

EC 111: Principles of Microeconomics

Lecture Notes, Chapter 7: Consumers, Producers, and the Efficiency of Markets

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7 Consumers, Producers, and the Efficiency of Markets

In Chapter 6 a price ceiling, a price floor or a tax moved the price and the quantity, and we said who gained and who lost. We did not say by how much. This chapter puts a dollar figure on it. It also asks a bigger question: is the outcome of a free market good for society as a whole, or could someone in charge do better?

Definition 7.1 (Welfare economics). **Welfare economics** is the study of how the allocation of resources affects people's economic well-being.

We measure the well-being of buyers with *consumer surplus* and the well-being of sellers with *producer surplus*. Their sum, *total surplus*, is the yardstick for judging a market.

7.1 Consumer surplus

7.1.1 Willingness to pay

Four fans each want one ticket to a Red Sox playoff game. Each has a top price in mind:

Fan	Willingness to pay
Ana	\$250
Ben	\$200
Cleo	\$150
Dev	\$100

Definition 7.2 (Willingness to pay). A buyer's **willingness to pay** is the most she would pay for a good. It measures how much she values it.

A fan buys if the price is at or below her willingness to pay. If Ana buys at \$180, she pays \$70 less than the ticket is worth to her: she is \$70 better off.

Definition 7.3 (Consumer surplus). **Consumer surplus** is a buyer's willingness to pay minus the price she actually pays, summed over all buyers.

7.1.2 Willingness to pay and the demand curve

The four values give a demand schedule. Above \$250 no one buys; between \$200 and \$250 only Ana buys; between \$150 and \$200 Ana and Ben buy; between \$100 and \$150 three fans buy; at \$100 or less all four do. Drawn as a curve, demand is a staircase (Figure 1). The height of the demand curve at each quantity is the willingness to pay of the **marginal buyer**: the buyer who would leave the market first if the price rose a little.

At a price of \$180, Ana and Ben buy, and

$$CS = (250 - 180) + (200 - 180) = 70 + 20 = \$90.$$

At \$120, Cleo buys too, and $CS = 130 + 80 + 30 = \$240$. In both cases consumer surplus is the shaded area between the demand curve and the price.

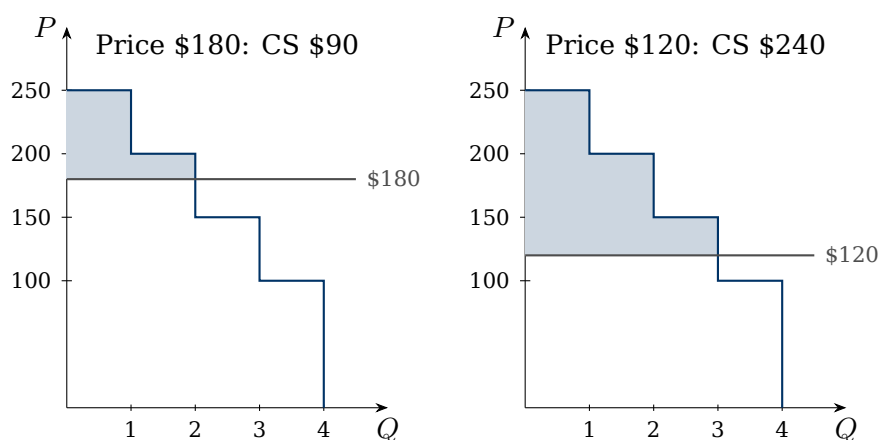


Figure 1: The four fans' demand curve. Each step is one fan's willingness to pay. Consumer surplus (shaded) is the area below the demand curve and above the price.

Key point

Consumer surplus is the area **below the demand curve and above the price**. This holds for any demand curve, not only a staircase.

7.1.3 Consumer surplus in a market

With many buyers the steps become a smooth line. Take the market from Chapter 6:

$$Q_d = 400 - P, \quad Q_s = 3P, \quad P^* = 100, \quad Q^* = 300.$$

Demand reaches $Q = 0$ at $P = 400$: no buyer values the good above \$400. Consumer surplus is the triangle between the demand curve and the price line (Figure 2, left):

$$CS = \frac{1}{2} \times \text{base} \times \text{height} = \frac{1}{2} \times 300 \times (400 - 100) = \$45,000.$$

Common mistake

The height of the CS triangle is the demand curve's price intercept *minus the price*, not the intercept itself. Here it is $400 - 100 = 300$, not 400.

