

## Review Session Handout #3

### Chapter 4: Government in the Market: Price Controls, Taxes, and Subsidies

*Introduction to Microeconomics: Markets, Strategy, and Real-World Cases*

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**Exercise R3.1.** A city sets a rent ceiling of \$600 per month. The following schedule lists, at each monthly rent, the number of apartments renters want and the number of apartments landlords offer.

| Monthly rent | Apartments demanded | Apartments supplied |
|--------------|---------------------|---------------------|
| \$500        | 700                 | 300                 |
| \$600        | 600                 | 400                 |
| \$700        | 500                 | 500                 |
| \$800        | 400                 | 600                 |
| \$900        | 300                 | 700                 |

- (a) Find the free-market equilibrium rent and number of apartments rented.
- (b) At the \$600 ceiling, find the number of apartments demanded and the number supplied. Is the ceiling binding?
- (c) Find the shortage created by the ceiling and the number of apartments actually rented.
- (d) Using the schedule, find the most that the renter of the 400th apartment would pay and the least that its landlord would accept. Use these values to compute the deadweight loss from the ceiling.

*Solution.*

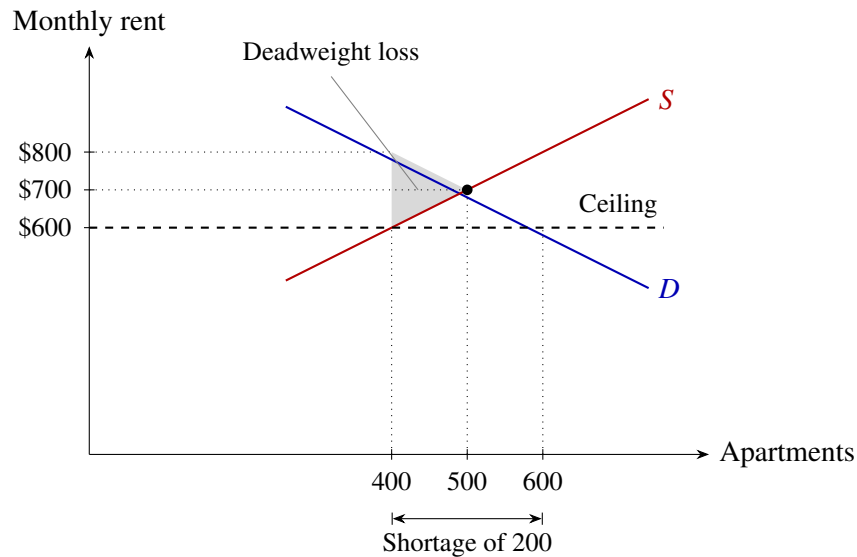
**Part (a).** At a rent of \$700, renters want 500 apartments and landlords offer exactly 500. The free-market equilibrium rent is \$700 per month, and 500 apartments are rented.

**Part (b).** At \$600, renters want 600 apartments, but landlords offer only 400. The ceiling lies below the equilibrium rent of \$700, so it is binding: it prevents the rent from rising to the level at which the market clears.

**Part (c).** The ceiling creates a shortage of  $600 - 400 = 200$  apartments. Because the rent cannot rise, the number of apartments actually rented is the smaller of the two quantities, the 400 apartments landlords are willing to supply. The rent ceiling therefore reduces the number of apartments rented from 500 to 400.

**Part (d).** Reading the demand side of the schedule, renters want 400 apartments at a rent of \$800, so the renter of the 400th apartment would pay up to \$800 a month. Reading the supply side, landlords offer 400 apartments at a rent of \$600, so the landlord of the 400th apartment would accept as little as \$600. For that apartment, the renter's value exceeds the landlord's cost by  $\$800 - \$600 = \$200$ , and this gap shrinks to zero at the 500th apartment, where both equal \$700. The deadweight loss is the value of the 100 mutually beneficial rentals that no longer take place, the triangle

$$\frac{1}{2} \times 100 \times \$200 = \$10,000 \text{ per month.}$$



*Remark.* For each of the 100 apartments between the 400th and the 500th, the renter would pay more than the landlord needs to receive, yet the ceiling prevents these rentals. The deadweight loss of \$10,000 a month measures the value of those forgone trades.

