Consumer and Producer Surplus

Lecture notes · Principles of Economics I · Module 1: Markets, demand and supply · Lesson 3

Learning objectives

O1	Explain willingness to pay, and read it from a demand curve.
O2	Calculate consumer surplus for individual buyers and as an area on a demand diagram.
O3	Calculate producer surplus for individual sellers and as an area on a supply diagram.
O4	Explain why a competitive equilibrium maximises total surplus, and state the limits of that result.

Prerequisites: Lessons 1-2 of this course (demand, supply, equilibrium; revenue as an area); the area of a rectangle and a triangle.

Contents: 1. Gains from trade · 2. Willingness to pay and the demand curve · 3. Consumer surplus · 4. Producer surplus · 5. Total surplus and efficiency · 6. Limits of the efficiency result · Worked examples · Summary · References

1. Gains from trade

When a trade is voluntary, both sides normally expect to gain from it, otherwise one of them would walk away. A buyer gains when the good is worth more to her than she pays; a seller gains when he receives more than the lowest price he would have accepted.

Consumer surplus and producer surplus measure these gains in money. Together they show how much value a market creates, which is why they are the basic tools economists use to judge whether a market, a tax or a price control makes people better or worse off.

2. Willingness to pay and the demand curve

Willingness to pay is the highest price a buyer would pay for a unit of a good rather than go without it. It reflects how much the buyer values that unit, given their income and the alternatives available.

If we line up all potential buyers from the highest willingness to pay to the lowest, and draw each as a bar, we get a downward staircase. With very many buyers, each buying a small amount, the staircase becomes a smooth line: the demand curve.

So a demand curve can be read in two ways. Horizontally: at a given price, how much is demanded. Vertically: at a given quantity, the willingness to pay of the marginal buyer (the last buyer who just finds it worth buying). For the mango market, the height of the demand curve is (1100 - Q) / 200 dollars.

3. Consumer surplus

Consumer surplus for one buyer = willingness to pay - price actually paid. For a market, consumer surplus is the sum over all buyers: the area below the demand curve and above the price, up to the quantity bought.

Five-buyer example at a price of $3: willingness to pay $5, $4.50, $4, $3.50 and $3 gives gains of $2, $1.50, $1, $0.50 and $0, so consumer surplus is $5.

Mango market: the demand curve meets the price axis at $5.50 (where the quantity demanded is zero). At the equilibrium price of $3 the quantity is 500 kg, so consumer surplus is the triangle 1/2 x 500 x ($5.50 - $3) = $625 per day.

When the price falls, consumer surplus rises for two reasons: buyers who were already buying pay less, and new buyers enter. If the mango price fell to $2, consumer surplus would rise to $1,225: a gain of $500 for existing buyers plus $100 for new buyers.

