

# Taxation and Efficiency

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EC313 - Public Economics: Taxation

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# Goals of This Section

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- Discuss the effects of price changes on consumer behaviour
- Introduce the concept of excess burden of a tax
- Show how to measure excess burden using indifference curves
- Show how to measure excess burden using demand/supply curves
- Show equivalent interpretation with elasticities
- Discuss factors that affect excess burden

# Excess Burden of a Tax with Indifference Curves

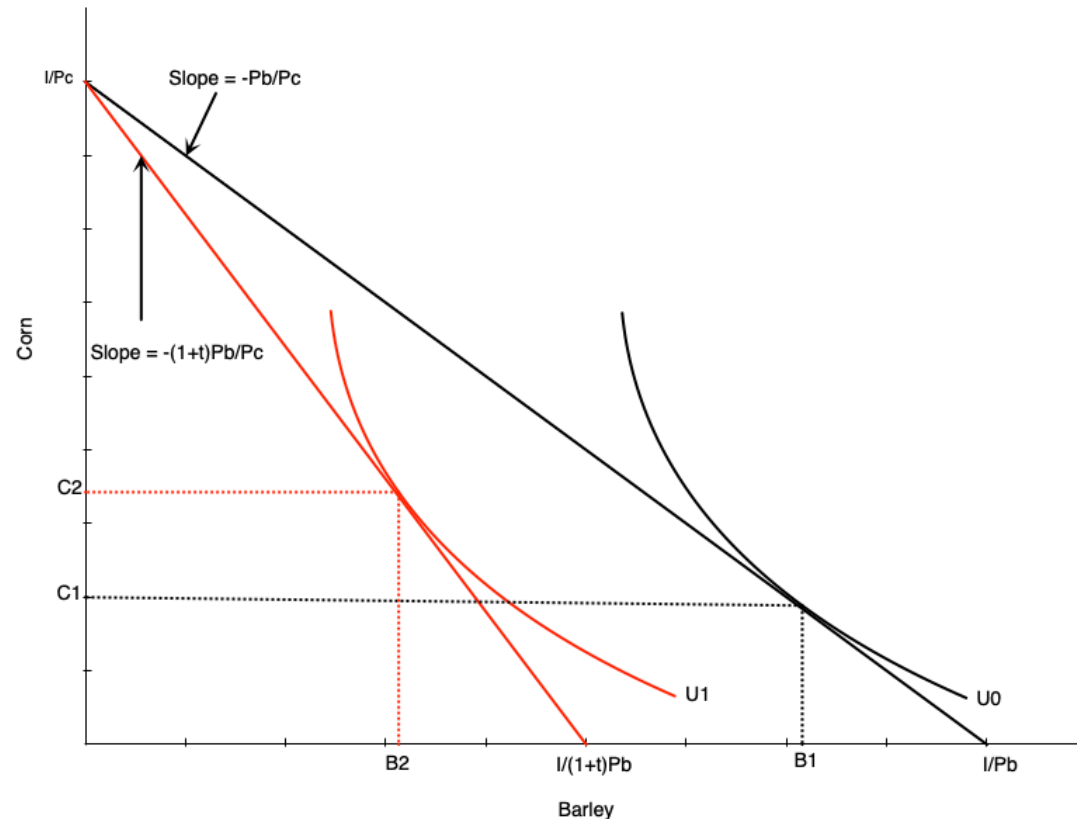
# Introduction

- Governments levy taxes mainly to raise revenue to fund public goods and services
- Taxes can impose different types of costs on consumers
  - The direct cost of sending money to the government
  - Taxes can distort behaviour because of changes in prices
    - Without taxes consumers make choices about consumption
    - Taxes force them to substitute away from the taxed good and make sub-optimal choices
- Ideally a tax imposes the least possible cost in order to raise revenue
  - When the costs are larger, we say there is an excess burden

# Ad Valorem Tax on Consumers

- Below we will see what happens when an ad valorem tax is imposed on one good
  - An ad valorem tax is a percentage tax on the price of a good
  - For example, a 10% sales tax on a \$1 item means the consumer pays \$1.10
- We will use indifference curves and budget constraints to analyze the effects of the tax
- We will then compare to a lump-sum tax
- Lesson is that ad valorem taxes that distort behaviour create excess burden
- Lump-sum taxes that do not distort behaviour do not create excess burden
- Difference due to the distortionary effect of changing relative prices with ad valorem taxes

# Ad Valorem Tax on Consumers

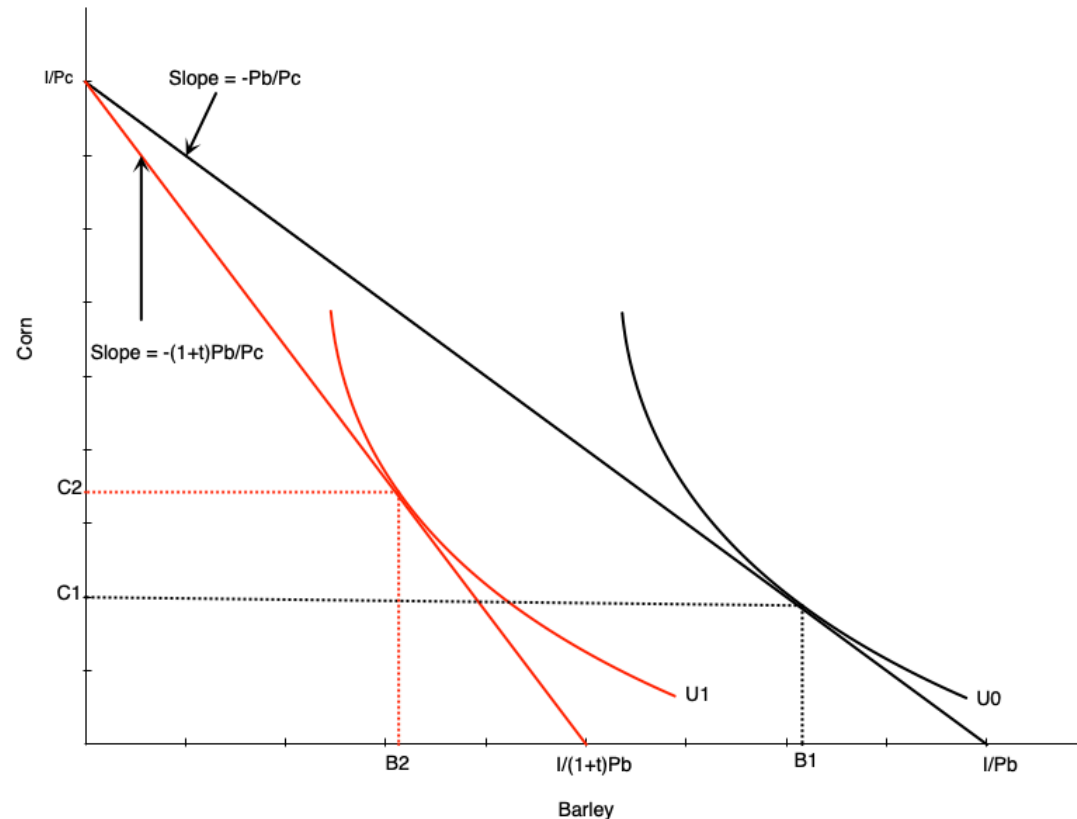


- Graph shows consumption decision for barley and corn
- Initially prices are  $P_B$  and  $P_C$
- Budget constraint is  $I = P_B B + P_C C$
- To plot budget constraint, put  $C$  on left side

$$C = \frac{I}{P_C} - \frac{P_B}{P_C} B$$

- Slope of budget constraint is  $-\frac{P_B}{P_C}$
- Intercepts are  $\frac{I}{P_C}$  and  $\frac{I}{P_B}$
- Optimal consumption bundle is  $B_1$  and  $C_1$

