

31E12100 Microeconomics policy

Lecture 2: Microeconomic foundations of policy analysis

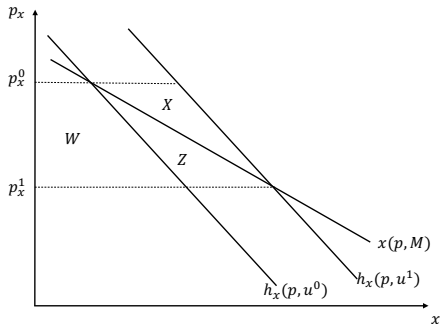
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Plan for the lecture

- Measurement of welfare impacts
 - Deadweight loss of taxes and
 - Consumer price index
- Two illustrations of policy-induced welfare impacts: houses and cars
- Two readings: in-kind transfers and excess burden of taxation
- Notion of efficiency in policy analysis: Kaldor-Hicks criterion

Recall: the relationship between CV, EV, and ΔCS



How to make use of it in the policy analysis?

Measuring welfare changes: deadweight loss from taxation

To fix ideas, we consider a simple equilibrium model where individual has M units of numeraire y with price set to 1. Firms can convert y into J consumption goods $x = (x_1, \dots, x_J)$. Production cost is $c(x) = \sum_{j=1}^J c_j(x_j)$ and prices are $p = (p_1, \dots, p_J)$. Government sets tax τ on good 1. Consumer's problem is now

$$\begin{aligned} \max_{x,y} u(x) + y \\ \text{s.t. } p \cdot x + \tau x_1 + y = M \end{aligned}$$

The representative firm takes the prices as given and maximizes $\{p \cdot x - c(x)\}$. The social welfare W is the sum of the consumer welfare, profits, and tax revenue. Let us denote $W(\tau)$ because the tax has an impact on the social welfare.

Measuring welfare changes: the deadweight loss from taxation

Two basic approaches:

1. Estimate the primitives: J-good demand and supply system estimation to recover primitive functions u and c . Once estimated, one may directly compute $W(\tau)$. The building blocks in this approach are Stone (1954) and Deaton and Muellbauer (1980). Alternatively, one may estimate a demand system and then integrate the Hicksian demand to obtain the expenditure function that defines CV and EV . E.g., Hausman and Newey (1995).
2. Sufficient statistics approach: Based on Harberger (1964). It has gained popularity in the recent past as a midway between structural and reduced-form approaches (Saez, 2001; Chetty, 2006). In the problem set, you are asked to show that in the example above the marginal welfare effect of the tax takes the form:

$$\frac{\partial W(\tau)}{\partial \tau} = \tau \frac{\partial x_1(p, M)}{\partial \tau}.$$

Measuring welfare changes: the deadweight loss from taxation, cont.

Sufficient statistics approach, continued:

$$\frac{\partial W(\tau)}{\partial \tau} = \tau \frac{\partial x_1}{\partial \tau}.$$

The problem set will elaborate the reasons for this result. The point is that it is enough to estimate the impact of the tax on the observable demand, without a need to recover the primitives of the welfare program. The impact on demand is can estimated using reduced-form program-evaluation methods.

Measuring welfare changes: The consumer price index



The Economist, May 11, 2013

Cost of living I: The consumer price index

- The Economist, May 11, 2013: The most popular measure, the consumer price index (CPI), is a representative basket of goods and services drawn from a survey of the spending habits of 12,200 households. The index assumes that consumers buy the same quantity of each commodity from one period to the next until the basket is updated, every two years. The change in the cost of that basket is the inflation rate. But this almost certainly overstates the cost of living.
- The CPI Commission concluded that the change in the Consumer Price Index overstates the change in the cost of living by about 1.1 percentage points per year. (Boskin et al., J. of Econ. Perspectives, Winter 1998).

CPI and expenditure function $e(p, u)$

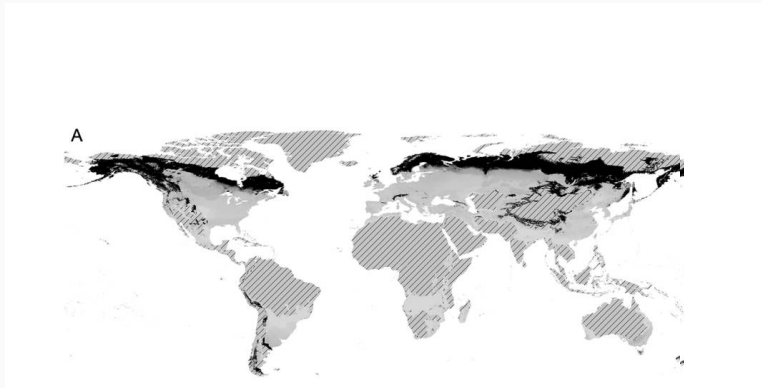
Expenditure function is always concave in prices: for two price vectors (p^0, p^1) and scalar $\lambda \in [0, 1]$, we have

$$e(\lambda p^0 + (1 - \lambda)p^1, u) \geq \lambda e(p^0, u) + (1 - \lambda)e(p^1, u)$$

From this we can see that The Economist is right! How?