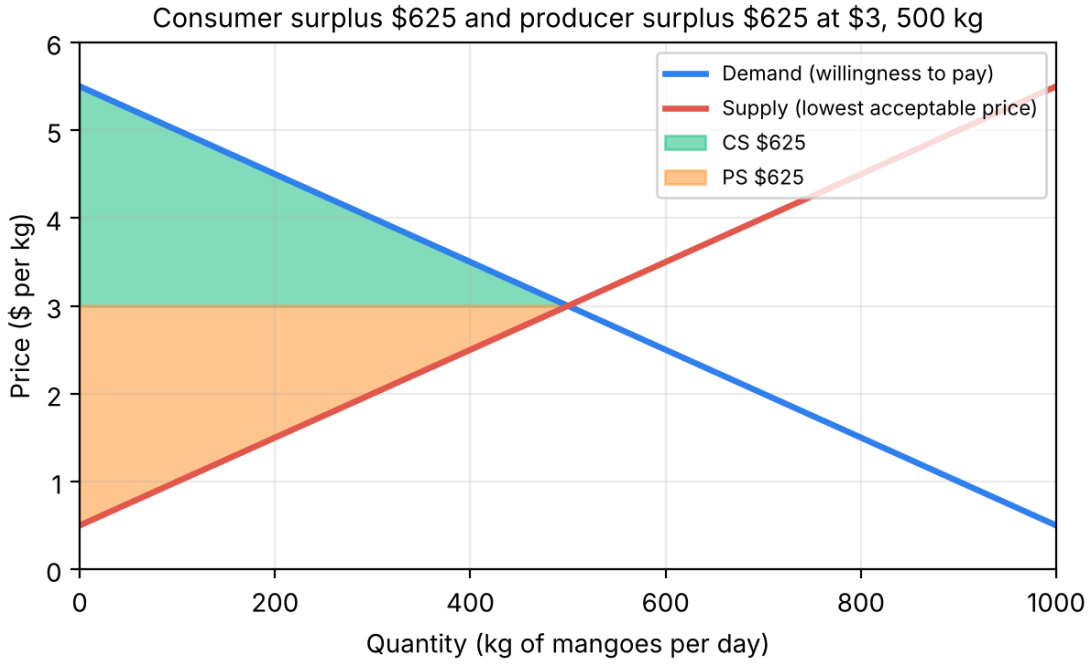


Figure 1. Consumer surplus (green) and producer surplus (orange) in the mango market.

4. Producer surplus

Each seller has a lowest acceptable price for each unit, below which supplying it is not worthwhile. For a competitive seller this reflects the extra (marginal) cost of producing and delivering that unit, including the value of the seller's time.

Producer surplus for one unit = price received - lowest acceptable price. For a market, producer surplus is the area above the supply curve and below the price, up to the quantity sold.

Five-seller example at $3: lowest acceptable prices $1, $1.50, $2, $2.50 and $3 give producer surplus $5.

Mango market: the supply curve meets the price axis at $0.50, so producer surplus at $3 is 1/2 x 500 x ($3 - $0.50) = $625 per day.

Producer surplus is not the same as profit. It is measured against the extra cost of each unit and ignores fixed costs that must be paid whatever the output, such as the rent of a stall. Profit subtracts all costs.

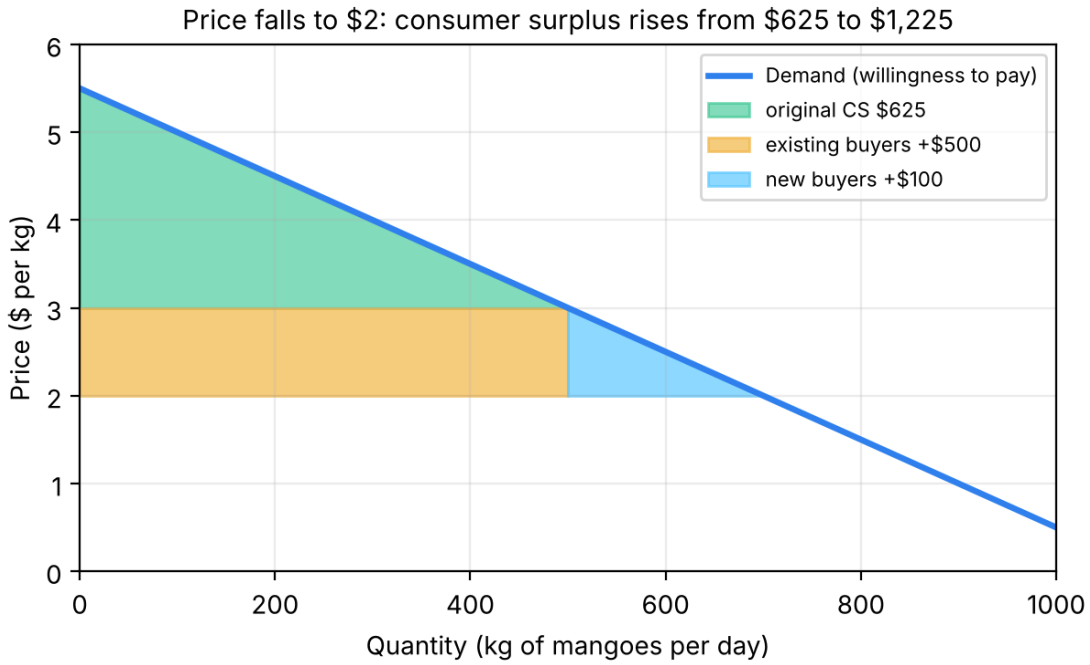


Figure 2. How a lower price raises consumer surplus.