**Exercise R3.2.** A state imposes a tax of \$0.75 per gallon on gasoline, which gas stations must pay to the state. The following schedule lists the weekly quantities demanded and supplied, in millions of gallons, at each price per gallon.

| Price per gallon | Quantity demanded | Quantity supplied |
|------------------|-------------------|-------------------|
| \$3.00           | 64                | 52                |
| \$3.25           | 62                | 56                |
| \$3.50           | 60                | 60                |
| \$3.75           | 58                | 64                |
| \$4.00           | 56                | 68                |
| \$4.25           | 54                | 72                |
| \$4.50           | 52                | 76                |

- Find the no-tax equilibrium price and quantity.
- Find the after-tax outcome: the price paid by buyers, the price kept by sellers, and the quantity traded.
- Compute the weekly tax revenue and the deadweight loss of the tax.
- Who bears more of the tax, buyers or sellers? Explain why.

*Solution.*

**Part (a).** At \$3.50 per gallon, buyers want 60 million gallons and sellers offer exactly 60 million. The no-tax equilibrium price is \$3.50 and the quantity is 60 million gallons a week.

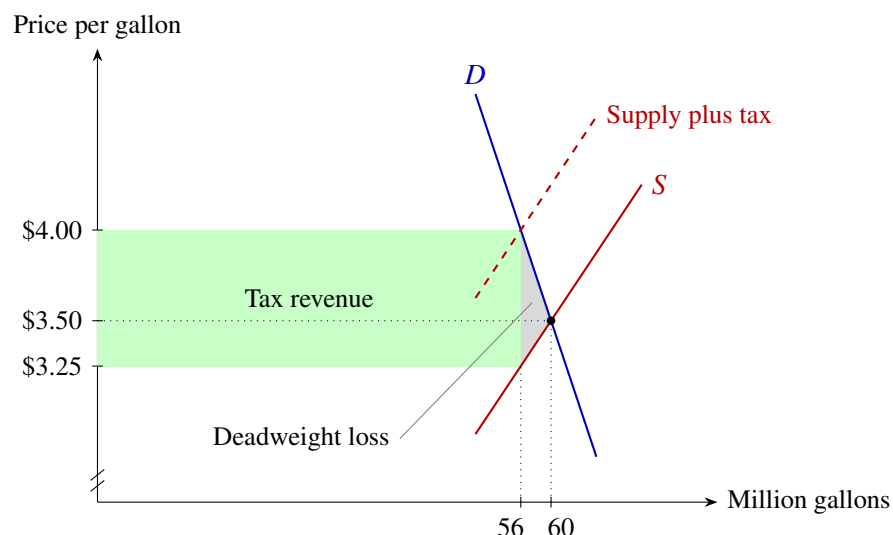
**Part (b).** The tax drives a wedge of \$0.75 between the price buyers pay and the price sellers keep. We look for the quantity at which the price buyers are willing to pay exceeds the price sellers need to receive by exactly \$0.75. At 56 million gallons, buyers are willing to pay \$4.00 (the demand side of the schedule) and sellers need \$3.25 (the supply side), a difference of exactly \$0.75. The table compares the outcomes.

|                                   | No tax | With \$0.75 tax |
|-----------------------------------|--------|-----------------|
| Price buyers pay                  | \$3.50 | \$4.00          |
| Price sellers keep                | \$3.50 | \$3.25          |
| Quantity traded (million gallons) | 60     | 56              |

**Part (c).** The government receives \$0.75 on each of the 56 million gallons traded, a tax revenue of  $\$0.75 \times 56$  million = \$42 million a week. The tax eliminates 4 million gallons of trades that buyers valued above what sellers would have accepted. The deadweight loss is the triangle

$$\frac{1}{2} \times \$0.75 \times 4 \text{ million} = \$1.5 \text{ million a week.}$$

**Part (d).** Buyers' price rises by \$0.50, from \$3.50 to \$4.00, while sellers' price falls by \$0.25, from \$3.50 to \$3.25. Buyers bear \$0.50 of the \$0.75 tax (two-thirds) and sellers bear \$0.25 (one-third), even though the law requires gas stations to pay the tax. Following Section 4.4.1, the side of the market that is less elastic, less able to walk away, bears the larger share. In the schedule, a \$0.25 change in the price moves the quantity demanded by only 2 million gallons but the quantity supplied by 4 million: drivers keep buying gasoline when its price rises, as the inelastic gasoline demand of Section 3.7 predicts, while suppliers can more easily send gasoline to other markets.



*Remark.* The burden of a tax does not depend on whether the law requires buyers or sellers to pay it. Had the law required drivers, instead of gas stations, to pay the \$0.75, drivers would still pay \$4.00 in total and stations would still keep \$3.25. The split is decided by how easily each side of the market can walk away.