Measuring welfare changes: Climate change application

Costinot et al. JPE 2016: Impact of Climate Change in Agricultural Markets. Prediction on global wheat output (gaining regions dark). Which crops are produced and where? How does the supply of crops affect prices around the world? How changes in productivity and prices map into consumption and welfare changes?



Measuring welfare changes III: Climate change application

Utility depends on aggregate crop consumption C_i

$$C_i = \left[\sum_k (\beta_i^k)^{1/\kappa} (C_i^k)^{(\kappa-1)/\kappa} \right]^{(1-\kappa)/\kappa}$$

where C_i^k is consumption of each crop which depends varieties from from different origins C_{ji}^k ,

$$C_i^k = \left[\sum_j (\beta_{ji}^k)^{1/\kappa} (C_{ji}^k)^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)}$$

Here $\kappa > 0$ denotes the elasticity of substitution between different crops (wheat vs. corn) and $\sigma > 0$ denotes the elasticity of substitution between different varieties of a given crop (French vs. US wheat), and β 's are demand shifters.

Consumer faces crop prices and has given income \rightarrow consumption bundle is a bundle of crops depending on a cost-of-living index constituting prices. The problem set I asks you to derive the compensation variation that will turn out to depend on a price index for the consumption bundle: the welfare changes follow directly from the index.

When is it important to use CV or EV in policy evaluation, rather than just ΔCS

CS is an approximate welfare measure

- The difference does not matter if the policy-induced welfare change has small income effects
- But one must use either CV or EV if choices have big budgetary implications (think of automobiles or housing).

Discrete choice and CV/EV

Many policy relevant choices are discrete by nature:

- location to live
- a car/major appliance model to purchase
- university to study (if you are accepted to many)
- voting decision
- the type house to build

For example, in transportation, education, health care, child care, and pollution public policies can change the quality of some publicly or privately supplied good. The good affected is subject to discrete choice. Empirical discrete choice models such (as logit) allow evaluating the CV and thus WTP directly because the estimation deals with the systematic part the utility change (details in the *book by Ken Train*)

Discrete choice and CV/EV

Suppose individuals choose not all products one of J products, each having a vector of characteristics $x_j = (x_{1j}, \dots, x_{Kj})$ such features of a car, etc. When agent i buys, the utility is

$$u_{ij} = v_{ij} + \epsilon_{ij}$$
$$v_{ij} = M^i - p_j + \zeta_j + \phi^i(x_j)$$

where M^i is income, $\phi^i(x_j) + \zeta_j + \epsilon_{ij}$ is utility over the attributes, with ζ_j and ϵ_{ij} unobservable to the econometrician.

Discrete choice and CV/EV

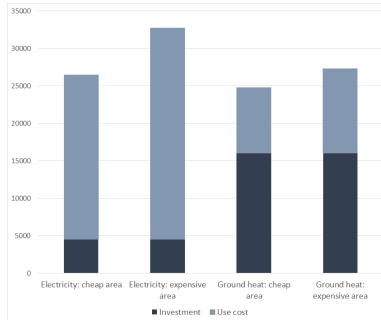
To illustrate, assume only one good $J = 1$ with fixed price $p > 0$. If the consumer buys, $u_i = M^i - p + \zeta + \phi(x) + \epsilon_i$. If no purchase, then we have just $u_i = M^i$. Let $V^i = \phi^i(x) + \zeta + \epsilon_i$ denote the utility over the attributes, and that these are distributed according to some cumulative distribution function $F(V^i)$ in the population. Let EM denote the average income in the population. All consumers above some cutoff buy the good, $V^i \geq \bar{V}$. If government sets a tax τ on the price, the welfare of the representative consumer is

$$W(\tau) = EM + \int_{V^i \geq \bar{V}} \{V^i - (p + \tau)\} dF(V^i) + t \int_{V^i \geq \bar{V}} dF(V^i)$$

The discrete choice models estimate this type of welfare before and after the tax, for example.