5. Total surplus and efficiency

Total (social) surplus = consumer surplus + producer surplus = value to buyers - cost to sellers. In the mango market it is $625 + $625 = $1,250 per day: the area between the demand and supply curves up to the equilibrium quantity.

For each unit, the height of the demand curve shows its value to a buyer and the height of the supply curve shows its cost to a seller. The vertical gap is the surplus that unit creates when it is traded.

If fewer units are traded than the equilibrium (say 400 kg), some units worth more than they cost are not traded: total surplus falls by $50 to $1,200. If more are traded (say 600 kg), some units cost more than they are worth: again $50 is lost. The equilibrium quantity maximises total surplus, so economists call the competitive outcome efficient.

Note that the price itself does not change total surplus at a given quantity: a higher price moves surplus from buyers to sellers, but the total stays the same. What matters for efficiency is how much is traded and by whom.



Figure 3. Lost surplus when the traded quantity differs from the equilibrium.

6. Limits of the efficiency result

Efficiency is about the size of the gains, not their distribution. An efficient outcome can still be judged unfair, and people with low incomes may be priced out entirely. Judging fairness needs value judgements that the surplus measures do not supply.

The result assumes competitive markets in which buyers and sellers bear all the costs and benefits of their choices. With external effects (such as pollution), market power, or poor information, the market quantity can be inefficient. Later lessons study these market failures.

Two meanings of 'surplus': in Lesson 1 a surplus was unsold output (excess supply). Consumer and producer surplus are gains from trade. Always check which meaning is intended.

Going deeper: surplus with general straight lines

Write demand as P = A - bQ (A is where demand meets the price axis) and supply as P = C + dQ (C is where supply meets the price axis), with A > C.

At the equilibrium quantity Q*, CS = 1/2 x Q* x (A - P*) and PS = 1/2 x Q* x (P* - C). Total surplus = 1/2 x Q* x (A - C).

For the mango market A = 5.50, b = 1/200, C = 0.50, d = 1/200, so Q* = (A - C)/(b + d) = 5/(1/100) = 500 and total surplus = 1/2 x 500 x 5 = 1,250, as in the video.

If either curve is steeper (buyers or sellers less responsive), the triangles change shape. Elasticity (Lesson 2) therefore affects how a market's gains are split between buyers and sellers.

Why the price does not change total surplus at a given quantity

Suppose 500 kg are traded but at $3.50 instead of $3. Each kilogram costs buyers 50 cents more and earns sellers 50 cents more. Consumer surplus falls by 500 x 0.50 = $250 and producer surplus rises by the same $250. Total surplus is unchanged.

A price is a transfer between buyers and sellers. Efficiency depends on which units are traded: a unit should be traded if and only if its value to a buyer exceeds its cost to a seller.

Common mistakes to avoid

Confusing consumer surplus (a gain from trade) with a market surplus (unsold goods).

Using the whole area under the demand curve as consumer surplus: you must subtract what buyers actually pay (the rectangle below the price).

Taking the triangle's height from the origin instead of from the price line.

Treating producer surplus as profit (it ignores fixed costs).

Concluding that 'efficient' means 'fair' or 'best for everyone'.

Applying the idea: ticket pricing (qualitative)

Concert organisers often set prices below what many fans would pay. Fans who get tickets enjoy large consumer surplus; when tickets are resold at higher prices, part of that surplus is captured by resellers instead.

Variable pricing, auctions and early-bird schemes try to charge each buyer closer to their willingness to pay. They move surplus from buyers to sellers and can also change who gets the tickets. Whether that is desirable involves both efficiency and fairness questions.

