

Handout 4: Supply, Demand, and Government Policies

Mankiw Ch 6

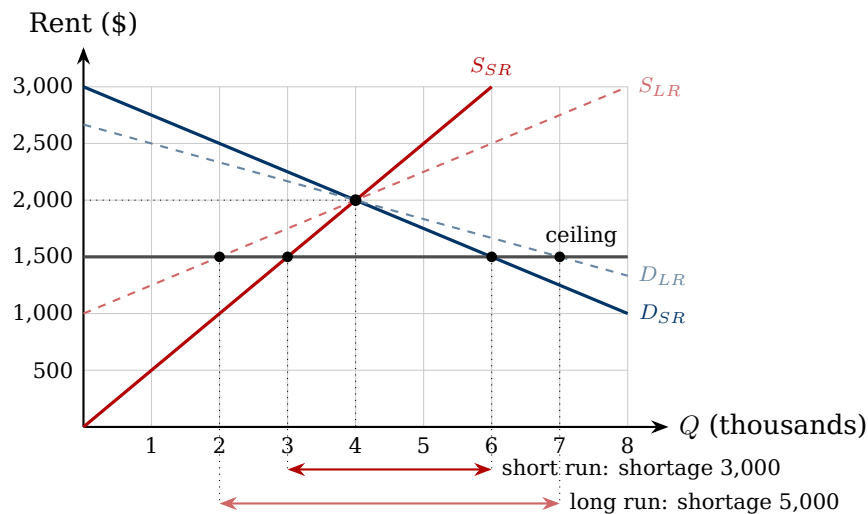
Answer key

Problem 1. Rent control near campus

The market for one-bedroom apartments near campus is described by

$$Q_d = 12,000 - 4P \quad Q_s = 2P$$

where P is the monthly rent in dollars and Q is the number of apartments.



- a) Draw both curves on the grid. Find the equilibrium rent and number of apartments rented.

$12,000 - 4P = 2P$, so $P^* = \$2,000$ and $Q^* = 4,000$ apartments. Demand runs from \$3,000 on the rent axis; supply starts at the origin.

- b) The city caps rents at \$2,500. What happens?

Nothing. The cap is **not binding**: the market rent of \$2,000 is already legal. Rent stays \$2,000 and 4,000 apartments are rented.

- c) The city caps rents at \$1,500 instead. Is the cap binding? Find the quantity supplied, the quantity demanded, the shortage or surplus, and the number of apartments actually rented.

Binding: \$1,500 is below \$2,000. $Q_s = 2 \times 1,500 = 3,000$ and $Q_d = 12,000 - 6,000 = 6,000$, a **shortage of 3,000**. Only **3,000** apartments are rented, 1,000 fewer than without the cap: the short side of the market (supply) decides how many trades happen.

- d) The rent can no longer decide who gets the 3,000 apartments. Name two things that will decide it instead. Who gains from the cap, and who loses?

Any two of: **search time and luck** (who hears first, who can tour the same day); **the landlord's choice** (friends, relatives, tenants who look like the landlord's idea of a safe bet); **side payments** (key money, fees, furniture sold at inflated prices); **lower quality** (repairs put off, since the landlord cannot lose a tenant). Gain: the 3,000 households who get an apartment pay \$500 a month less. Part of that gain goes to search time, side payments and worse upkeep. Lose: households who would have rented at \$2,000 and now get nothing (at least 1,000 of them); and landlords, who get \$500 less on each unit and take 1,000 units off the market. Of the 3,000 who want an apartment at \$1,500 and cannot find one, some would not have rented at \$2,000 anyway; they are no worse off.

e) Over several years both curves change to

$$Q_d = 16,000 - 6P \quad Q_s = 4P - 4,000.$$

Check that without the cap the equilibrium is the same as in (a). With the \$1,500 cap, find the shortage and the number of apartments rented now. Why did the curves change this way?

