Distribution of Number of Windows, 1747–1757 Sample



Exercise: Excess burden with multiple taxes

Example: A consumer supplies labour and buys gin and rum. Suppose that the initial tax on rum is $t_r > 0$, and a positive tax on gin is introduced. Label the change in excess burden in the two markets, and write down the formula for it. Show that the change in EB is negative if t_g is small.

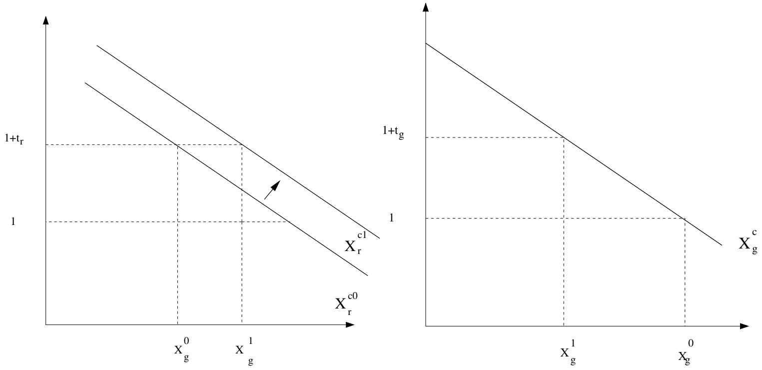


Figure: EB in rum and gin markets

Here is the math behind the graphical analysis. This is not testable material – understanding the graphs alone will suffice.

From our previous formula, gin EB is

$$\Delta EB_g \approx -\frac{1}{2} t_g \Delta X_g \approx -\frac{1}{2}(t_g)^2 \frac{\partial X_g}{\partial p_g} > 0$$

Change in rum EB is approximately the rectangular area

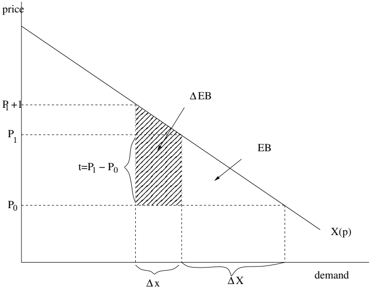
$$\Delta EB_r \approx -t_r \Delta X_r \approx -t_r t_g \frac{\partial X_r}{\partial p_g} < 0$$

If t_g is small, the first term is of smaller magnitude than the second. So EB falls when a small tax is introduced on a substitute for a taxed good.

What is the right way to design the tax system to raise government revenue? For example:

- should Toronto tax transit users, homeowners, or something else?
- should we have high tax rates on alcohol and tobacco – or a uniform tax (GST) on all sales?
- who should pay a higher tax on her labour income – a small business owner, or a university professor?

Designing the optimal tax system is a difficult problem in general, but we can develop some simple rules based on our excess burden formula.



Suppose we have a tax rate t on X: should we increase it some more?

- Existing tax causes $EB \approx \frac{1}{2}t\Delta X$, gets revenue $R = tX$.

Now, increase tax rate by one cent:

- EB rises by:

$$\Delta EB \approx t\Delta x \approx -t\frac{\partial X}{\partial p} \approx \Delta X$$

- Revenue rises by:

$$\Delta R \approx X + t\Delta x \approx X - \Delta X$$

At an optimal tax system, the marginal excess burden per dollar of marginal revenue should be the same for all tax bases X and Y:

$$\frac{\Delta X}{X-\Delta X} = \frac{\Delta Y}{Y-\Delta Y} \quad \text{or} \quad \frac{\Delta X}{X} = \frac{\Delta Y}{Y}$$

This is the Ramsey rule: To raise revenue at minimum excess burden, decrease all demands by the same percentage amount.

- Consumption loss is least costly to consumers if same for all commodities.

Frank Ramsey was a Cambridge philosopher and mathematician – and wrote three great economics papers while a grad student!

Frank Ramsey, 1903-30

A special case: Inverse elasticity rule

- Suppose that elasticities of demand are constant, and there are no cross-price substitution effects
- Example: Elasticity of demand for Y for Y is 0.8, and the elasticity of demand for X is 0.4.
  - How much higher should the tax rate on X be, compared to the tax rate on Y?
- With no cross-price effects, optimal tax rates are *inversely proportional to demand elasticities*

Key concepts

consumer surplus
excess burden/deadweight loss
Harberger triangle
marginal excess burden
optimal commodity taxation
Ramsey rule
inverse elasticity rule