Worked examples

Worked example 1: consumer surplus from a schedule

Five buyers have willingness to pay $5, $4.50, $4, $3.50 and $3 for one kilogram each. The price is $3.50. Who buys, and what is consumer surplus?

Step 1. Buyers whose willingness to pay is at least $3.50 buy: Lena, Ama, Ben and Chen (Chen is just willing).

Step 2. Gains: 5 - 3.50 = 1.50; 4.50 - 3.50 = 1; 4 - 3.50 = 0.50; 3.50 - 3.50 = 0.

Step 3. Consumer surplus = 1.50 + 1 + 0.50 + 0 = $3. Compared with $5 at $3, the higher price lowers it and Dara no longer buys.

Worked example 2: surplus areas in the mango market

Using Qd = 1100 - 200P and Qs = -100 + 200P, find consumer, producer and total surplus at equilibrium.

Step 1. Equilibrium: 1100 - 200P = -100 + 200P gives P = $3 and Q = 500 kg.

Step 2. Demand meets the price axis where Qd = 0: P = 1100/200 = $5.50. Supply meets it where Qs = 0: P = 100/200 = $0.50.

Step 3. CS = 1/2 x 500 x (5.50 - 3) = $625.

Step 4. PS = 1/2 x 500 x (3 - 0.50) = $625.

Step 5. Total surplus = $1,250 per day.

Worked example 3: how a price fall changes consumer surplus

The mango price falls from $3 to $2 (along the demand curve). Find the new consumer surplus and split the change into its two parts.

Step 1. At $2, Qd = 700 kg; CS = 1/2 x 700 x (5.50 - 2) = $1,225.

Step 2. Change = $1,225 - $625 = $600.

Step 3. Existing buyers: 500 kg each $1 cheaper = $500 (a rectangle).

Step 4. New buyers: triangle 1/2 x 200 x 1 = $100.

Step 5. Check: 500 + 100 = 600.

Worked example 4: the cost of trading the wrong quantity

Suppose only 400 kg of mangoes are traded. Find the lost surplus and the remaining total surplus.

Step 1. At 400 kg: willingness to pay = (1100 - 400)/200 = $3.50; lowest acceptable price = (400 + 100)/200 = $2.50.

Step 2. The units from 400 to 500 kg would each create surplus; together they form a triangle 1/2 x 100 x (3.50 - 2.50) = $50.

Step 3. Total surplus = $1,250 - $50 = $1,200 per day.

Summary

• Willingness to pay is the highest price a buyer would pay; the demand curve lines buyers up by it.

• Consumer surplus = willingness to pay - price: the area below demand and above the price ($625 a day for mangoes).

• Producer surplus = price - lowest acceptable price: the area above supply and below the price ($625 a day).

• Total surplus = value to buyers - cost to sellers ($1,250 a day); the price only transfers surplus at a given quantity.

• A competitive equilibrium maximises total surplus (efficiency); trading less or more loses surplus.

• Efficient is not the same as fair; externalities and market power can make markets inefficient.

References

References: KN-UGR-ECO-C01-M01-T03-L01
OpenStax, Principles of Economics 3e (2023), ch. 3 "Demand and Supply", the section on price ceilings and price floors, where consumer surplus, producer surplus, social (total) surplus and deadweight loss are defined. https://openstax.org/details/books/principles-economics-3e. Cited only; no OpenStax text or figures are reproduced (their licence is CC BY-NC-SA).
N. Gregory Mankiw, Principles of Economics (Cengage, any recent edition), ch. 7 "Consumers, Producers, and the Efficiency of Markets": willingness to pay, consumer and producer surplus, market efficiency, and the limits of the efficiency result (equality, market power, externalities). Cited only.
The mango market and the five buyers and sellers are illustrative (the same equations as Lessons 1 and 2). The real-life examples are stated qualitatively; no estimates are quoted.
All references were consulted for accuracy; no text or figures from them are reproduced in the video. Verify links and section titles before publication.
Numbers in these notes are computed from the same equations as the video and checked automatically. The mango market and the named buyers and sellers are illustrative.