At \$2,000: $Q_d = 16,000 - 12,000 = 4,000$ and $Q_s = 8,000 - 4,000 = 4,000$. Same equilibrium.
 At \$1,500: $Q_d = 16,000 - 9,000 = 7,000$ and $Q_s = 6,000 - 4,000 = 2,000$. The **shortage grows from 3,000 to 5,000**, and apartments rented **fall from 3,000 to 2,000**. Both curves became **more elastic**. Given years, landlords convert units to condos, stop building, and let buildings run down; students who would have shared a place or lived at home want their own apartment at \$1,500. The same cap does more damage the longer it lasts.

f) Suppose the city drops the cap and instead gives every renter a \$600 monthly housing voucher, using the short-run curves. Demand shifts up by \$600: $Q_d = 12,000 - 4(P - 600)$, where P is the rent landlords receive. Find the rent landlords receive, what tenants pay out of pocket, and the number of apartments rented.

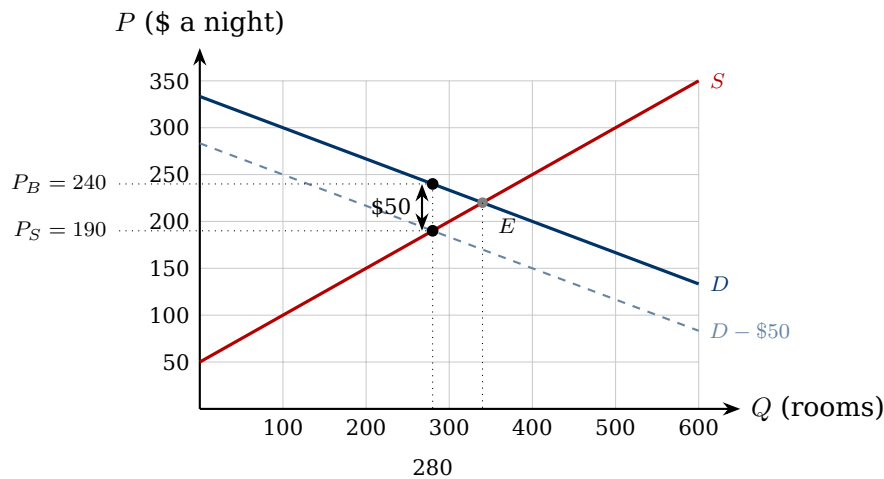
$14,400 - 4P = 2P$, so landlords receive $P = \$2,400$ and $Q = 4,800$. Tenants pay $2,400 - 600 = \$1,800$.
 No shortage, and 800 *more* apartments than before. But tenants pay only \$200 less; landlords get \$400 more. Supply is less elastic than demand here ($E_s = 1$, $E_d = 2$ at the equilibrium), so landlords capture two-thirds of a subsidy, just as the less elastic side bears more of a tax. The city pays $600 \times 4,800 = \$2.88$ million a month.

Problem 2. A hotel room tax

In a Cape Cod town on a summer night, the market for hotel rooms is

$$Q_d = 1,000 - 3P \quad Q_s = 2P - 100$$

where P is the price of a room for one night.



- a) Draw both curves on the grid. Find the equilibrium price and number of rooms.

$$1,000 - 3P = 2P - 100, \text{ so } 5P = 1,100: P^* = \$220, Q^* = 340 \text{ rooms.}$$

- b) The town levies a \$50 tax on each room-night, paid by the guest. Write the new demand curve in terms of the price hotels receive. Find the number of rooms rented, the price guests pay, the price hotels keep, and the town's tax revenue per night.

Guests will pay a hotel \$50 less than before for any number of rooms, so demand shifts **down by \$50**: $Q_d = 1,000 - 3(P + 50) = 850 - 3P$.
 $850 - 3P = 2P - 100$, so hotels keep $P_S = \$190$; guests pay $P_B = 190 + 50 = \$240$;
 $Q = 2(190) - 100 = 280$ rooms.
 Revenue = $50 \times 280 = \$14,000$ a night.

- c) How much of the \$50 do guests bear, and how much do hotels bear?

Guests pay \$240 instead of \$220: **\$20**. Hotels keep \$190 instead of \$220: **\$30**.
 The law taxed guests; hotels carry most of it.

- d) Now suppose the law puts the \$50 tax on the hotels instead. Show that nothing changes.

Supply shifts **up by \$50**: $Q_s = 2(P - 50) - 100 = 2P - 200$. Then $1,000 - 3P = 2P - 200$, so guests pay $P = \$240$, hotels keep $240 - 50 = \$190$, and $Q = 1,000 - 720 = 280$. The same three numbers: it does not matter which side the law taxes.

