Lecture Notes 2

Taxation

Markeljan Blacëri
University of Padova
markeljan.blaceri@phd.unipd.it

A.Y. 2025-2026

Types of Taxes

- **Payroll tax**: a tax levied on the earnings of workers.
- **Individual income tax**: a tax paid by individuals on income accrued during the year.
- **Corporate income tax**: a tax levied on the earnings of corporations.

Types of Taxes

Wealth Tax

Wealth tax: a tax paid on the value of the assets, such as real estate or stocks, held by a person or family.

- **Property taxes**: a form of wealth tax based on the value of real estate, including the value of the land and any structures built on the land.
- **Estate taxes**: a form of wealth tax based on the value of the estate left behind when one dies.

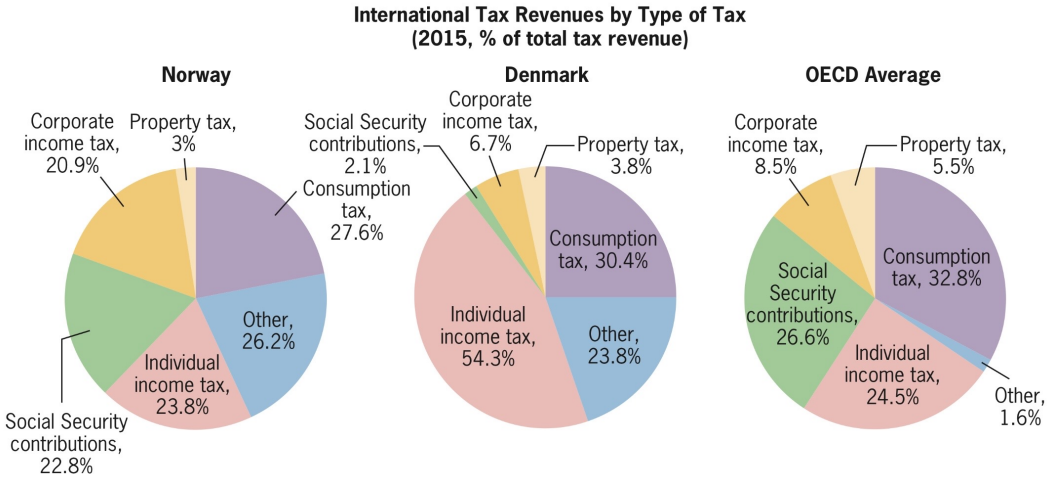
Types of Taxes

Consumption Tax

Consumption tax: A tax paid on individual or household consumption of goods (and sometimes services).

- **Sales taxes**: taxes paid by consumers to vendors at the point of sale.
- **Excise tax**: tax paid on the sales of particular goods, for example cigarettes or gasoline.

Tax Revenues by Type of Tax



Computing the Tax Base

1. The income tax calculation begins by adding up one's various sources of income to compute **gross income**.
   - Wages and salaries,
   - Capital income (interest, dividends, rental income),
   - Other business income.
2. Adjust the gross income downward by subtracting the amounts spent on several items to obtain the **adjusted gross income**.
   - Contributions to retirement savings,
   - Alimony paid to a former spouse,
   - One-half of the payroll taxes paid by the self-employed,
   - Contributions to Health Savings Accounts, etc.

Computing the Tax Base: Exemptions & Deductions

The taxpayer then subtracts exemptions and deductions from the adjusted gross income.

1. An exemption is a fixed amount of money that can be deducted for the taxpayer, the taxpayer's spouse, and any other dependents who live in the house.
2. Two forms of deductions:
   - **Standard deduction**: a fixed amount that a taxpayer can deduct from taxable income.
   - **Itemized deductions**: a taxpayer deducts the total amount of money spent on various expenses, such as gifts to charity and interest on home mortgages.

The remainder after subtracting exemptions and deductions is called **taxable income**.

Example: Computing the Tax Base

Example: Suppose Maria has the following annual income and deductions.

Description	**Amount (€)**
Wages and salaries	50,000
Interest income	2,000
Dividends	1,000
Gross income	53,000
Retirement contribution	-2,000
Health Savings Account (HSA)	-1,000
Adjusted gross income	50,000
Standard deduction	-13,000
Taxable income	**37,000**

The taxable income is the base on which tax rates are applied to compute the tax liability.