First illustration of CV: housing & heating

How much households are willing to pay to obtain lower energy costs?
WTP determines investments in technologies that achieve those lower costs. Important for policies: taxes determine the relative cost of using different technologies. Source: Anna Sahari, EER 2019.



House size 170 m^2 , heat need 120 kWh/m^2 , discount rate 5%, lifetime 20 years.

First illustration of CV: housing & heating

The results indicate that Finnish households are willing to give away now about 10€ income for each 1€ of lower heating costs per year in the future

Table 5: Results from estimation in WTP space

	1	2	3	4
Investment cost				
Heating cost (WTP)	-13.307*** (0.533)	-13.307*** (0.533)	-11.914*** (0.853)	-9.515*** (0.783)
<i>Interaction terms</i>				
Net income (€10 000)			-0.622***	-0.493***
Education			-1.682***	-0.397
Age (10 years)			0.318*	-0.135
Children			-1.431***	-1.386***
Family size			0.417***	0.669***
House owner			2.484***	1.696***
<i>SD of random coefficients</i>				
Heating cost (WTP)		0.005		
<i>Constant for electric heating and interactions</i>				
Electric heating	2.244***	2.244***	1.745***	10.803***
Year 2011	-1.368***	-1.368***	-1.504***	-1.433***
Location:town	0.472	0.472	1.127***	1.031***
House size (10m ²)				-0.864***
Net income (€10 000)				0.276
Education				-1.287***
Age (10 years)				0.616***
Children				0.277
Family size				0.106
House owner				-0.039
<i>Coefficient on investment costs</i>				
	-0.140*** (0.011)	-0.140*** (0.011)	-0.139*** (0.011)	-0.189*** (0.012)
Log likelihood	-8469	-8469	-8339	-8015
Number of households: 8413				

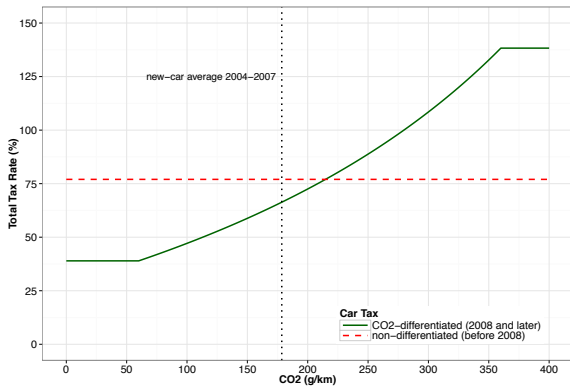
Notes: The table presents results from a logit estimation of heating system choice. The options are electric heating, hydroelectric heating and ground heat. The coefficients are directly interpreted as willingness to pay-values. The indicator variables include education (=1 if at least Bachelor-level), children (=1 if family with children), house owner (=1 if current dwelling is a detached house) and location (=1 if town plan in force at building site). Net income refers to total household income net of taxes. Significance levels: * 10%, ** 5%, *** 1%.

Second illustration of CV: the 2008 Finnish car tax reform

The relative prices of cars changed overnight: what was the impact on consumers? Source: Robin Stitzing, doctoral thesis 2016

- The reform makes the final price of the car to depend on its emissions.
- The car tax reform coincided with the introduction of mandatory EU CO2 emissions standards to manufacturers
- The Finnish reform was unique in Europe in providing strong monetary incentives also for consumers
- The 2008 car tax reform is on average worth 40 euros to 2010 households. Most households would not have bought a new car regardless of the differentiation of tax rates, and are thus unaffected by the tax reform.
- Households who would have bought a new car under the car tax benefit on average by 1 633 euros.

The reform



Reading I: Deadweight loss of Christmas

Waldfogel (AER,1993) asked the following questions from a group of students about the gifts they received

- What were the purchase prices of the gifts?
- How much would you be willing to pay for the items?
- How much would you be willing to accept in cash, instead of receiving the gifts?