- e) On the slides (\$40 tax, $Q_d = 400 - P$, $Q_s = 3P$) buyers bore \$30 of \$40. Here guests bear only \$20 of \$50. Compute the price elasticities of demand and supply at the equilibrium, and explain the difference.

At $P = 220$, $Q = 340$: demand changes by 3 rooms per \$1, so $E_d \approx 3 \times 220/340 = \mathbf{1.94}$; supply changes by 2 rooms per \$1, so $E_s \approx 2 \times 220/340 = \mathbf{1.29}$.

Here **supply is the less elastic side**, so hotels bear more. On the slides demand was less elastic ($E_d = 1/3$, $E_s = 1$), so buyers bore more. Guests' share $\approx E_s/(E_s + E_d) = 2/(2 + 3) = 0.40$ (the $220/340$ cancels), and $0.40 \times \$50 = \$20$. Both sides are elastic here; supply is less so. A hotel cannot add rooms for the summer and can only leave some empty, while tourists can pick another town or a shorter stay.

- f) The town doubles the tax to \$100. Does its revenue double?

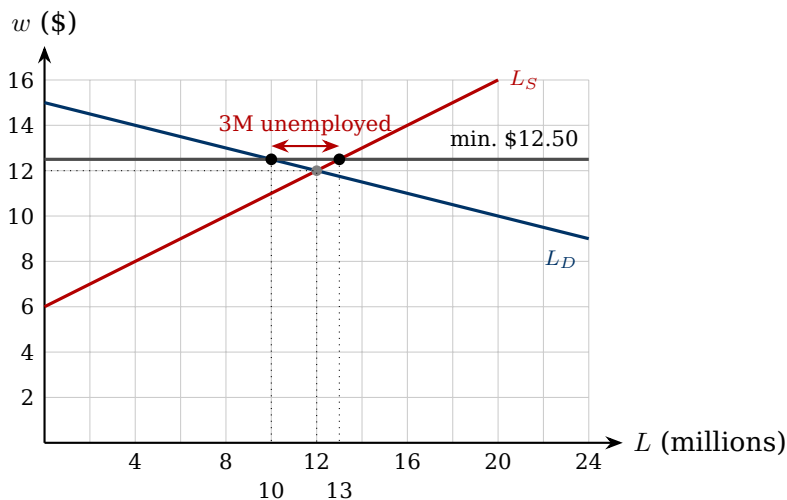
$1,000 - 3(P + 100) = 2P - 100$, so $P_S = \$160$, $P_B = \$260$, $Q = 220$. Revenue = $100 \times 220 = \mathbf{\$22,000}$, not \$28,000. Each dollar of tax shrinks the market further, so the tax base falls as the rate rises. Chapter 8 returns to this.

Problem 3. Minimum wage or wage subsidy?

The labor market for unskilled workers is described by

$$L_D = 60 - 4w \quad L_S = 2w - 12$$

where L_D is the number of workers (in millions) firms want to hire, L_S the number who want to work, and w the hourly wage in dollars. The number unemployed is $L_S - L_D$, and the unemployment rate is (number unemployed)/ L_S .



- a) Draw both curves on the grid, marking where each meets the wage axis. Find the equilibrium wage and employment.

Labor demand meets the wage axis at \$15 ($60 - 4w = 0$ gives $w = 15$ at $L = 0$), labor supply at \$6. $60 - 4w = 2w - 12$, so $w^* = \$12$ and $L^* = 12$ million.

- b) The government sets a minimum wage of \$12.50. Is it binding? Find labor demanded, labor supplied, the number unemployed and the unemployment rate.