Applying Tax Rates

Once the **taxable income** is computed, the next step is to apply the **tax rates** established by the tax code.

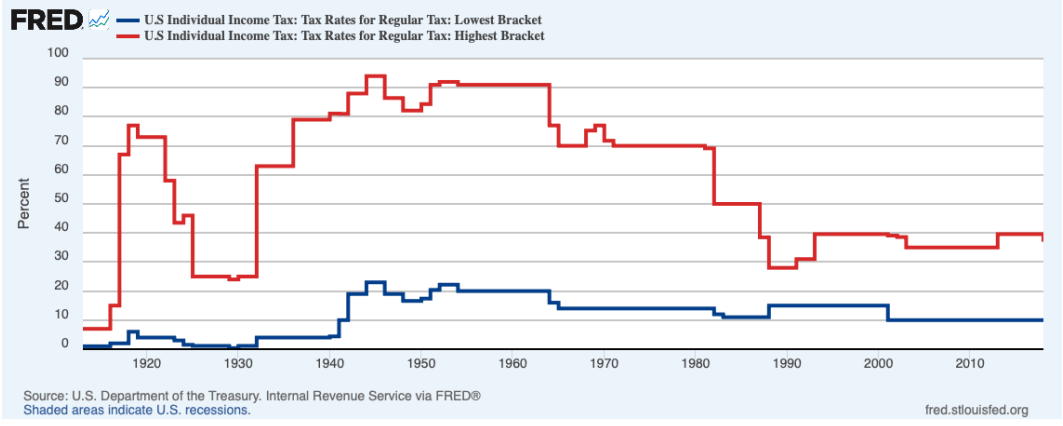
Basic principle:

- Each taxpayer pays taxes based on the amount of **taxable income**.
- Governments typically define a set of **tax brackets**, each associated with a different tax rate.

Example of tax brackets:

Taxable income range (€)	Tax rate
0 – 15,000	15%
15,001 – 30,000	25%
30,001 – 60,000	35%
Over 60,000	43%

Tax Rates


FRED
U.S Individual Income Tax: Tax Rates for Regular Tax: Lowest Bracket
U.S Individual Income Tax: Tax Rates for Regular Tax: Highest Bracket
Percent
100
90
80
70
60
50
40
30
20
10
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Source: U.S. Department of the Treasury. Internal Revenue Service via FRED®
Shaded areas indicate U.S. recessions.
fred.stlouisfed.org

Example: Computing the Tax Liability

Example: Maria has a taxable income of **€37,000**. The tax system is defined as follows:

Taxable income range (€)	Tax rate
0 – 15,000	15%
15,001 – 30,000	25%
30,001 – 60,000	35%

Step 1. Apply the tax rates to each bracket:

$$\begin{aligned} 15{,}000 \times 0.15 &= 2{,}250 \\ (30{,}000 - 15{,}000) \times 0.25 &= 3{,}750 \\ (37{,}000 - 30{,}000) \times 0.35 &= 2{,}450 \end{aligned}$$

Step 2. Total tax liability:

$$2{,}250 + 3{,}750 + 2{,}450 = \textbf{€8,450}$$

Final Tax Payment

Once the **tax liability** has been computed, the taxpayer's **final tax payment** is determined by considering:

- **Tax credits**: amounts by which taxpayers are allowed to reduce the taxes they owe to the government through spending, for example on child care.
- **Withholding**: the subtraction of estimated taxes owed directly from a worker's earnings.

Final tax payment:

$$\text{Tax due (or refund)} = \text{Tax liability} - \text{Credits} - \text{Withholdings}$$

- If the result is positive $\rightarrow$ the taxpayer must pay additional taxes.
- If the result is negative $\rightarrow$ the taxpayer receives a refund.

Example: From Income to Final Tax Payment

Example: Summary of Maria's income, deductions, and taxes.

Description	**Amount (€)**
Wages and salaries	50,000
Interest income	2,000
Dividends	1,000
Gross income	53,000
Retirement contribution	-2,000
Health Savings Account (HSA)	-1,000
Adjusted gross income	50,000
Standard deduction	-13,000
Taxable income	37,000
Tax liability (from brackets)	8,450
Tax credit (child credit)	-1,000
Tax after credits	7,450
Withholdings during the year	-7,000
Final tax payment due	**450**

Poll Tax of Margaret Thatcher (1990)



Tax Fairness

Once we know how taxes are computed, we can ask: what makes a tax system fair?