# Ad Valorem Tax on Consumers



- An ad valorem tax of  $t$  on barley is imposed
- Price of barley rises to  $P_B(1 + t)$
- New budget constraint is  

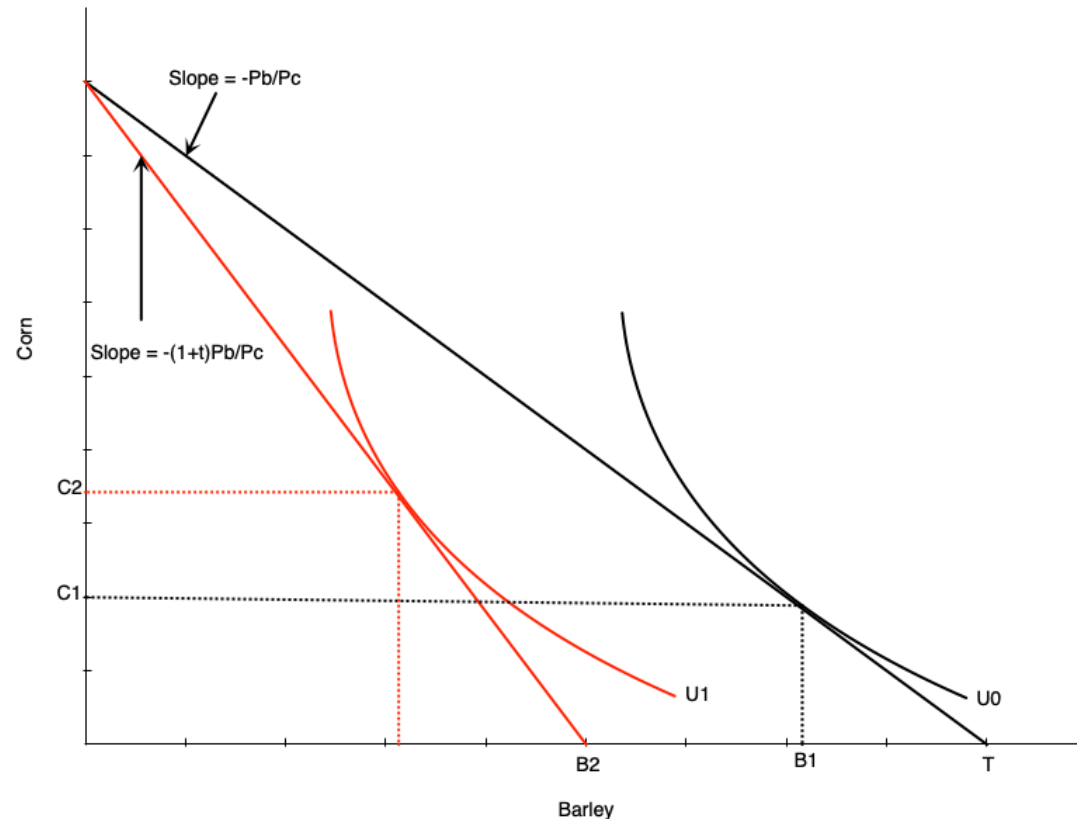
$$I = P_B(1 + t)B + P_C C$$
- Rearranging gives

$$C = \frac{I}{P_C} - \frac{P_B(1 + t)}{P_C} B$$

- Slope of new budget constraint is  $-\frac{P_B(1+t)}{P_C}$
- Intercepts are  $\frac{I}{P_C}$  and  $\frac{I}{P_B(1+t)}$
- New optimal bundle is  $B_2$  and  $C_2$



# Ad Valorem Tax on Consumers



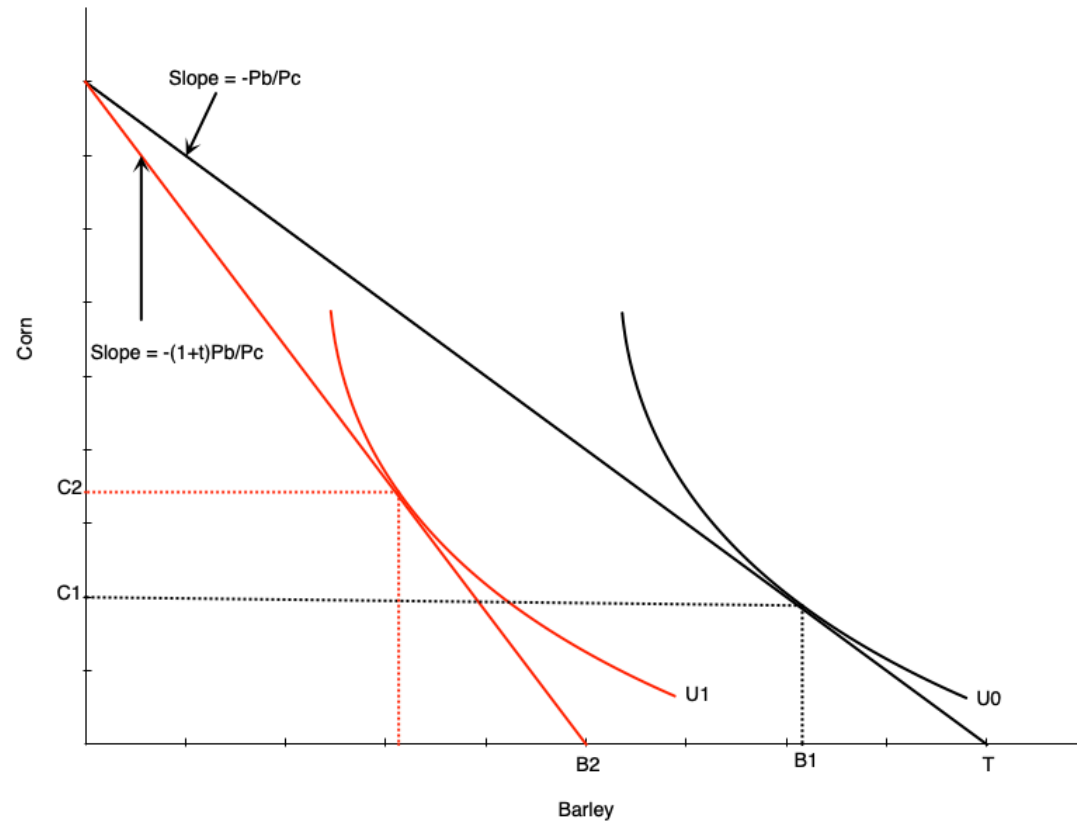
- Vertical distance between budget lines is tax collected
- On the old budget line if consumer buys  $B_2$  barley, corn consumption is

