Michael Plasmeier

11/19

14.01 Problem Set # 8

Due: November 19, 2010

87

1. (36 points) Suppose that two competing firms, A and B, produce a homogeneous good. Both firms have a marginal cost of $MC = \$50$. Describe what would happen to output and price in each of the following situations if the firms are at

(i) Cournot equilibrium,
(ii) collusive equilibrium,
and (iii) Bertrand equilibrium (price competition).

Oh for each

a. Because Firm A must increase wages, its MC increases to \$80.
b. The marginal cost of both firms increases.
c. The demand curve shifts to the right.

Not do the actual analysis

2. (25 points) Consider a market in which two firms produce a homogeneous product. Market demand is given by $Q_d(P) = 200 - P$. The cost functions for firm A and firm B are $TC_a(q_a) = 5q_a$ and $TC_b(q_b) = 0.5q_b^2$, respectively.

(a) (7 points) Find the Cournot equilibrium quantities supplied by each firm. Graph your result using reaction functions. Find the market price, and calculate profits for each firm.

(b) (8 points) Now suppose that firm A chooses how much to produce before firm B does (i.e. firm A is a Stackelberg leader, B a follower). Calculate quantities, market price and profit for each firm.

(c) (5 points) Now consider the case where total social welfare is maximized. Find market quantity, quantities supplied by each of the two firms, and market price.

(d) (5 points) Compare firm output, total output and price for parts (a) through (c). Do your values make sense?

3. (28 points). Suppose a perfectly competitive labor market has a demand curve of $L = 120 - 2w$ and a supply curve of $L^D = 8w$, where w is the wage rate is dollars and L^S is the quantity of labor in person-hours.

a) (2 points) What are the equilibrium values of the wage and employment?

b) (4 points) Suppose the government imposed a minimum wage of \$14 per hour. Now what are the equilibrium values of the wage and employment?

c) (8 points) Repeat part a, assuming now that the market is a monopsony.

d) (8 points) Repeat part b, assuming now that the market is a monopsony.

e) (6 points) Does the imposition of the minimum wage decrease employment here under perfect competition? What about under monopsony? Give a brief intuitive explanation for your answer and why it may be

different under the two different market structures.

4. (11 points) Suppose you face the following lottery. You can earn 1 of 3 possible grades in this class: an "A", a "C", or an "F", with the following probabilities: $\pi_A = \frac{2}{10}, \pi_C = \frac{6}{10}$, and $\pi_F = \frac{2}{10}$. Your current wealth (w) is \$400. If you receive an "A", you gain (e.g. I pay you) \$500. However, if you get an "F", you lose (e.e. you pay the) \$300. If you receiv a "C", you DO NOT GAIN OR LOSE anything. Assume your utility function, defined over wealth, is $U(w) = \sqrt{(w)}$.

(a) (6 points) What is your expected utility (EU). [Hint: be sure to calculate your total wealth in each "state"]

(b) (5 points) What is the certainty equivalent level of wealth ($w*$), that is, the guaranteed payoff at which a person is "indifferent" between accepting the guaranteed payoff and his expected utility from (a).

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1. A, B homogeneous good

$MC_A = MC_B = 50$

a) Because Firm A must increase wages its $MC_A = 80$
(and I am assuming $MC_B = 50$)

i) Cournot equilibrium - In this model the firms try to adjust their output - which they do at the same time - taking into account each other

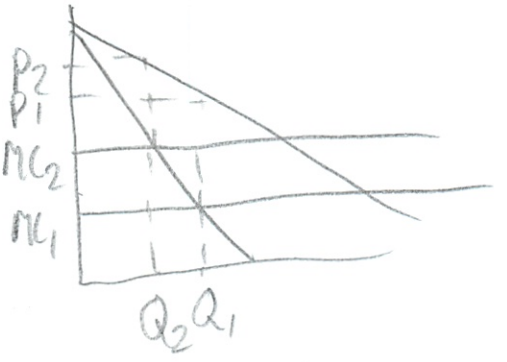
In this model the firms make economic profits - so they may be able to asorb the cost increase and stay in business. They will likely be more profitable producing less, so they will do this and the other firms will know their production possibly will change and adjust accordingly.

$Q_A \downarrow \quad P \uparrow$
$Q_B \uparrow$

(2)

ii) Collusive equalibium, The firms are still acting like a monopoly together, and split the market. Assuming the price is > 70, the arrangements do not change because the other firm is happen at the current level - and must be kept happy for the collusion to continue.