Economists usually distinguish two main concepts of fairness:

1. **Horizontal equity**: individuals who are similar but who make different economic or lifestyle choices should be treated in the same way by the tax system.
2. **Vertical equity**: groups with more resources should pay higher taxes than do lower-resource groups.

Key question: How should taxes increase with income to balance *equity* (fairness) and *efficiency* (incentives)?

Average and Marginal Tax Rates

To evaluate fairness, economists use two key measures:

1. **Average Tax Rate (ATR):**

$$\text{ATR} = \frac{\text{Total taxes paid}}{\text{Total income}}$$

   It shows the overall share of income paid in taxes.

2. **Marginal Tax Rate (MTR):**

$$\text{MTR} = \frac{\text{Change in taxes paid}}{\text{Change in income}}$$

   It shows how much of the *next euro* of income is taxed.

Example: Marginal and Average Tax Rates

Recall Maria's taxable income: **€37,000**. Her tax liability (using the same brackets) was **€8,450**.

Income range (€)	**Tax rate**	**Tax paid (€)**
0 – 15,000	15%	2,250
15,001 – 30,000	25%	3,750
30,001 – 37,000	35%	2,450
Total		**8,450**

Average Tax Rate (ATR):

$$\text{ATR} = \frac{8{,}450}{37{,}000} = 0.228 \Rightarrow \textbf{22.8\%}$$

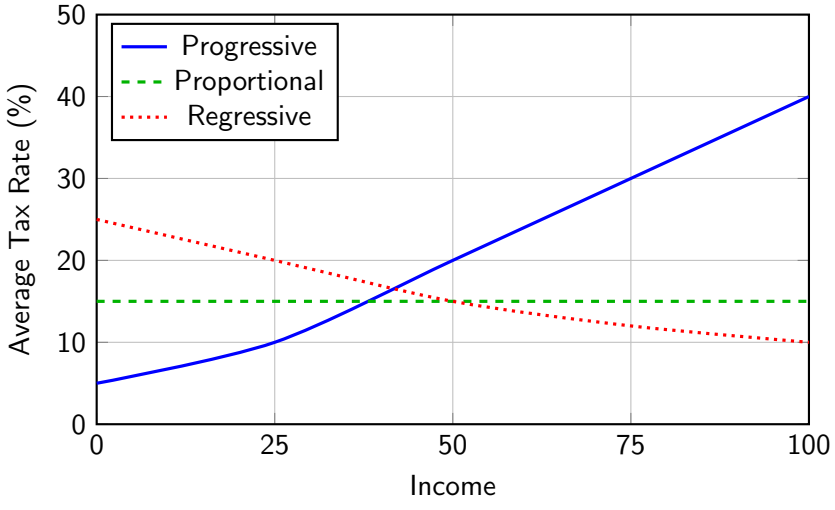
Marginal Tax Rate (MTR):

$$\text{MTR} = 35\%$$

Tax Systems

- **Progressive**: tax systems in which effective average tax rates rise with income.
- **Proportional**: tax systems in which effective average tax rates do not change with income, so that all taxpayers pay the same proportion of their income in taxes.
- **Regressive**: tax systems in which effective average tax rates fall with income.

Comparing Tax Systems



The Marriage Tax

The **marriage tax** (or **marriage bonus**) occurs when a couple's total tax liability changes due to being married, even if their combined income stays the same.

Taxation approaches:

- **Individual basis:** Each spouse is taxed separately on their own income; the family tax bill is the sum of individual taxes.
- **Family basis:** The spouses' incomes are combined; the tax is calculated on total family income.

Why it happens:

- Progressive tax brackets mean combining incomes can:
  - Push the household into a **higher bracket** $\rightarrow$ **marriage tax**.
  - Spread income across brackets $\rightarrow$ **marriage bonus** if one spouse earns much less.

Example: The Marriage Tax

Tax schedule: 15% up to €15,000; 25% on €15,001–€30,000; 35% on €30,001–€60,000; 43% above €60,000.