$$C' = \frac{I}{P_C} - \frac{P_B}{P_C} B_2$$

- On the new budget line if consumer buys  $B_2$  barley, corn consumption is

$$C_2 = \frac{I}{P_C} - \frac{P_B(1+t)}{P_C} B_2$$

# Ad Valorem Tax on Consumers



- Difference is

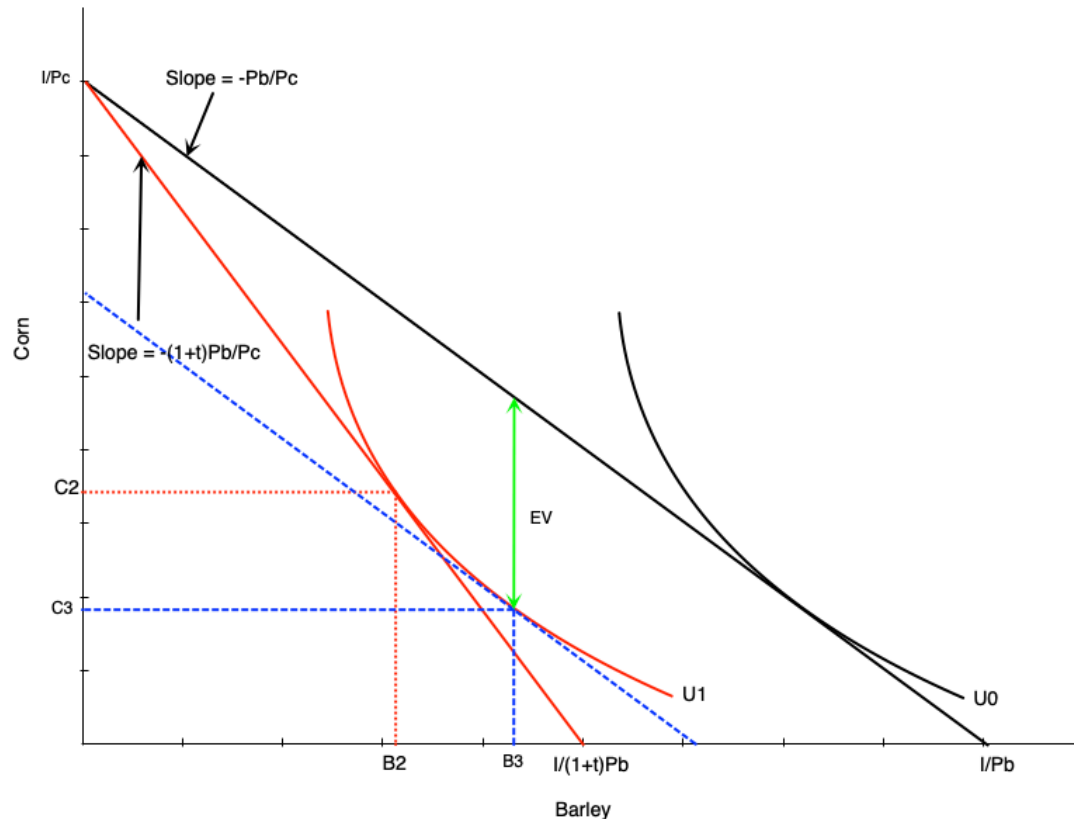
$$C' - C_2 = \frac{P_B t}{P_C} B_2$$

- Measures reduction in corn consumption due to tax
- To measure in dollar terms

$$P_C(C' - C_2) = tP_B B_2$$

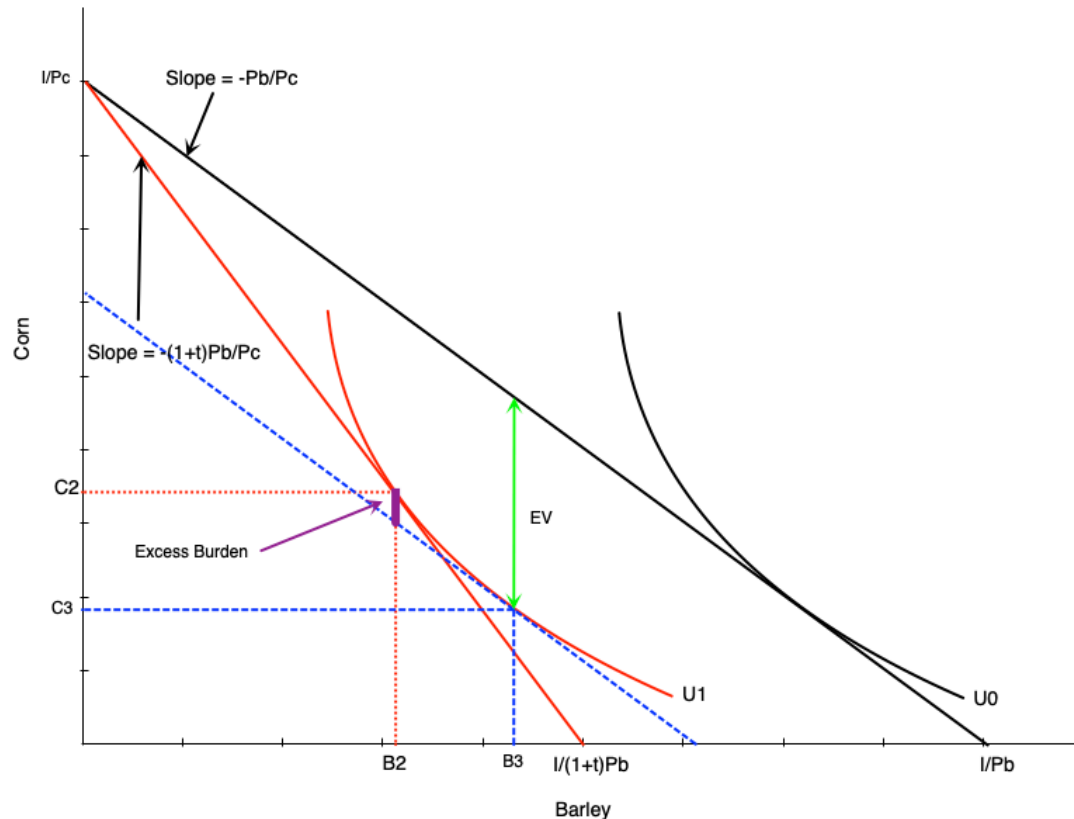
- This is the tax rate times the value of barley consumed