We will connect this reading to the welfare analysis

DWL of Christmas

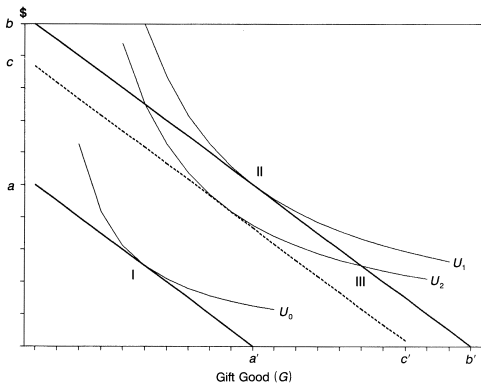


FIGURE 1. GIFT-GIVING AND DEADWEIGHT LOSS

Notes: The amount of the gift good (G) is on the horizontal axis. The vertical axis measures all other goods, in dollars. Point I on budget line aa' describes the recipient's holdings of the gift good and all other goods prior to receipt of the gift, when her utility is U_0 . When she receives $a'c'$ units of the gift good, her holdings are represented by point III on budget line bb' . At this point her utility is U_2 . Had she received a cash gift of equal cost to the giver, she could have chosen any point on budget line bb' , and she would have chosen point II, with utility U_1 . Because the utility of the bundle chosen freely by the recipient exceeds utility of an equal-cost bundle that includes the gift, there is a deadweight loss. In dollars, this deadweight loss is distance cb on the vertical axis.

Observations: theory

- aa' is the original budget set and the gift puts the consumer on the budget set bb'
- on the new set, the consumer could move to utility level U_1 if the gift is in cash.
- with in-kind gift, the utility level is U_2 , which could be reached with lower budget cc'
- the difference $b'-c'$ measures the value destroyed by the gift.
- paper measures the “yield”, which is the recipients valuation divided by the price of the goods. Turns out be less than one, as expected.

Observations: empirics

- the paper estimates the following relationship between value (v) and price (p)

$$\ln(v) = -.314 + .964 \ln(p)$$

- recall that

$$\frac{d \ln v}{d \ln p} = \frac{dv/v}{dp/p} = \textit{elasticity}$$

so that .964 is the elasticity measuring the value destruction

- looking at levels,

$$\begin{aligned} \ln(v) &= -.314 + .964 \ln(p) \\ &= \ln(\exp(-.314)p^{.964}) \Rightarrow v = .73p^{.964} \end{aligned}$$

100 dollar gift is worth 62 dollars.

Observations: empirics

TABLE 1—AVERAGE AMOUNTS PAID AND VALUES OF GIFTS, BY RECIPIENT

Variable	Survey 1	Survey 2
Amount paid (\$)	438.2	508.9
Value (\$) ^a	313.4	462.1
Percentage ratio of average value to average price paid ^b	71.5	90.8
Average percentage yield ^c	66.1 (3.3)	87.1 (3.2)
Number of recipients	86	58

^aIn survey 1, respondents valued their gifts by their willingness to pay for them. In survey 2, respondents valued their gifts as the money they would accept in lieu of the gifts (see text).

^bRatio of average value to average price paid.

^cAverage of (value_i/price_i). The standard error of average yield is given in parentheses.

Figure 3: WTA is higher (Survey 2) than WTP (Survey 1), common result in economics. Value destruction greatest for more distant relatives but these tend to give more cash.

Reading II: Window tax

This reading helps us to discuss

- how to perform a linear approximation of the welfare changes
- how to connect a given price elasticity of demand to welfare changes
- the excess burden of taxation
- the leakage rate of taxation

You will have to use these concepts in the first problem set. We'll do this analysis in the classroom.

Window tax: William III of England



Reading II: Window tax

The window tax consisted of a set of “notches”. For example, a homeowner paid

- no tax if the house had fewer than 10 windows;
- 6 pence per window if the house had 10 to 14 windows;
- 9 pence per window if the house had 15 to 19 windows;
- 1 shilling per window if the house had 20 or more windows.

A **notch** in a tax schedule exists if a small change in behavior leads to a large change in tax liability. A **kink** in a tax schedule exists if a small change in behavior leads to a large change in the marginal tax rate but just a small change in tax liability (consider tax brackets in income taxation).

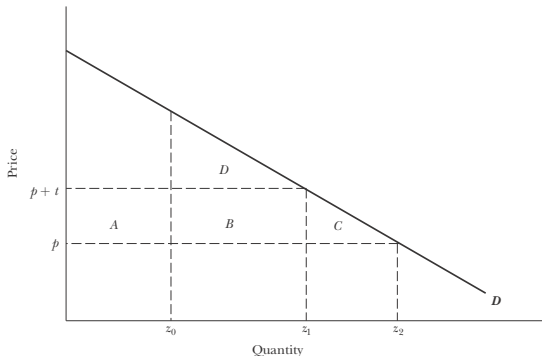
Window tax – a property tax?



Window tax – is there a deadweight loss?



How to measure the deadweight loss?