Individual	Income (€)	Tax (€)	Notes
Marco	30,000	6,000	Individual tax
Maria	30,000	6,000	Individual tax
Joint	60,000	16,500	Combined as married
Marriage Effect	-	+4,500	Marriage penalty
Luigi	50,000	13,000	Individual tax
Anna	10,000	1,500	Individual tax
Joint	60,000	16,500	Combined as married
Marriage Effect	-	+2,000	Marriage penalty

Tax Brackets: Married Filing Separately vs. Jointly

Tax Rate	Married Filing Separately ($)	Married Filing Jointly ($)
10%	0 – 11,600	0 – 23,200
12%	11,601 – 47,150	23,201 – 94,300
22%	47,151 – 100,525	94,301 – 201,050
24%	100,526 – 191,950	201,051 – 383,900
32%	191,951 – 243,725	383,901 – 487,450
35%	243,726 – 365,600	487,451 – 731,200
37%	365,601 and up	731,201 and up

Source: Internal Revenue Service (IRS), Federal Income Tax Rates and Brackets.

Tax Incidence: Who Bears the Burden of a Tax?

- The **statutory incidence** of a tax describes who is legally responsible for paying it.
- The **economic incidence** describes who actually bears the burden of the tax, after market adjustments.
  - When **a tax is imposed on producers** in a competitive market, producers will raise prices to some extent to offset this tax burden, and the producers' income will not fall by the full amount of the tax.
  - When **a tax is imposed on consumers** in a competitive market, the consumers will not be willing to pay as much for the taxed good, so prices will fall, offsetting to some extent the statutory tax burden on consumers.

Example: A tax on sellers may raise prices to consumers — shifting part of the burden to buyers.

Rule #1 of Tax Incidence

Rule #1

Tax laws do not accurately identify who actually bears the burden of the tax.

Tax Burdens

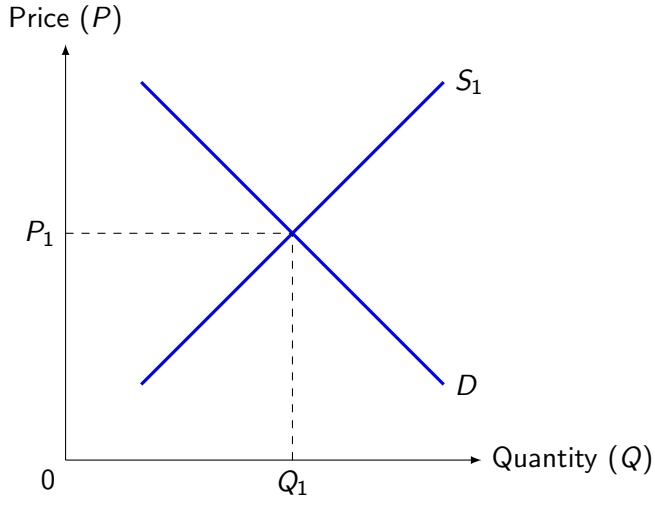
- **Tax burden for consumers**:

$$\text{consumer tax burden} = (\text{post-tax price} - \text{pre-tax price} + \text{per-unit tax payments by consumers})$$

- **Tax burden for producers**:

$$\text{producer tax burden} = (\text{pre-tax price} - \text{post-tax price}) + \text{per-unit tax payments by producers}$$

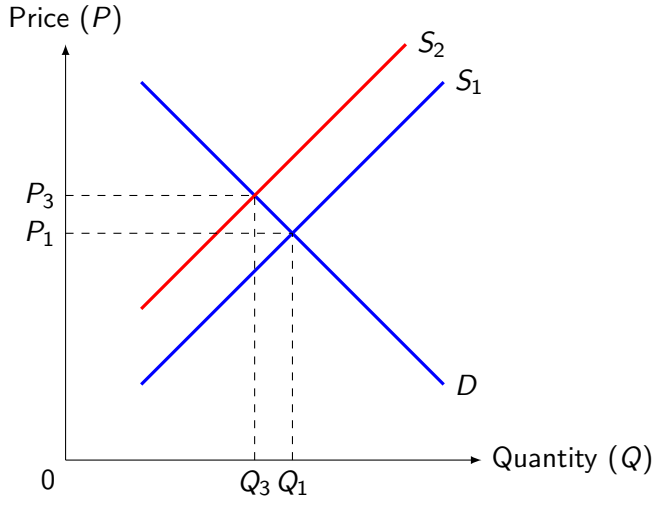
Competitive Equilibrium



Competitive Equilibrium: Interpretation

- The **competitive equilibrium** occurs where **demand equals supply**.
- The corresponding price P_1 is the **equilibrium price**, and the quantity Q_1 is the **equilibrium quantity**.
- At P_1, there is **no excess demand or excess supply** — the market **clears**.