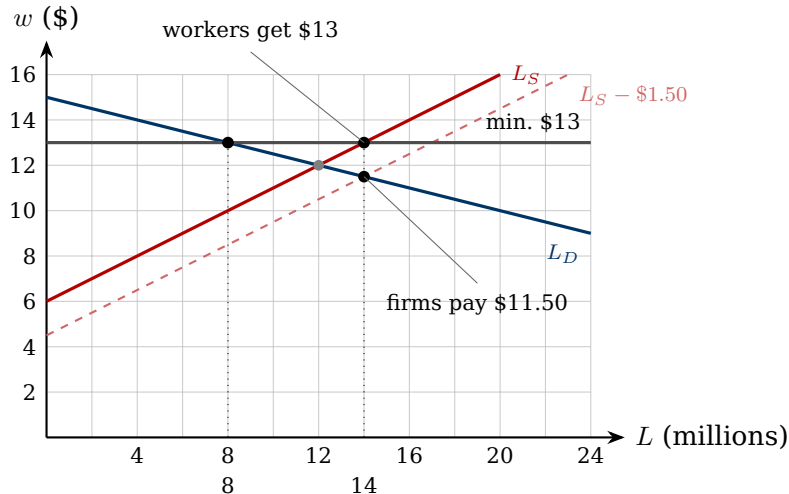
Binding: \$12.50 is above \$12. $L_D = 60 - 50 = 10$ million, $L_S = 25 - 12 = 13$ million. Unemployed = $13 - 10 = 3$ million; rate = $3/13 = 23.1\%$. Employment falls from 12 to 10 million.

- c) Using the equilibrium and the point in (b), compute the midpoint wage elasticities of labor demand and of labor supply. Which one decides how many jobs the minimum wage destroys?

$\% \Delta w = 0.50/12.25 = 4.08\%$.
 Demand: $\% \Delta L = (10 - 12)/11 = -18.2\%$, so $E_D = 18.2/4.08 = 4.45$: elastic.
 Supply: $\% \Delta L = (13 - 12)/12.5 = 8.0\%$, so $E_S = 8.0/4.08 = 1.96$: elastic.
Labor demand decides the jobs lost: the more elastic it is, the more firms cut hiring when the wage floor rises. Labor supply decides how many extra people come looking for work.

- d) In the long run, would you expect the number unemployed at a \$12.50 minimum to rise or fall? The unemployment rate? Explain using elasticity.

Both curves become more elastic over time. Firms replace workers with machines, self-checkout and fewer shifts, so L_D at \$12.50 falls below 10 million; more people enter the market to look for jobs at that wage, so L_S rises above 13 million. The number unemployed $L_S - L_D$ **rises**. The rate, $1 - L_D/L_S$, also **rises**, since L_D falls while L_S grows.



- e) The minimum wage is raised to \$13. Find employment, the number unemployed, and the unemployment rate. Compare total wage income of unskilled workers ($w \times \text{employment}$) with the no-minimum equilibrium.

$L_D = 60 - 52 = 8$ million employed; $L_S = 26 - 12 = 14$ million, so **6** million unemployed, a rate of $6/14 = 42.9\%$. Employment is 4 million below the equilibrium 12 million.

Wage income: $12 \times 12 = \$144$ million an hour without the minimum; $13 \times 8 = \$104$ million with it. The 8 million who keep their jobs gain \$1 an hour (\$8 million); the 4 million who lose them give up \$48 million.

- f) Instead of a minimum wage, the government pays workers \$1.50 for every hour they work (a wage subsidy, roughly like the Earned Income Tax Credit). A subsidy is a tax in reverse: workers now need \$1.50 less from the employer to supply the same labor, so labor supply shifts *down* by \$1.50: $L_S = 2(w + 1.5) - 12$, where w is the wage firms pay. Find the wage firms pay, what workers take home, employment, and the cost to the government.

$L_S = 2w - 9$. Then $60 - 4w = 2w - 9$, so firms pay $w = \$11.50$, workers take home $11.50 + 1.50 = \$13.00$, and employment is $60 - 46 = 14$ million. Cost: $\$1.50 \times 14 = \$21$ million an hour.

Of the \$1.50, workers get \$1.00 (\$12 to \$13) and firms \$0.50 (\$12 to \$11.50). Labor supply is the less elastic side ($E_S \approx 2 \times 12/12 = 2$ against $E_D \approx 4$), so it gets the larger share.

- g) Workers take home \$13 an hour under both policies. Compare them: how many work, and who pays?