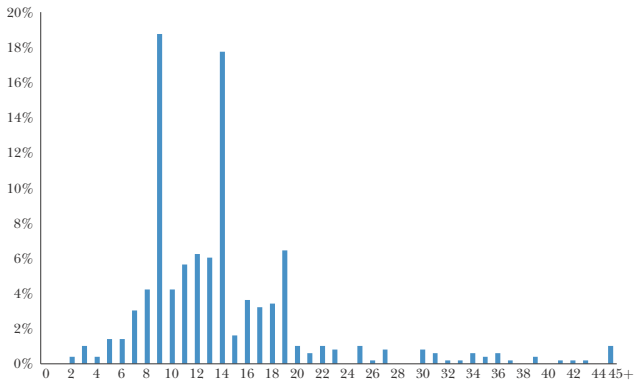


Notes: Consider a simple window tax that includes just one notch. Consumers pay no tax if they own z_0 or fewer windows but pay a tax of t pence per window if they own more than z_0 windows. Case I includes consumers who would own fewer than z_0 windows in the absence of the tax. Case I consumers pay no tax and suffer no deadweight loss. Case II consumers purchased more than z_0 windows before the tax and continue to purchase more than z_0 windows after the tax is imposed. They pay a total tax bill of $A + B$, suffer a welfare loss of $A + B + C$, and thus incur a deadweight loss of C . Case III includes consumers who would buy more than z_0 windows if there were no tax, but exactly z_0 once the tax is imposed. These consumers pay zero tax and suffer a welfare loss of $D + B + C$. Aside from Case I consumers, the decision on whether to pay the tax turns on the relative sizes of area D and area A .

Bunching at notches

Figure 2

Distribution of Number of Windows, 1747–1757 Sample



Tools for welfare analysis

The analyst knows the price elasticity of demand, let this be e_d .
the consumer surplus (CS) changes according to

$$\Delta CS = -q\Delta p - \frac{e_d q (\Delta p)^2}{2p}$$

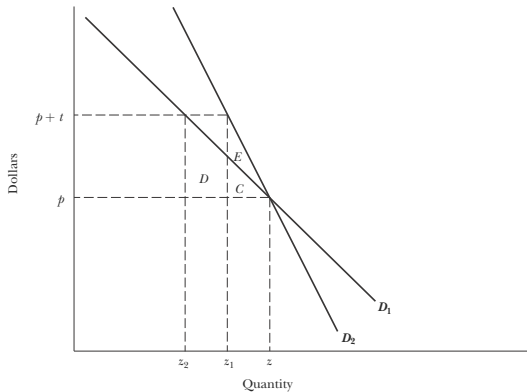
where Δp and Δq are price and quantity changes.

- in the reading, the authors assumed a linear demand for all consumers (the same slope but different intercept).
- the linear demand was calibrated to the data on the distribution of windows (very rough but pedagogical) to come up with an estimate for the price elasticity of demand

Excess Burden of taxation can be measured in different ways. The reading considered excess burden that is sometimes called “leakage”: the ratio of the deadweight loss to the total tax revenue raised. These concepts are in the problem set.

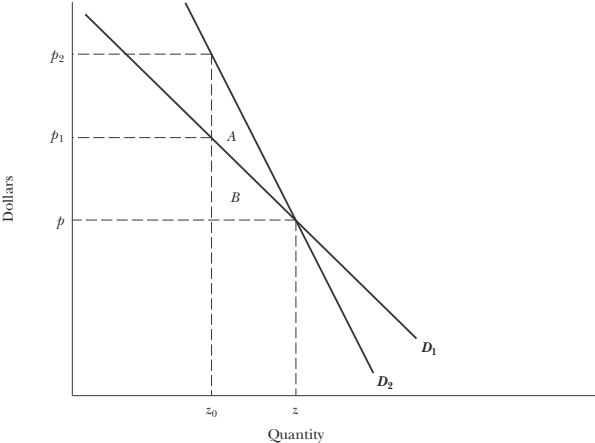
Demand elasticity and the deadweight loss: the standard case

Figure 5
Deadweight Loss from a Tax



With notches, the role of demand slope is reversed

Figure 4
Deadweight Loss from a Quantity Restriction



A concluding remark: welfare changes and efficiency

Net Benefits and Pareto Efficiency

If net welfare changes are positive, then it is possible to find a set of transfers that makes at least one person better off without making anyone else worse off.

We should focus on **Potential Pareto Efficiency** (i.e. Kaldor-Hicks criterion)

- Society maximizes aggregate wealth.
- If different policies have different winners and losers, then, in aggregate, costs and benefits will average out over the entire population.
- It counters incentive to give too much weight to organized groups and too little weight to unorganized groups.
- It is possible to do redistribution wholesale rather than within each separate policy.

Do you see how this criterion is different from the Pareto efficiency?

The difference between potential Pareto efficiency and Pareto efficiency