7.1.4 How a lower price raises consumer surplus

Suppose supply grows and the price falls from \$100 to \$80. Buyers now buy $400 - 80 = 320$ units. Consumer surplus rises for two reasons (Figure 2, right):

- **Existing buyers** pay \$20 less on the 300 units they were already buying: $300 \times 20 = \$6,000$ (the rectangle).
- **New buyers** enter the market. The 20 extra units are each worth between \$80 and \$100 to the buyers who now buy them: $\frac{1}{2} \times 20 \times 20 = \$200$ (the small triangle).

New consumer surplus: $\frac{1}{2} \times 320 \times (400 - 80) = \$51,200 = 45,000 + 6,000 + 200$.

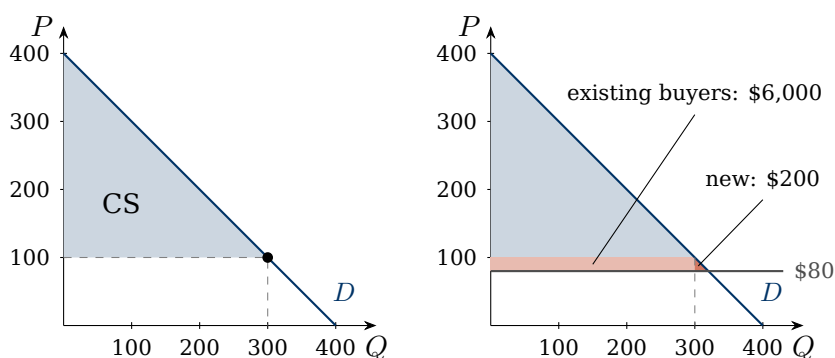


Figure 2: Left: consumer surplus at $P = 100$ is \$45,000. Right: when the price falls to \$80, existing buyers gain the rectangle and new buyers the small triangle.

7.1.5 What does consumer surplus measure?

Consumer surplus measures the benefit buyers get from a market *as the buyers themselves see it*. That makes it a good measure of well-being when we respect people's own judgments of what is good for them, which economists usually do for ordinary goods. The usual exception is addiction. A heroin user's willingness to pay may say more about the addiction than about what makes the user better off, and few policy-makers would count that buyer's surplus as a gain to society.

7.2 Producer surplus

7.2.1 Cost and the willingness to sell

Now the other side. Four students could each tutor one hour of economics. Tutoring takes time they could spend on other things, so each has a lowest price at which the hour is worth it:

Tutor	Cost
Eli	\$20
Fay	\$30
Gus	\$45
Hal	\$60

Definition 7.4 (Cost). A seller's **cost** is the value of everything she gives up to produce the good, including her time. It is the lowest price at which she is willing to sell.

Definition 7.5 (Producer surplus). **Producer surplus** is the price a seller receives minus the seller's cost, summed over all sellers.

If tutoring pays \$50 an hour, Eli, Fay and Gus tutor, and

$$PS = (50 - 20) + (50 - 30) + (50 - 45) = 30 + 20 + 5 = \$55.$$

At \$35 only Eli and Fay tutor, and $PS = 15 + 5 = \$20$. The supply curve is again a staircase (Figure 3), and its height at each quantity is the cost of the **marginal seller**: the seller who would leave first if the price fell a little.