# Equivalent Variation



- As a comparison, consider leaving prices unchanged and reducing income to reach the same utility as we got with the tax
  - This income reduction is the **equivalent variation**
- Shift the original budget line parallel in until it is tangent to the new indifference curve
- Distance between the original and new budget lines is the equivalent variation

# Excess Burden

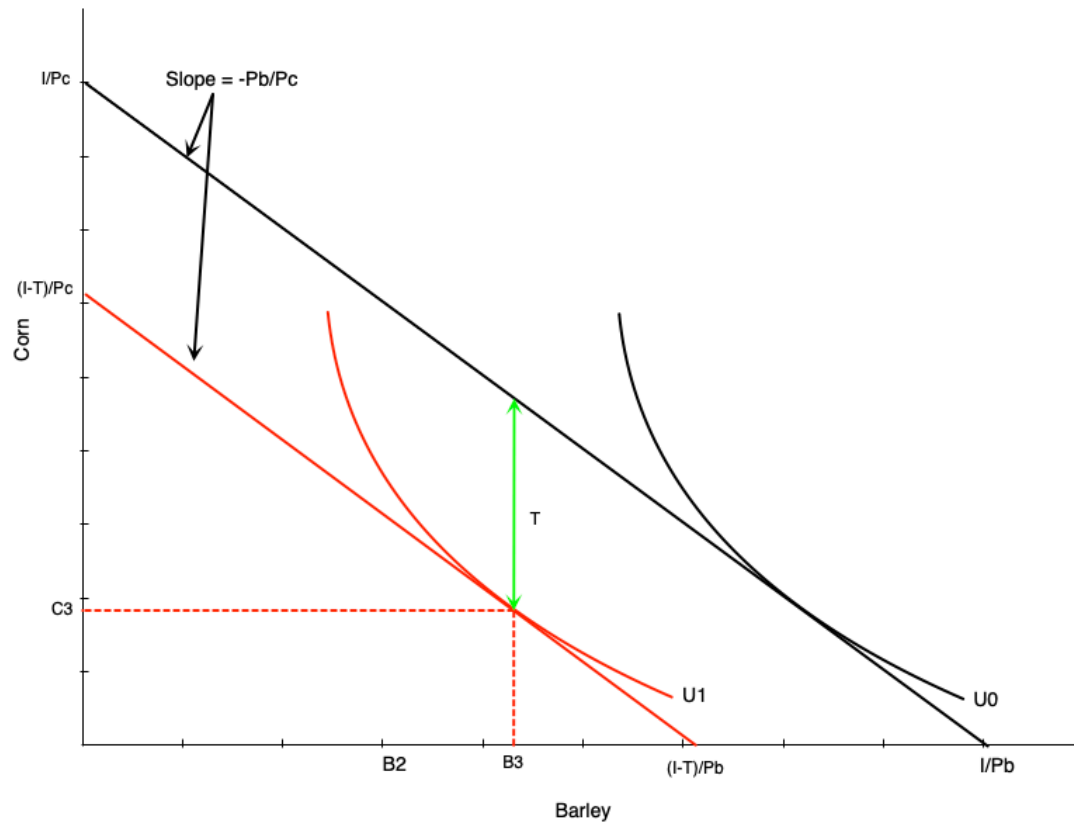


- The **excess burden** of a tax is the loss in welfare beyond the tax revenue collected
- In the graph it is the difference between the equivalent variation and the tax revenue collected
  - Equivalent variation measures loss in welfare
    - Distance in green
  - Tax revenue is money collected by government
    - Distance between black and red budget lines
- In this case, equivalent variation is larger than tax revenue

# Excess Burden

- An ad valorem tax on one good creates two effects
  1. Income effect: consumer is poorer, so consumes less of all normal goods
  2. Substitution effect: relative price of taxed good rises, so consumer substitutes away from taxed good
- Excess burden arises because of the substitution effect
  - Consumer substitutes away from taxed good to other goods
  - This leads to a loss in welfare beyond the tax revenue collected
- One way to see this is to compare an ad valorem tax to a lump-sum tax
  - Lump-sum tax only has income effect, no substitution effect
  - So no excess burden

# Lump Sum Tax



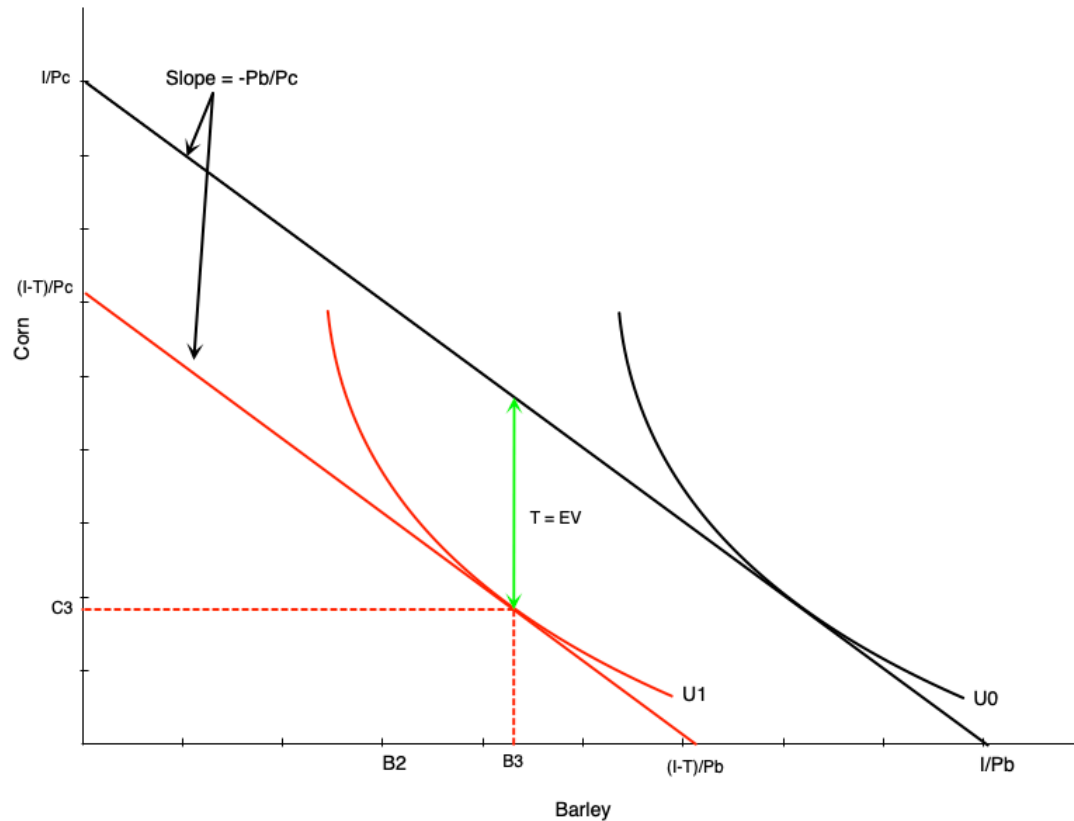
- A lump-sum tax  $T$  is imposed
- New budget constraint is  

$$I - T = P_B(1 + t)B + P_C C$$
- Rearranging gives

$$C = \frac{I - T}{P_C} - \frac{P_B(1 + t)}{P_C} B$$

- Budget line shifts down in parallel by  $T$ 
  - Prices do not change, so slope does not either
- New optimal bundle is  $B_3$  and  $C_3$