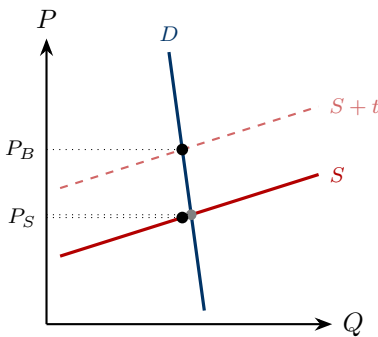
Minimum wage: 8 million work, 6 million who want to work at \$13 cannot find a job. No government spending; the cost falls on the 4 million who lose their jobs, and on firms and their customers.

Subsidy: 14 million work (the same 14 million who want to work at \$13), nobody is left out, and taxpayers pay \$21 million an hour. The market still clears. The subsidy helps more low-wage workers, but it is not free: which is better

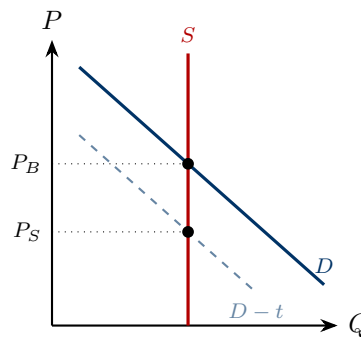
depends on how much weight one puts on the jobs lost versus the tax bill.

Problem 4. Who really pays?

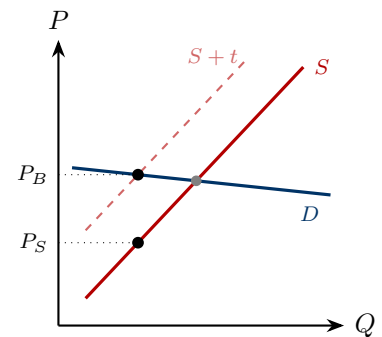
For (a)–(c), draw the market with the tax, say which side is less elastic, and say who bears most of the tax.



(a) patients bear most



(b) landowners bear all



(c) stations bear most

- a) A \$20 tax on each vial of insulin, sent to the government by pharmacies.

Patients cannot do without insulin: demand is **very inelastic**. Supply is far more elastic than this nearly vertical demand. Supply shifts up by \$20; the price patients pay rises by almost the whole \$20 and the price pharmacies keep barely falls. **Patients bear most of it**, although the pharmacies send the check.

- b) A tax on land in a city, paid by landowners. The amount of land cannot change.

Supply is **perfectly inelastic** (vertical). Whichever side the law taxes, the quantity stays the same and the price users pay stays the same; the landowners' price falls by the full tax. **Landowners bear all of it**. It is the Fenway result: a fixed supply passes none of the tax on.

- c) A town adds a 20-cent tax on each gallon of gasoline. The next town, five minutes away, does not.

Drivers can fill up next door, so demand at this town's stations is **very elastic** (nearly flat). The pump price rises only a little, most of the 20 cents comes out of what the stations keep, and gallons sold in town fall a lot. **Station owners bear most**, and the town collects less than it expected.

- d) Congress moves the whole 15.3% payroll tax onto employers, so workers' paychecks no longer show a deduction. Will workers' take-home pay rise?