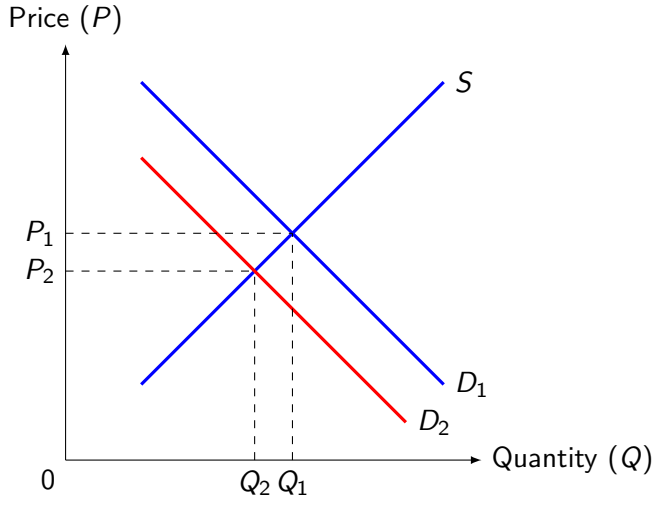
Tax Imposed on Producers



Tax Imposed on Producers: Interpretation

- A **per-unit tax on producers** increases production costs.
- The **supply curve shifts upward** by the amount of the tax (from S_1 to S_2).
- The new equilibrium occurs at a **lower quantity** Q_2.
- Buyers pay a **higher price** P_2.
- Sellers receive a **lower net price** ($P_2 - \text{tax}$).
- The tax drives a **wedge between the price paid by buyers and the price received by sellers**.

Tax Imposed on Consumers



Tax Imposed on Consumers: Interpretation

- A **per-unit tax on consumers** increases the price buyers must pay for each unit purchased.
- The **demand curve shifts downward** by the amount of the tax (from D_1 to D_2).
- The new equilibrium occurs at a **lower quantity** Q_2.
- Buyers pay a **higher total price** ($P_2 + \text{tax}$), which includes the tax.
- Sellers receive a **lower net price** P_2 for the good.

Tax Incidence Example

Setup:

$$Q^d(P) = 80 - 2P, \quad Q^s(P) = 3P - 20, \quad \tau = 10$$

Initial equilibrium: $Q^d(P) = Q^s(P) \Rightarrow P_0 = 20, \quad Q^* = 40$

Tax on Producers:

$$P_S = P_C - 10$$

$$\begin{aligned} Q^s_\tau(P_C) &= 3(P_C - 10) - 20 \\ &= 3P_C - 50 \end{aligned}$$

- Post-tax eq: $Q^{**} = 28$, $P_C = 26$, $P_S = 16$
- Consumer burden:
$$(26 - 20) + 0 = 6$$
- Producer burden:
$$(20 - 26) + 10 = 4$$

Tax on Consumers:

$$P_C = P_S + 10$$

$$\begin{aligned} Q^d_\tau(P_S) &= 80 - 2(P_S + 10) \\ &= 60 - 2P_S \end{aligned}$$