# Lump Sum Tax



- Tax revenue is  $T$ 
  - Does not depend on how much of each good is consumed
- Equivalent variation is also  $T$ 
  - Distance between original and new budget lines is  $T$
- So there is no excess burden
  - Welfare loss equals tax revenue collected
- Arises because a lump sum tax is a pure income effect
  - No substitution effect, so no excess burden

# Challenges with Excess Burden



# Efficiency

- If lump sum taxes do not create excess burden, why not use them?
- Often they are unattractive politically
  - A fixed tax on everyone is viewed as unfair
  - It is also regressive
- There are few examples in the world
  - UK had a poll (head) tax in the late 80s that was unpopular
  - Some municipal government charge fixed fees for licenses/permits
- So governments widely use distortionary taxes instead

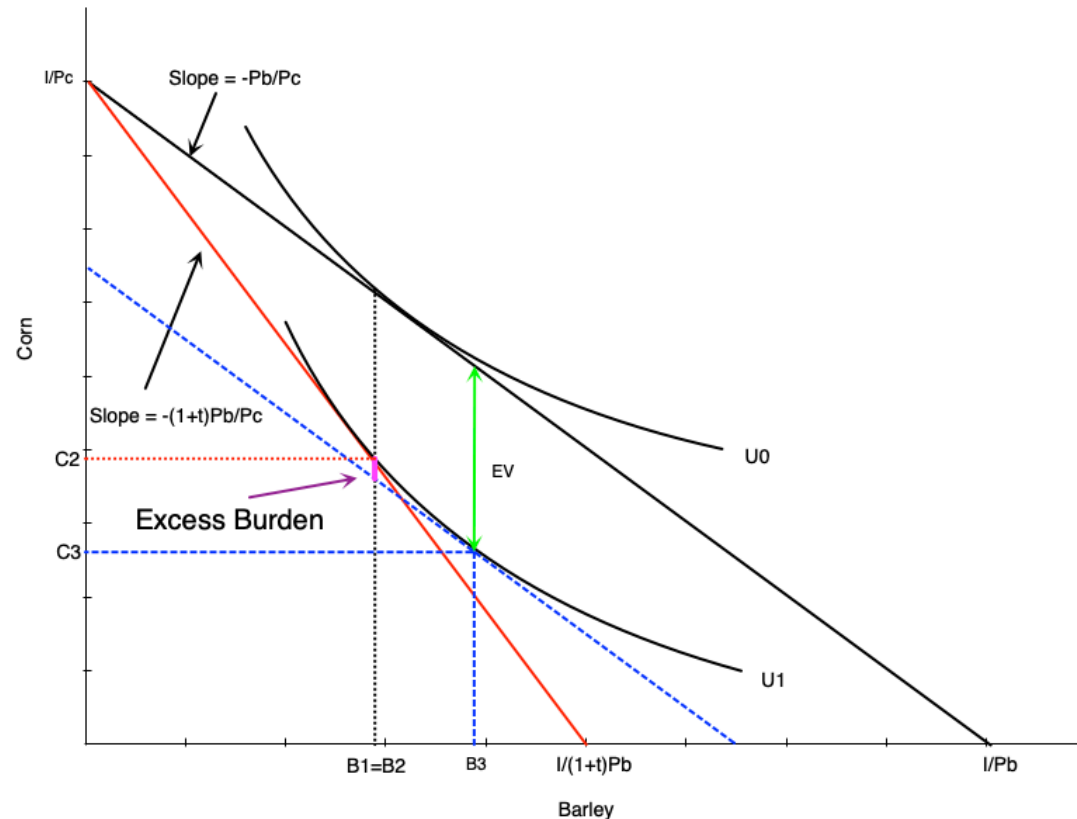
# Income taxes

- Income taxes can also involve excess burdens
- Income taxes distort labour supply decisions
  - Higher tax rates reduce the after-tax wage
  - This causes people to substitute away from labour towards leisure
  - This is a substitution effect that creates excess burden
- Like with goods, income taxes change relative prices, and therefore behaviour
- Changes the price of leisure relative to consumption

# Excess Burden with Inelastic Demand

- Suppose that a tax is introduced on barley, but barley consumption does not change
- Does this mean there is no excess burden?
- Answer: no
  - Consumer faces different relative prices
  - These distort the consumer's choices
  - This leads to inefficiency, and excess burden

# Excess Burden with Inelastic Demand



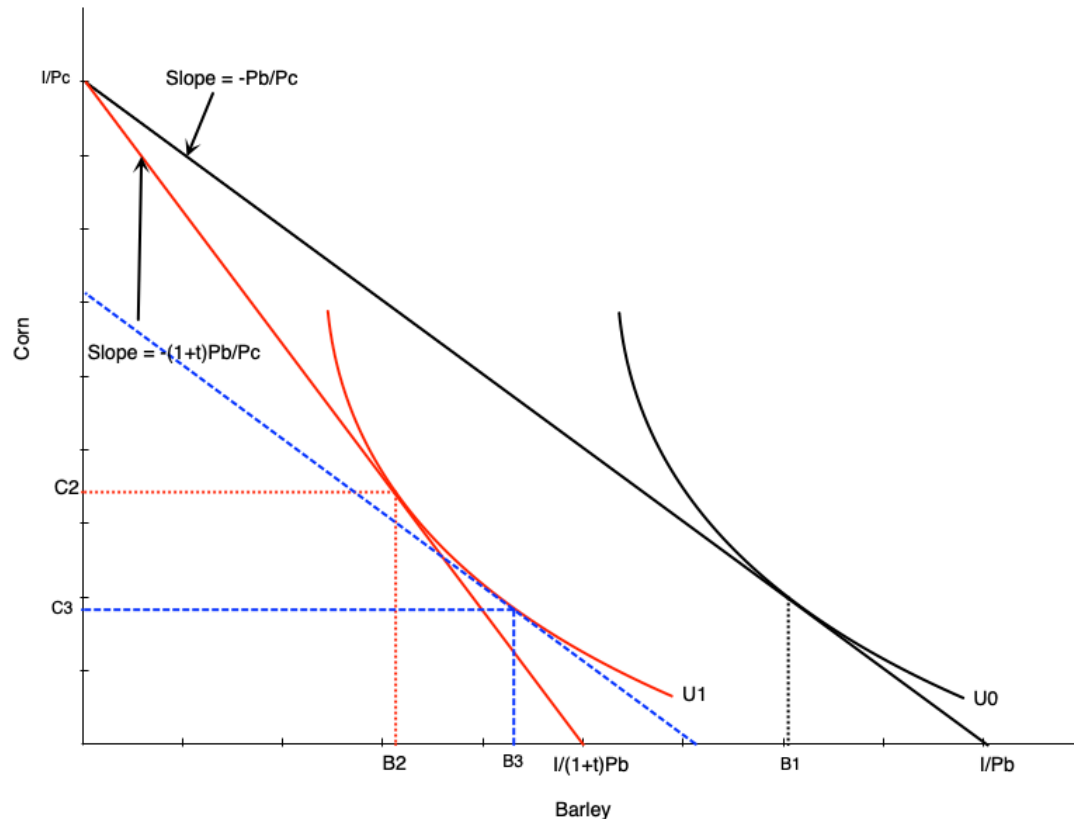
- Graph looks similar to before
- This time barley consumption stays constant
- Corn consumption rises due to relatively lower price
- Excess burden is about the change in the consumption *bundle*
  - Not just the change in quantity of one good