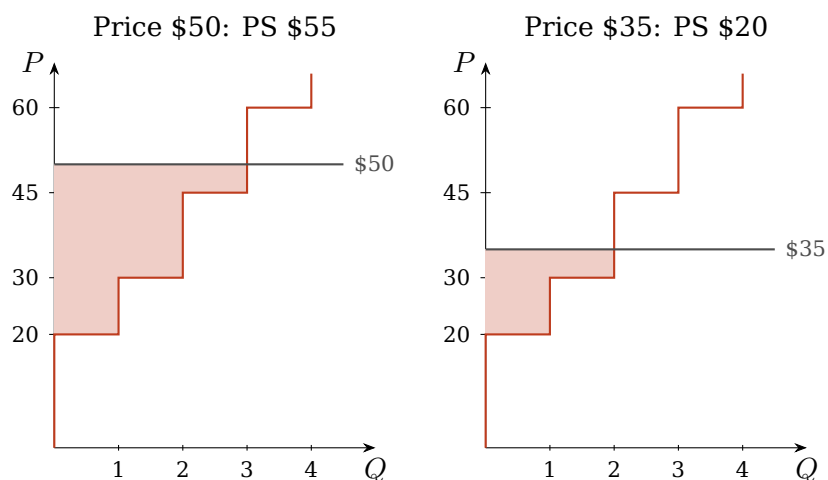


Figure 3: The four tutors' supply curve. Each step is one tutor's cost. Producer surplus (shaded) is the area above the supply curve and below the price.

Key point

Producer surplus is the area **above the supply curve and below the price**.

7.2.2 Producer surplus in a market

In the Chapter 6 market, supply is $Q_s = 3P$, which starts at the origin. At $P = 100$,

$$PS = \frac{1}{2} \times 300 \times 100 = \$15,000.$$

If demand grows and the price rises to \$120, sellers offer $3 \times 120 = 360$ units. Producer surplus rises for two reasons, just as consumer surplus did when the price fell: sellers already in the market get \$20 more on 300 units (\$6,000), and new sellers bring 60 more units to market, each costing between \$100 and \$120 to make ($\frac{1}{2} \times 60 \times 20 = \$600$). New producer surplus: $\frac{1}{2} \times 360 \times 120 = \$21,600$.

7.3 Market efficiency**7.3.1 Total surplus**

Add the two measures:

CS = value to buyers – price paid,

PS = price received – cost to sellers.

The price is paid by buyers and received by sellers, so in the sum it cancels:

Total surplus = value to buyers – cost to sellers.

In the Chapter 6 market, total surplus at the equilibrium is $45,000 + 15,000 = \$60,000$: the whole area between the demand curve and the supply curve, out to $Q^* = 300$ (Figure 4).

Definition 7.6 (Efficiency). An allocation of resources is **efficient** if it maximizes total surplus.

Definition 7.7 (Equality). **Equality** is the property of distributing economic prosperity uniformly among the members of society.

Efficiency asks whether the pie is as large as it can be; equality asks whether it is divided fairly. The price decides how the surplus from each trade is split between buyer and seller, but not how large it is. If Ana, who values a ticket at \$250, buys from a seller whose cost is \$140, the trade creates $250 - 140 = \$110$ of surplus at any price. At \$200, Ana keeps \$50 and the seller \$60; at \$150, Ana keeps \$100 and the seller \$10.

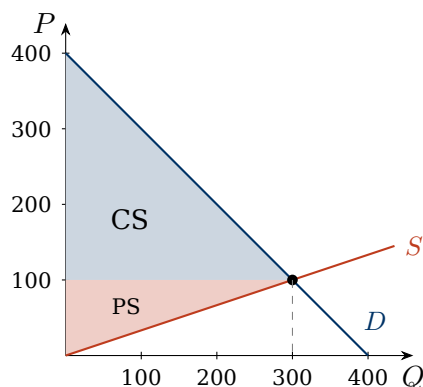


Figure 4: Total surplus in the market $Q_d = 400 - P$, $Q_s = 3P$: consumer surplus \$45,000 plus producer surplus \$15,000.

7.3.2 Evaluating the market equilibrium

Imagine a *benevolent social planner* who knows every buyer's value and every seller's cost and wants to make total surplus as large as possible. What would the planner do? Exactly what the market already does. The equilibrium at $P = 100$ has three properties.