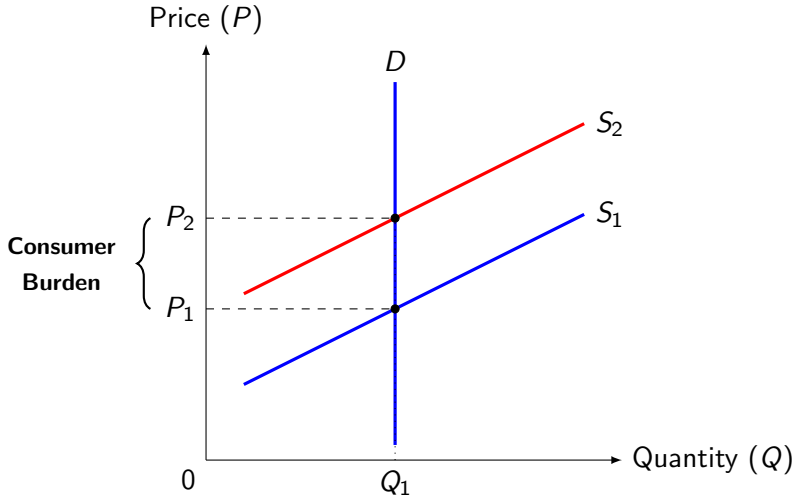
- Post-tax eq: $Q^{**} = 28$, $P_S = 16$, $P_B = 26$
- Consumer burden:
$$(16 - 20) + 10 = 6$$
- Producer burden:
$$(20 - 16) + 0 = 4$$

Rule #2 of Tax Incidence

Rule #2

The side of the market on which the tax is imposed is irrelevant to the distribution of the tax burdens: tax incidence is identical whether the tax is levied on producers or consumers.

Perfectly Inelastic Demand



Perfectly Inelastic Demand

Setup: $Q^d(P) = Q_0, \quad Q^s(P) = a + bP, \quad$ per-unit tax τ
Pre-tax equilibrium:

$$Q^d = Q^s \implies Q_0 = a + bP_1 \implies P_1 = \frac{Q_0 - a}{b}, \quad Q_1 = Q_0$$

Post-tax equilibrium (tax on producers): $P_S = P_C - \tau$

$$Q^s_\tau(P_B) = a + b(P_C - \tau)$$

$$Q_0 = Q^s_\tau(P_C) \implies P_B = P_1 + \tau$$

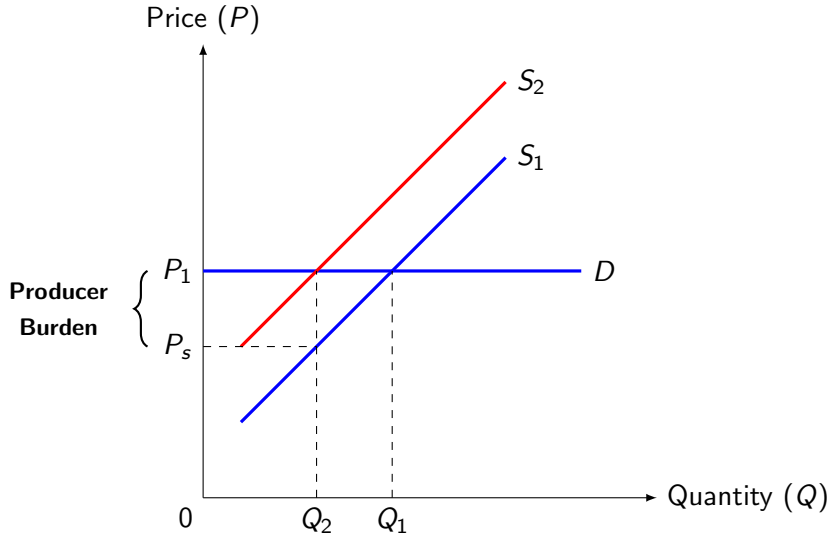
$$P_S = P_C - \tau = P_1, \quad Q_2 = Q_0$$

Tax incidence:

$$\text{Consumer burden} = [(P_1 + \tau) - P_1] + 0 = \tau$$

$$\text{Producer burden} = [P_1 - (P_1 + \tau)] + \tau = 0$$

Perfectly Elastic Demand



Perfectly Elastic Demand

Setup:

$$Q^d(P) = Q(P) \text{ at } P = P_0, \quad Q^s(P) = a + bP, \quad \text{per-unit tax } \tau$$

Pre-tax equilibrium:

$$Q_1 = Q^d(P_0) = Q^s(P_0), \quad P_1 = P_0$$

Post-tax equilibrium (tax on producers): $P_S = P_C - \tau$

$$Q^s_\tau(P_C) = a + b(P_C - \tau)$$

$$P_C = P_0, \quad Q_2 = Q^s_\tau(P_0) = a + b(P_0 - \tau), \quad P_S = P_C - \tau = P_0 - \tau$$

Tax incidence:

$$\text{Consumer burden} = [(P_0 - P_0) + 0] = 0$$

$$\text{Producer burden} = [(P_0 - P_0) + \tau] = \tau$$

Rule #3 of Tax Incidence

Rule #3

The incidence of taxation on producers and consumers is ultimately determined by the *elasticities of supply and demand*, i.e., how responsive the quantity supplied or demanded is to price changes.