# Excess Burden with Demand Curves

# Aside: Compensated vs Ordinary Demand Curves

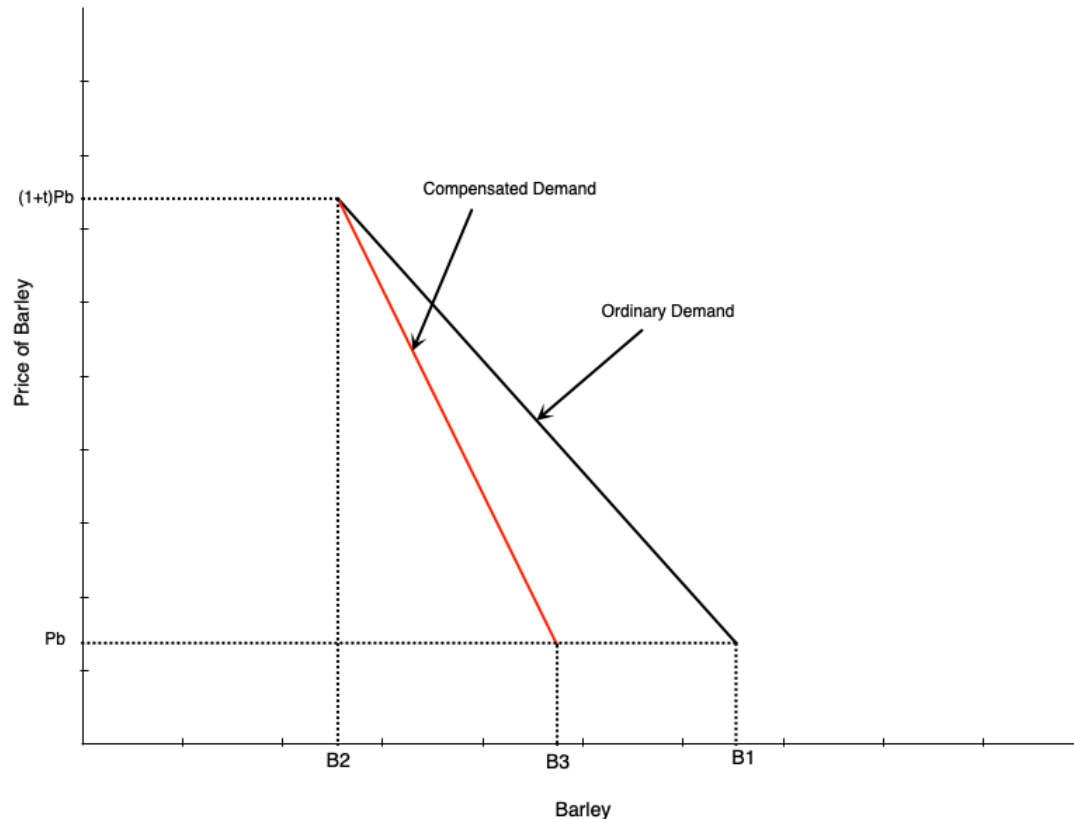
- A demand curve measures the change in quantity demanded as price changes
- **Ordinary (Marshallian) demand curve:** measures the total change in quantity demanded as price changes
  - Includes both income and substitution effects
- **Compensated (Hicksian) demand curve:** measures the change in quantity demanded as price changes, holding utility constant
  - Only includes substitution effect
  - Can hold utility constant at initial level or new level
- Excess burden is related to the substitution effect, so we use compensated demand curves

# Aside: Compensated vs Ordinary Demand Curves



- Consider a tax on barley
  - Price of barley rises from  $P_B$  to  $P_B(1 + t)$
- The ordinary demand curve measures change from old equilibrium at old prices to new equilibrium at new prices
  - Includes both income and substitution effects
- The compensated demand curve measures starts from new utility curve at old prices then new equilibrium at new prices
  - Only includes substitution effect
- The drop in demand is larger for ordinary demand