1. **The goods go to the buyers who value them most.** Everyone whose willingness to pay is above \$100 buys; everyone below \$100 does not. Handing the 300 units out any other way, by lottery for example, would give some to buyers who value them below \$100 and leave out some who value them more.
2. **The goods are made by the sellers with the lowest cost.** Every seller whose cost is below \$100 produces; every seller above \$100 does not.
3. **The quantity maximizes total surplus.** At $Q = 200$, the next unit is worth \$200 to a buyer (the height of demand, $400 - 200$) and costs about \$67 to make (the height of supply, $200/3$); producing it adds about \$133 to total surplus. At $Q = 360$ the next unit is worth \$40 and costs \$120; producing it loses \$80. Only at $Q^* = 300$, where value equals cost, is there no gain left from producing more or less (Figure 5).

Key point

In a competitive market, the equilibrium maximizes total surplus. No planner could do better.

No buyer or seller in the market is trying to maximize total surplus. Each looks after their own interest: buyers compare their value with the price, and sellers compare their cost with the price. The price does the coordinating. This is what Adam Smith (1776) meant when he wrote that each participant is “led by an invisible hand to promote an end which was no part of his intention.” In Chapter 4 Hayek described the price as a signal; this chapter measures what the signal is worth.

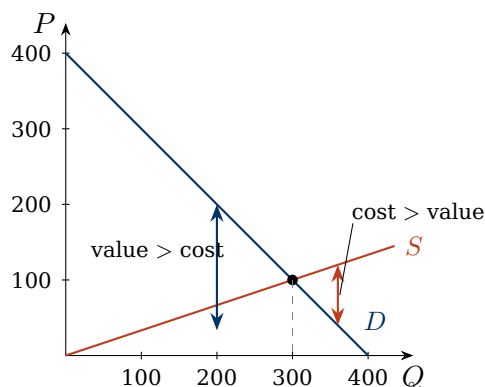


Figure 5: Below Q^* the value of the next unit exceeds its cost; above Q^* the cost exceeds the value. Total surplus is largest at $Q^* = 300$.

7.4 Price controls and deadweight loss

The surplus tools let us return to Chapter 6 and measure what a price control costs. Take the \$80 ceiling in the same market. Sellers offer $3 \times 80 = 240$ units, and only 240 are sold. The 240th unit is worth $400 - 240 = \$160$ to buyers and costs \$80 to make.

Suppose the 240 units go to the buyers who value them most. Then (Figure 6)

$$\begin{aligned} CS &= 240 \times (160 - 80) + \frac{1}{2} \times 240 \times (400 - 160) \\ &= 19,200 + 28,800 = \$48,000, \\ PS &= \frac{1}{2} \times 240 \times 80 = \$9,600, \\ TS &= \$57,600. \end{aligned}$$

Total surplus is \$2,400 lower than the \$60,000 at the equilibrium. The lost surplus is the triangle between demand and supply from $Q = 240$ to $Q = 300$: $\frac{1}{2} \times 60 \times (160 - 80) = \$2,400$. These 60 units were worth more to buyers than they cost to make, and the ceiling stops them from being traded.

Definition 7.8 (Deadweight loss). A **deadweight loss** is the fall in total surplus when a market is moved away from the efficient quantity.

The ceiling also moves surplus between the two sides. Buyers gain $48,000 - 45,000 = \$3,000$ and sellers lose $15,000 - 9,600 = \$5,400$. The \$2,400 deadweight loss is the difference: no one gets it. And \$2,400 is the smallest possible loss. If the 240 units are rationed by lines, by luck or by the landlord's choice, some go to buyers who value them less than others who are left out, and the loss is larger. A tax creates a deadweight loss the same way: it stops trades that were worth more to buyers than they cost sellers (see the \$40 tax example in the slides).

In class

Market: $Q_d = 90 - P$, $Q_s = 2P$.

(a) Find the equilibrium price and quantity.

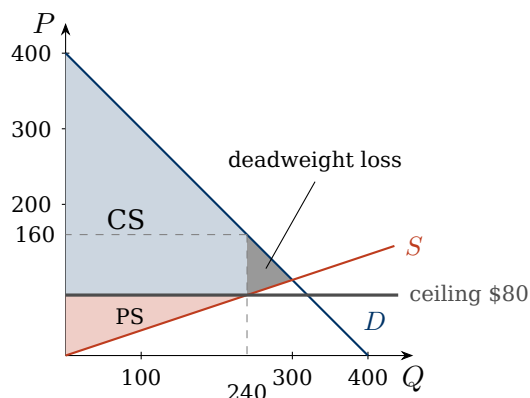


Figure 6: A price ceiling at \$80. Consumer surplus (blue) and producer surplus (red) assume the 240 units go to the buyers who value them most. The grey triangle, \$2,400, is the deadweight loss.