- Parties with inelastic supply or demand bear taxes.
- Parties with elastic supply or demand avoid them.

Consumer Tax Burden

Consider a tax paid by consumers. The total price change is $\Delta P + \tau$.

1. Elasticity of demand and supply:

$$\varepsilon_d = \frac{\Delta Q}{(\Delta P + \tau)} \frac{P}{Q}, \quad \varepsilon_s = \frac{\Delta Q}{\Delta P} \frac{P}{Q}$$

2. Rearrange terms so that the two expressions can be set equal to each other:

$$\frac{\Delta Q}{Q} = \varepsilon_d \times \frac{(\Delta P + \tau)}{P} = \varepsilon_s \times \frac{\Delta P}{P}$$

3. Solve for the change in price as a fraction of τ:

$$\frac{\Delta P}{\tau} = \frac{\varepsilon_d}{\varepsilon_s - \varepsilon_d}$$

Consumer Tax Burden (cont'd)

- **If demand is perfectly inelastic** ($\varepsilon_d = 0$): Consumers must have the product (think essential medicine). Since their quantity demanded does not change when the price changes, they have no ability to shift the tax burden back to producers. They therefore bear the **entire cost of the tax**. The producer's market price does not need to change to maintain equilibrium.
- **If demand is perfectly elastic** ($\varepsilon_d = \infty$): Consumers can easily switch to perfect substitutes. If producers try to charge even slightly more, consumers leave the market. In this case, consumers have maximum power to shift the burden. The only way the market clears is if producers **fully absorb the tax** by lowering the price they receive by τ, keeping the final consumer price unchanged.

Producer Tax Burden

$$\frac{\Delta P}{\tau} = \frac{\varepsilon_s}{\varepsilon_s - \varepsilon_d}$$

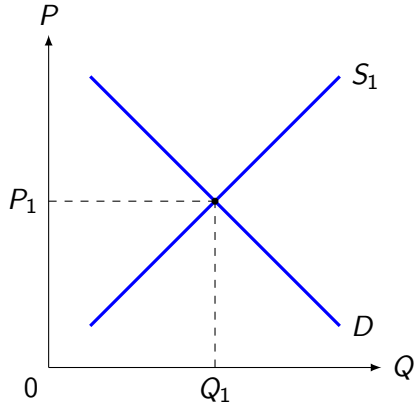
- **If supply is perfectly inelastic** ($\varepsilon_s = 0$): Producers must sell the same quantity regardless of price. Since they cannot adjust production, they have no ability to shift the tax burden to consumers. They therefore **bear the entire cost of the tax**.
- **If supply is perfectly elastic** ($\varepsilon_s = \infty$): Producers can easily switch to other markets or uses for their resources. They will only continue to sell if they receive the same net-of-tax price as before. Consumers must pay the full tax. Hence, **consumers bear the entire tax burden**.

Tax Efficiency

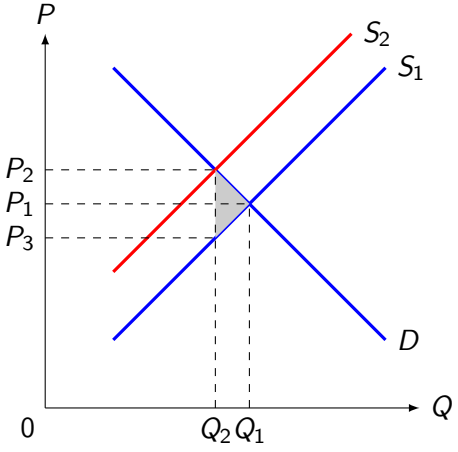
Taxes create distortions — they reduce total surplus.