# Aside: Compensated vs Ordinary Demand Curves



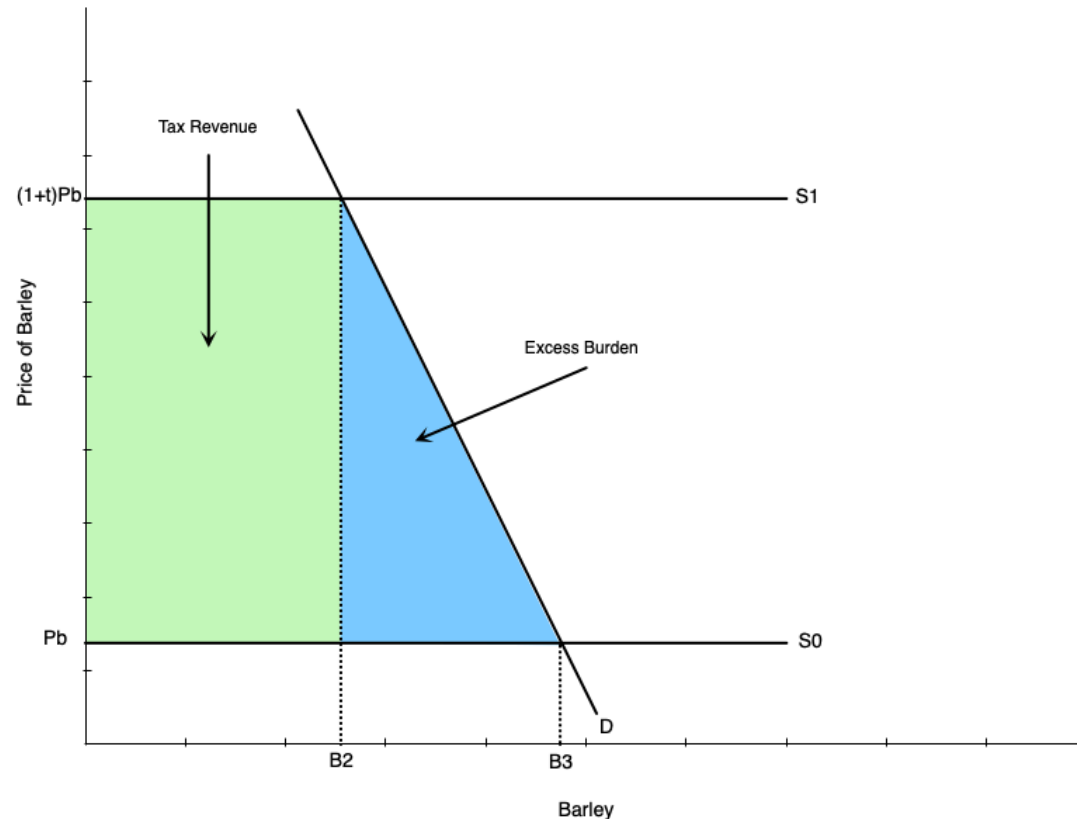
- Demand curve is plot of price vs quantity demanded
- On left we plot price before and after tax against quantities
- Drop in quantity is larger for ordinary demand curve
  - Includes both income and substitution effects
  - So ordinary demand curve is flatter
- Compensated demand curve is steeper because it only includes substitution effect



# Excess Burden with Demand Curves

- Excess burden of a tax is related to the substitution effect
- We can use compensated demand curve to measure it
- Recall that it is loss in welfare beyond tax revenue collected
- The loss in welfare to the consumer is measured by the drop in consumer surplus
  - This is the area under the compensated demand curve between old and new prices
- Part of that loss is tax revenue collected
  - This is the rectangle with height equal to the tax and width equal to new quantity
- The other part is lost entirely to the consumer
  - This is the excess burden

# Excess Burden with Demand Curves



- Imagine a tax is imposed on barley
- Supply is perfectly elastic
  - So economic incidence falls entirely on consumers
- Price rises from  $P_B$  to  $P_B(1 + t)$
- Compensated quantity demanded falls from  $B_3$  to  $B_2$
- Tax revenue is green rectangle
- Total fall in consumer surplus is green + blue areas
- Excess burden is blue area

# Excess Burden with Elasticities

- We can translate the excess burden area into a formula using elasticities
- The excess burden is the blue triangle
- Area of triangle is  $\frac{1}{2} \times \text{base} \times \text{height}$ 
  - Base is change in quantity:  $\Delta B = B_3 - B_2$
  - Height is tax:  $tP_b$
- The definition of elasticity at the original equilibrium is

$$\eta = \frac{\Delta B}{\Delta P} \times \frac{P_b}{B_3}$$

# Excess Burden with Elasticities

- Rearranging gives

$$\Delta B = \eta \times \frac{\Delta P}{P_b} \times B_3$$

- In our case,  $\Delta P = tP_b$ , so

$$\Delta B = \eta \times t \times B_3$$

- The area is then

$$\text{Excess Burden} = \frac{1}{2} \times (\eta \times t \times B_3) \times (tP_b) = \frac{1}{2} \times (\eta \times B_3) \times (t^2 P_b)$$

# Excess Burden with Elasticities

- Some insights with the formula

$$\text{Excess Burden} = \frac{1}{2} \times (\eta \times B_3) \times (t^2 P_b)$$

- Excess burden depends on three things
  1. Size of tax  $t$ 
    - Excess burden rises with square of tax rate
  2. Elasticity of demand  $\eta$ 
    - More elastic demand means larger excess burden
  3. Initial spending  $P_b B_3$ 
    - Larger initial spending means larger excess burden

# Additional Considerations for Excess Burden

# Pre-existing Distortions

- In the real world, there are many taxes and regulations that distort behaviour
- If a new tax is introduced, it may interact with these pre-existing distortions
  - Pre-existing distortions include monopoly power, externalities, and other taxes
- Having pre-existing distortions complicates the analysis of excess burden
  - A new tax may increase or decrease overall excess burden
  - Depends on how it interacts with pre-existing distortions
- **Theory of the Second Best:** If economic optimum cannot be achieved (due to existing distortions), the next best solution may involve introducing additional distortions

# Pre-existing Distortions

- Example 1: pre-existing tax on good A
  - This tax distorts consumption away from good A
  - Introducing a tax on good B may lead consumers to substitute towards good A
  - This can reduce the excess burden on good A by increasing its consumption
  - Overall excess burden may increase or decrease because of the new tax on good B