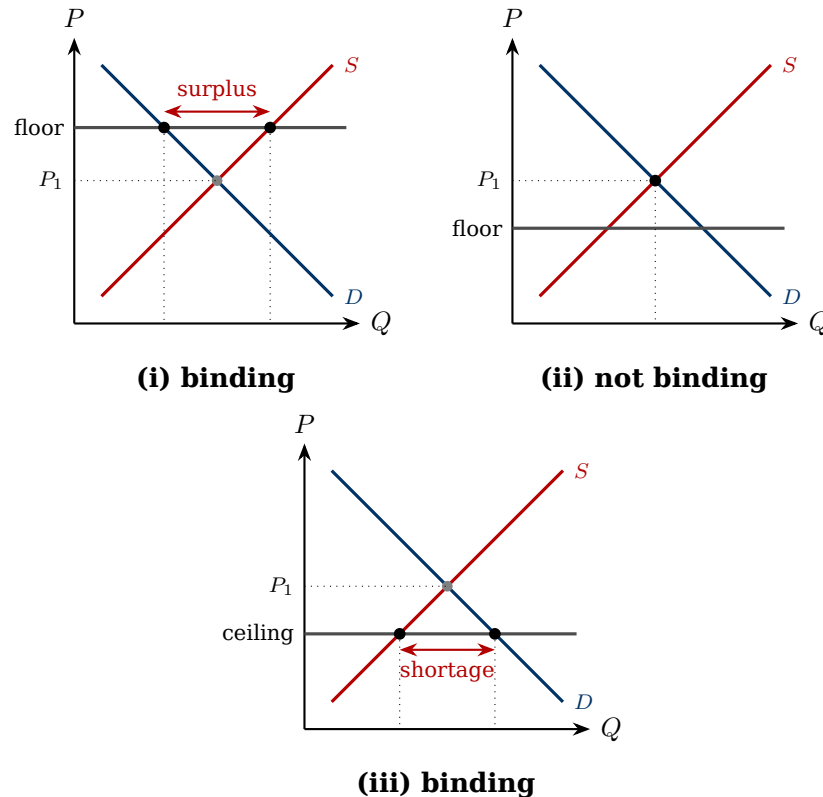
Not for long. Employers now owe an extra 7.65%, so labor demand shifts down by that amount; workers no longer owe their 7.65%, so labor supply shifts down by the same amount. The wage falls by about 7.65% and the outcome is the same as before: the same cost per worker to firms, the same take-home pay. Labor supply is inelastic, so **workers bear most of the tax either way**. Only while wages are fixed by existing contracts would take-home pay be briefly higher.

- e) In the Fenway example on the slides (25,000 seats, a \$10 tax on fans, who paid \$60), Boston moves the tax to the Red Sox. What happens to the price fans pay, the price the Red Sox keep, and the number of tickets sold?

Nothing changes: which side the law taxes never matters, as in 2(d). Fans still pay \$60, the Red Sox still keep \$50, 25,000 tickets are sold, and the city still collects \$250,000 a game. The fixed number of seats explains something else: why the Red Sox bear all of the tax.

Problem 5. Legalizing cannabis

A state legalizes cannabis: licensed shops may now sell it. Illegal dealers still operate and sell the same product, and the two are close substitutes: many buyers switch when legal cannabis costs more or is out of stock. Let P_1 be the equilibrium price in the legal market.



- a) The state sets a minimum price (a price floor) for legal cannabis. Show its effect on the legal market when (i) the floor is above P_1 and (ii) the floor is below P_1 . What happens to legal consumption in each case?

(i) **Binding.** The legal price rises to the floor; quantity demanded falls and quantity supplied rises, leaving a **surplus** of unsold legal cannabis. Legal consumption falls to quantity demanded at the floor.

(ii) **Not binding:** the market price P_1 is already above the floor. Nothing changes.

- b) With a binding floor, what happens to the illegal market?

Buyers priced out of the legal market can buy the same product from dealers, who are not bound by the floor and can undercut it. The floor hands dealers customers: **the illegal market grows**, and total consumption falls by less than legal sales do. Licensed shops sitting on unsold cannabis also have a reason to sell it off the books below the floor.

- c) The state instead sets a binding maximum price (a price ceiling). Show its effect in (iii). What happens in the legal market and in the illegal market, in the short run and in the long run?

The legal price falls to the ceiling; quantity supplied falls and quantity demanded rises: a **shortage**, and legal sales fall to quantity supplied at the ceiling. Buyers who find the shelves empty turn to dealers, who can charge *more* than the ceiling; licensed shops are tempted to divert product to them for the same reason. In the long run both curves become more elastic: licensed growers cut back or leave, and more people want cannabis at the low legal price. The shortage grows, and **the illegal market grows with it**.

- d) States that legalize cannabis tax it rather than fix its price. Using your answers, explain why a tax is a better tool than a floor or a ceiling if the goal is to move buyers out of the illegal market.

A **ceiling** leaves buyers who are willing to pay the legal price unserved, and dealers serve them. A **floor** raises the legal price just as a tax does, but the extra money goes to the shops, not the state, and the unsold surplus tempts shops to sell off the books. A **tax** raises revenue, creates no surplus or shortage, and can be set to keep the legal price close to the dealers' price. (A tax set too high pushes buyers back to dealers too; its size matters.)