**Exercise R3.3.** A state government pays installers a subsidy of \$4,000 for each home solar-panel installation. The following schedule lists the yearly number of installations demanded and supplied, in thousands, at each price per installation.

| Price per installation | Installations demanded | Installations supplied |
|------------------------|------------------------|------------------------|
| \$8,000                | 12                     | 4                      |
| \$9,000                | 11                     | 5                      |
| \$10,000               | 10                     | 6                      |
| \$11,000               | 9                      | 7                      |
| \$12,000               | 8                      | 8                      |
| \$13,000               | 7                      | 9                      |
| \$14,000               | 6                      | 10                     |
| \$15,000               | 5                      | 11                     |
| \$16,000               | 4                      | 12                     |

- Find the no-subsidy equilibrium price and quantity.
- Find the outcome with the subsidy: the price paid by buyers, the price received by sellers, and the number of installations.
- Compute the government's total yearly spending on the subsidy.
- Compute the deadweight loss from the subsidy (due to overproduction).

*Solution.*

**Part (a).** At \$12,000, buyers want 8 thousand installations and installers offer exactly 8 thousand. The no-subsidy equilibrium price is \$12,000 per installation, with 8,000 installations a year.

**Part (b).** With the subsidy, installers receive the price buyers pay plus \$4,000. We look for the quantity at which the price installers need to receive exceeds the price buyers are willing to pay by exactly \$4,000. At 10 thousand installations, buyers are willing to pay \$10,000 (the demand side of the schedule) and installers need \$14,000 (the supply side), a difference of exactly \$4,000. The table compares the outcomes.

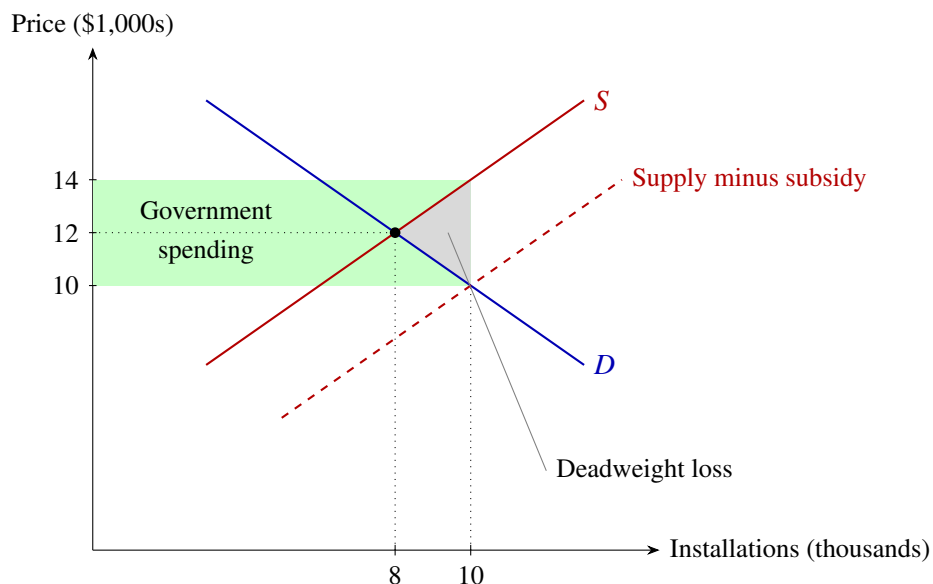
|                                    | No subsidy | With \$4,000 subsidy |
|------------------------------------|------------|----------------------|
| Price buyers pay                   | \$12,000   | \$10,000             |
| Price sellers receive              | \$12,000   | \$14,000             |
| Installations (thousands per year) | 8          | 10                   |

**Part (c).** The government pays \$4,000 on each of 10,000 installations, a bill of  $4,000 \times 10,000 = \$40$  million a year, raised through taxes elsewhere.

**Part (d).** The subsidy raises the number of installations from 8,000 to 10,000. For each of these 2,000 extra installations, the cost to installers exceeds the value to buyers. At the 10,000th installation, the installer

needs \$14,000 while the buyer values it at only \$10,000, a gap of \$4,000, and this gap shrinks to zero at the 8,000th installation, where both equal \$12,000. The deadweight loss is the triangle

$$\frac{1}{2} \times 2,000 \times \$4,000 = \$4 \text{ million a year.}$$



*Remark.* A subsidy is the mirror image of a tax. A tax reduces the quantity traded below the free-market level, while a subsidy raises it above that level, encouraging installations whose cost exceeds their value to buyers. In this example, the subsidy is split evenly, lowering the buyers' price by \$2,000 and raising the installers' price by \$2,000, because in the schedule a \$1,000 price change moves the quantity demanded and the quantity supplied by the same 1,000 installations.