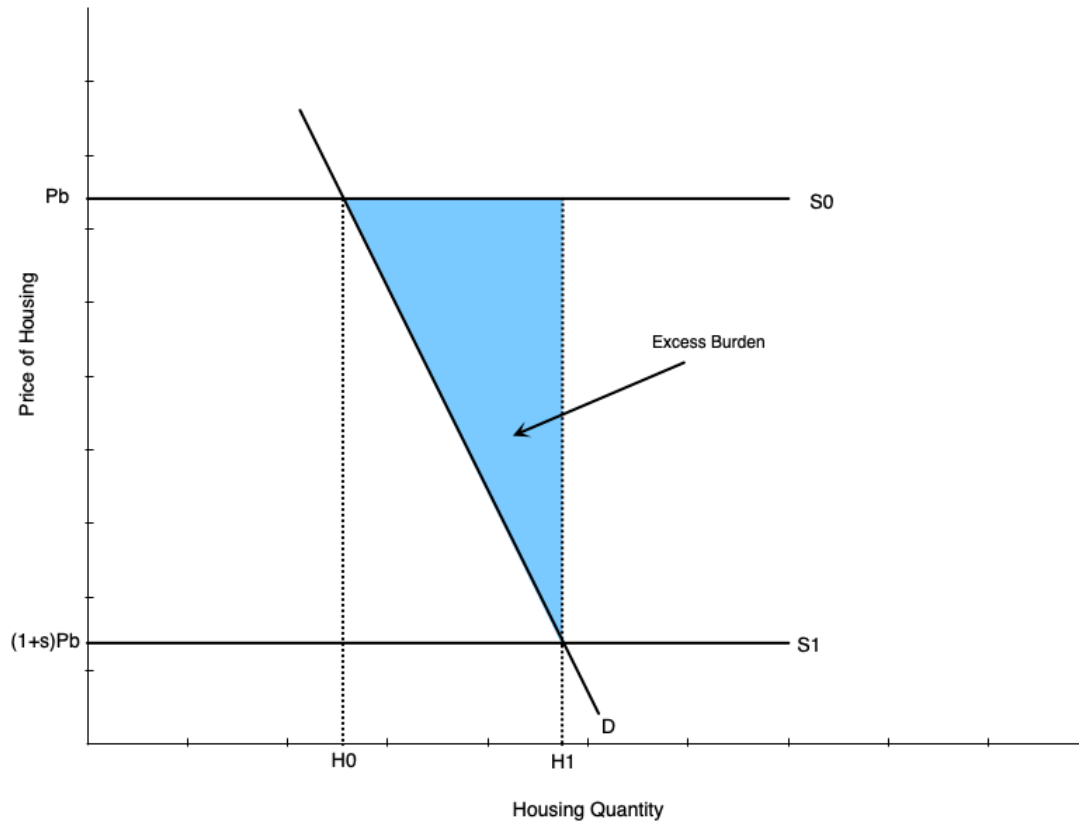
# Pre-existing Distortions

- Example 2: Minimum Wages
  - A labour market monopsony leads to lower wages and employment than in a competitive market
  - Imposing a minimum wage can increase employment and reduce the excess burden caused by monopsony power
- Example 3: Externalities from Carbon
  - A country has a negative externality from emissions and cannot impose a carbon tax
  - The next best outcome might involve subsidies for renewable energy, even if they distort energy markets
- General lesson is that impact of tax is not limited to the market it directly affects
  - Overall excess burden depends on interactions with other markets and distortions

# Excess Burden of a Subsidy

- A subsidy is a negative tax
  - It lowers the price paid by consumers or received by producers
- Problem is that it can lead to over-consumption or over-production
  - This creates inefficiencies and excess burden
- A subsidy will increase welfare (consumer surplus) but the cost to the government may exceed this increase
  - The difference is the excess burden of the subsidy

# Excess Burden of a Subsidy



- Picture a housing subsidy
- Prior to subsidy, optimal consumption is  $H_0$  at price  $P_h$
- Subsidy lowers price to  $(1 - s)P_h$
- New optimal consumption is  $H_1$
- Cost of subsidy is green plus blue rectangle
- Increase in consumer surplus is green area
- Excess burden is blue triangle

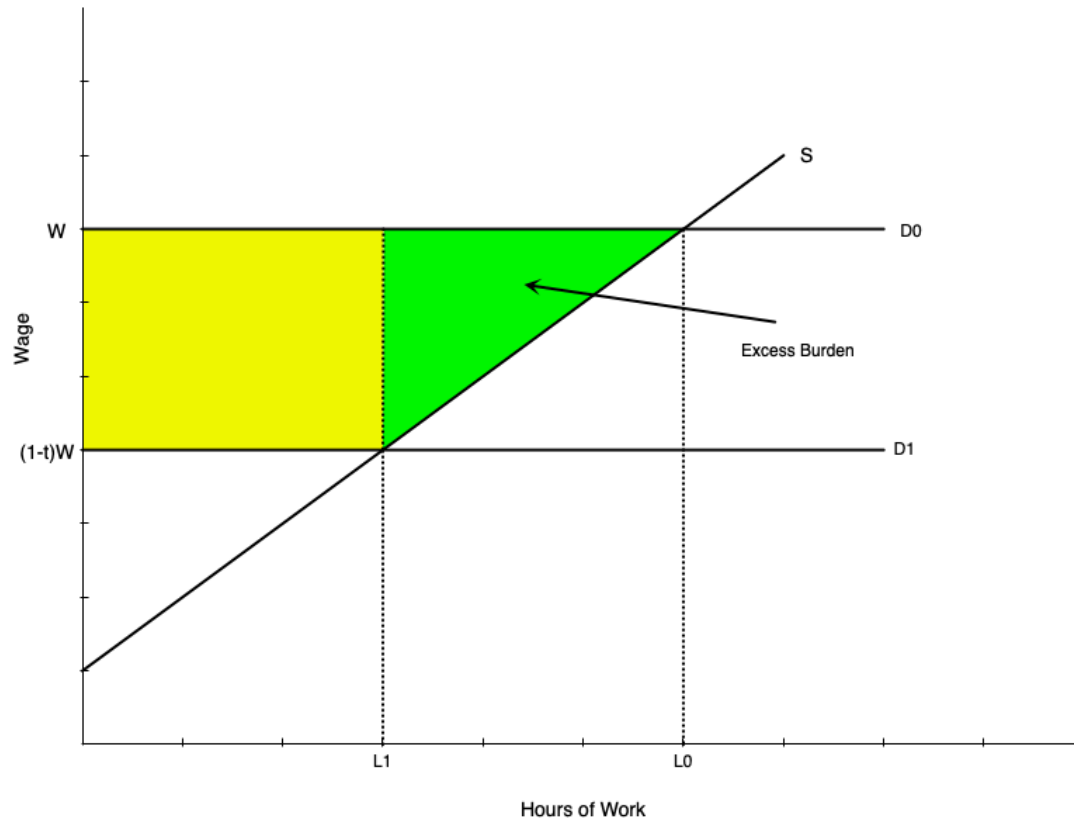
# Excess Burden of Income Tax

- Income taxes distort labour supply decisions
  - Higher tax rates reduce the after-tax wage
  - This causes people to substitute away from labour towards leisure
  - This is a substitution effect that creates excess burden

# Excess Burden of Income Tax

- Imagine a labour market with elastic labour demand
  - So a tax on labour is borne entirely by workers
- An income tax shifts down labour demand curve from  $D_0$  to  $D_1$ 
  - Reduces wage from  $\boxed{W}$  to  $(1 - t)W$
- Initially worker surplus is area below demand curve and above supply
- After tax, surplus falls by yellow plus green areas

# Excess Burden of Income Tax



- Some of the fall is collected by government as tax revenue
  - This is yellow rectangle
- The green triangle is lost entirely
  - This is the excess burden
- Result is very similar to excess burden from a tax on goods
  - Except here the tax is on wages and workers are suppliers

# Excess Burden of Income Tax

- The formula for excess burden is similar to that for goods

$$\text{Excess Burden} = \frac{1}{2} \times (\epsilon \times L_0) \times (t^2 W)$$

- Where  $\epsilon$  is the elasticity of labour supply
- Excess burden depends on
  1. Size of tax  $t$ 
    - Excess burden rises with square of tax rate
  2. Elasticity of labour supply  $\epsilon$ 
    - More elastic labour supply means larger excess burden
  3. Initial earnings  $WL_0$ 
    - Larger initial earnings means larger excess burden



# References



# References

- Rosen, Harvey S., and Lindsay M. Tedds, and Trevor Tombe, and Jean-Francois Wen, and Tracy Snoddon. Public Finance in Canada. 6th Canadian edition. McGraw-Hill Ryerson, 2023.
- Gruber, Jonathan. Public Finance and Public Policy. 7th edition. Worth Publishers, 2022.