- (b) Compute consumer surplus, producer surplus and total surplus.
 (c) A planner orders 40 units. What is the value of the 40th unit to buyers, its cost to sellers, and the deadweight loss?

Answers. (a) $90 - P = 2P$, so $P = 30$ and $Q = 60$. (b) Demand reaches zero at \$90. $CS = \frac{1}{2} \times 60 \times (90 - 30) = 1,800$; $PS = \frac{1}{2} \times 60 \times 30 = 900$; $TS = 2,700$. (c) The 40th unit is worth $90 - 40 = \$50$ and costs $40/2 = \$20$. The deadweight loss is the triangle from $Q = 40$ to $Q = 60$: $\frac{1}{2} \times 20 \times (50 - 20) = 300$, so TS falls to 2,400.

7.5 When the market gets it wrong

The conclusion that markets are efficient rests on two assumptions.

- **Markets are perfectly competitive.** Every buyer and seller is too small to affect the price. When one seller or a few have *market power*, they can keep the price above cost and the quantity below the efficient level (Chapters 16-17).
- **The price reflects all the costs and benefits.** When a market affects people outside it, as pollution does or as vaccination does, the buyers and sellers ignore those effects. These *externalities* make the market quantity too high or too low (Chapters 10-11).

These are **market failures**: cases where the market alone does not maximize total surplus and a well-designed policy can raise it.

7.5.1 Should there be a market for organs?

In the United States it is illegal to buy or sell a kidney. In effect the law sets a price ceiling at zero. Chapter 6 predicts what a binding ceiling does, and that is what we

see: a shortage, rationed by a waiting list, with tens of thousands of patients on the list and thousands dying each year while they wait. A legal market would raise the quantity supplied and would allocate kidneys to those who value them most. The arguments against are about equality, not efficiency: the poor would sell and the rich would buy, sellers might be pressured or exploited, and many people believe some things should not be for sale. Efficiency is one goal of policy, not the only one.

Note

“The market maximizes total surplus” is a statement about the size of the pie. It says nothing about whether the division is fair. Willingness to pay depends on income, so a market gives more to buyers who have more.

In class

Four buyers and four sellers; each buys or sells one unit.

Buyer	Value	Seller	Cost
A	250	E	60
B	200	F	90
C	150	G	140
D	100	H	210

- How many units trade in equilibrium?
- What range of prices clears the market?
- What is total surplus?

Answers. (a) Pair the highest values with the lowest costs while value $\geq$ cost: A-E, B-F, C-G. D (100) and H (210) do not trade: 3 units. (b) Any price from \$140 to \$150: at those prices G sells and H does not, C buys and D does not. (c) $(250 + 200 + 150) - (60 + 90 + 140) = 600 - 290 = \$310$, whatever the price in that range.

7.6 Summary

- Willingness to pay is the most a buyer would pay for a good. The height of the demand curve is the willingness to pay of the marginal buyer.
- Consumer surplus is willingness to pay minus the price, summed over buyers: the area below the demand curve and above the price. A lower price raises it, both for existing buyers and through new buyers.
- A seller's cost is the least she would accept. The height of the supply curve is the cost of the marginal seller.
- Producer surplus is the price minus cost, summed over sellers: the area above the supply curve and below the price. A higher price raises it.
- Total surplus is the value to buyers minus the cost to sellers. An allocation is efficient if it maximizes total surplus; equality is a separate question.
- A competitive equilibrium gives the goods to the buyers who value them most, has

them made by the sellers with the lowest cost, and produces the quantity that maximizes total surplus.

- A price control moves the market away from the efficient quantity. The fall in total surplus is the deadweight loss.
- Market power and externalities are market failures: the market alone does not maximize total surplus.

Exercises

Exercise 7.1. Four students want a used bike. Their willingness to pay is \$300, \$250, \$180 and \$120.