Competitive Equilibrium and Efficiency

- In a perfectly competitive market, the demand curve measures the social marginal benefit and the supply curve measures the social marginal cost.
- At the equilibrium, the sum of consumer surplus and producer surplus is at its maximum.
- All mutually beneficial trades take place — **the allocation is efficient: no further gains from trade are possible.**



Tax Inefficiency



- The tax shifts the supply curve in from S_1 to S_2.
- Trades that would be beneficial to both producers and consumers are not being made.
- The units between Q_2 and Q_1 are not being produced and consumed once the tax is in place.
- This reduction in quantity creates a *deadweight loss*.

Deadweight Loss

The tax reduces the traded quantity from Q_1 to Q_2, lowering social efficiency.

- Consumers forgo purchases between Q_2 and Q_1, losing surplus.
- Producers lose the profits they would have earned on these units.
- Part of the lost surplus goes to the government as tax revenue, but the rest disappears.

Deadweight loss measures the surplus lost to society that is not recaptured by the government.

Determinants of Deadweight Loss

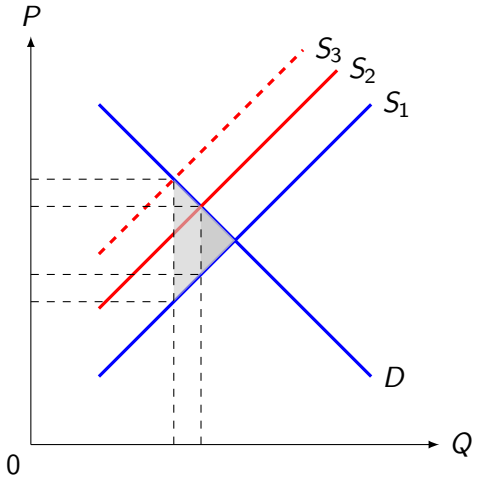
The formula for the DWL is:

$$\text{DWL} = -\frac{\varepsilon_s \varepsilon_d}{2(\varepsilon_s - \varepsilon_d)} \times \tau^2 \times \frac{Q}{P}$$

Derivation

1. Deadweight loss rises with demand and supply elasticities: the more easily buyers or sellers can switch to substitutes, the greater the inefficiency.
2. The deadweight loss rises with the square of the tax rate, so that the distortion from any given amount of tax is greater as the existing tax rate increases.

Marginal DWL Rises with Tax Rate



- The **marginal deadweight loss**, the increase in deadweight loss per unit increase in the tax, rises with the tax rate.

Exercise: Tax, Revenue, and DWL

Consider a market with the following linear demand and supply:

$$Q^d(P) = 80 - 2P, \quad Q^s(P) = 3P - 20$$

A per-unit tax of $\tau = 10$ is imposed on producers.

(a) Find the pre-tax equilibrium price and quantity.

(b) Find the post-tax equilibrium:

- Price paid by consumers.
- Price received by producers.
- Quantity sold.

(c) Compute the consumer surplus and producer surplus before and after the tax.

(d) Calculate the government revenue from the tax.

(e) Calculate the deadweight loss caused by the tax.

References I



Gruber, J. (2023). *Public Finance and Public Policy*. 7th Edition, Worth Publishers.



Internal Revenue Service (IRS). "Federal Income Tax Rates and Brackets." Available at: https://www.irs.gov/filing/federal-income-tax-rates-and-brackets

Deriving the Formula for Deadweight Loss

- The base of the DWL triangle is the change in quantity induced by the tax (ΔQ), and the height is the size of the tax, so:

$$\text{DWL} = -\frac{1}{2} \times \Delta Q \times \tau$$

- Recall that

$$\frac{\Delta Q}{Q} = \varepsilon_s \times \frac{\Delta P}{P}, \quad \Delta P = \frac{\varepsilon_d}{\varepsilon_s - \varepsilon_d} \times \tau$$

- Combining and rearranging these equations yields:

$$\Delta Q = \frac{\varepsilon_s \varepsilon_d}{\varepsilon_s - \varepsilon_d} \times \tau \times \frac{Q}{P}$$

- Substituting this equation into the formula for DWL yields:

$$\text{DWL} = -\frac{\varepsilon_s \varepsilon_d}{2(\varepsilon_s - \varepsilon_d)} \times \tau^2 \times \frac{Q}{P}$$