- Draw the demand curve for used bikes.
- If the price is \$200, who buys and what is consumer surplus?
- If the price falls to \$150, what is consumer surplus? How much of the increase goes to buyers who would have bought at \$200?

Exercise 7.2. In a market, $Q_d = 120 - 2P$ and $Q_s = 4P$.

- Find the equilibrium price and quantity.
- Compute consumer surplus, producer surplus and total surplus.
- Supply grows and the price falls to \$15. Find the new quantity demanded and the new consumer surplus. Split the increase between existing and new buyers.

Exercise 7.3. Return to the market of Exercise 7.2, with the original supply curve. The government sets a price ceiling of \$15.

- How many units are sold? Is there a shortage, and how large?
- What is the last unit sold worth to buyers, and what does it cost to make?
- Assuming the units go to the buyers who value them most, find consumer surplus, producer surplus, total surplus and the deadweight loss. Who gains and who loses?

Exercise 7.4. Four buyers value one unit each at \$90, \$70, \$50 and \$30. Four sellers can each produce one unit at a cost of \$20, \$40, \$60 and \$80.

- How many units are traded in a competitive market?
- What range of prices clears the market?
- What is total surplus? What would it be if a law required all four units to be produced and sold?

Exercise 7.5. Your neighbor values your snow blower at \$400. You value it at \$150.

- If you sell it to your neighbor for \$300, how much surplus does each of you get? How much total surplus does the sale create?
- Would the total be different at a price of \$200? What changes?
- The town bans the resale of used snow blowers. What does the ban cost?

Answers to exercises

Exercise 7.1. (a) A staircase: 0 bikes above \$300, 1 from \$250 to \$300, 2 from \$180 to \$250, 3 from \$120 to \$180, 4 at \$120 or less. (b) The \$300 and \$250 buyers: $CS = 100 + 50 = \$150$. (c) The \$180 buyer joins: $CS = 150 + 100 + 30 = \$280$. The two buyers who were already buying gain \$50 each, \$100 in all; the new buyer gets \$30.

Exercise 7.2. (a) $120 - 2P = 4P$, so $P^* = 20$ and $Q^* = 80$. (b) Demand reaches zero at $P = 60$. $CS = \frac{1}{2} \times 80 \times (60 - 20) = 1,600$; $PS = \frac{1}{2} \times 80 \times 20 = 800$; $TS = 2,400$. (c) $Q_d = 120 - 30 = 90$. $CS = \frac{1}{2} \times 90 \times (60 - 15) = 2,025$, up 425: existing buyers $80 \times 5 = 400$, new buyers $\frac{1}{2} \times 10 \times 5 = 25$.

Exercise 7.3. (a) $Q_s = 60$ and $Q_d = 90$: a shortage of 30, and 60 units are sold. (b) From $P = 60 - Q/2$, the 60th unit is worth \$30; from $P = Q/4$, it costs \$15. (c) $CS = 60 \times (30 - 15) + \frac{1}{2} \times 60 \times (60 - 30) = 900 + 900 = 1,800$; $PS = \frac{1}{2} \times 60 \times 15 = 450$; $TS = 2,250$. Deadweight loss $= 2,400 - 2,250 = 150 = \frac{1}{2} \times 20 \times (30 - 15)$. Buyers who get a unit gain: CS rises by 200. Sellers lose 350.

Exercise 7.4. (a) Pair \$90 with \$20 and \$70 with \$40; the next pair, \$50 and \$60, would lose \$10: 2 units. (b) Exactly two buyers buy if the price is above \$50 (and at most \$70); exactly two sellers sell if it is at least \$40 (and below \$60). Any price from \$50 to \$60 clears the market. (c) $TS = (90 + 70) - (20 + 40) = \$100$. With all four units: $(90 + 70 + 50 + 30) - (20 + 40 + 60 + 80) = 240 - 200 = \$40$, a deadweight loss of \$60.

Exercise 7.5. (a) You get $300 - 150 = \$150$ and your neighbor $400 - 300 = \$100$; total \$250. (b) At \$200 the total is still $400 - 150 = \$250$; only the split changes (you \$50, your neighbor \$200). (c) The \$250 of surplus from the sale is lost: a deadweight loss.