If A insists they readjust MR=MC, $Q_A \downarrow$ $Q_B \downarrow$ $P \uparrow$



-1

iii) Betrand equalibium - In a Betrand equalibium, the price is lowered though a price war to the competive levels, so A will go out of business, $Q_A \uparrow$ Price ↑ as B is now a monopoly

✓

not complety sure

(3)

b) The MC of both firms increase. (assuming same amt

i) Cournot - Both firms adjust their models (MR=MC) and their prediction of what competitor does,

Both Q ↓ P ↑

But book says that Cournot model provides no guidance on the dynamics of the adjustment process.

ii) Collusive - Like a monopoly whose costs have increased, the firm adjusts to the new MR=MC reality

↓ Q ↑ P

They continue to split the market between them, like before

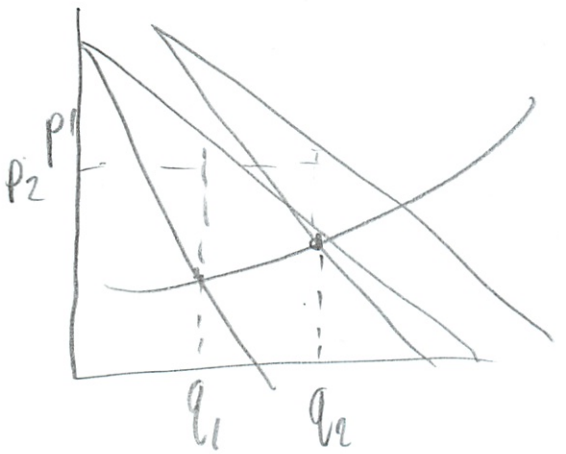
iii) Betrand - prices are already at the absolute lowest/competive levels, So both firms must raise their prices and lower quantities to be able to stay in business. We have not studied the mechanics of that.

Q ↓ P ↑

(4)

c) The demand curve shifts to the right (increases)

i) Cournot - Assuming both firms are aware of the new demand curve (and know that their opponent is aware) they just figure this in.



The Q of each ↑
P ↓

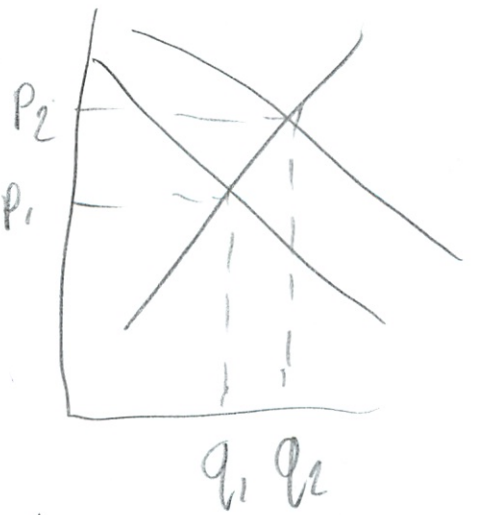
-1

ii) Collusive ↗ that diagram is actually Collusive outcome

P ↓ Q_A, Q_B ↑

X -1

iii) Bertrand. Compelive so P=MC.



P ↑
Q_A, Q_B ↑

-1

(5)

2. Two firms producing homogenious product.

$Q_d(P) = 200 - P$

$TC_a(q_a) = 5q_a \quad TC_b(q_b) = 1.5(q_b)^2$

a) Find the Cournot equalibium.

$Q = q_A + q_B = 200 - P \qquad P = 200 - Q$

$\Pi_A = TR_a - TC_a$

$= q_a P - 5q_a$

$= q_a(200 - q_a - q_b) - 5q_a$

$= 200q_a - q_a^2 - q_a q_b - 5q_a$

Want to find A's profit maximizing equation

$MR_A = MC_A$

$MR_A = \frac{\partial R}{\partial q_a} = 200 - 2q_a - q_b \qquad MC_a = \frac{\partial C_A}{\partial q_a} = 5$

$200 - 2q_a - q_b = 5$

$-2q_a - q_b = -195$

$q_a = \frac{-195 + q_b}{-2}$

$q_a(q_b) = 97.5 - \frac{q_b}{2}$

(6)

Now do the same for the other firm

$$\pi_b = TR_b - TC_b$$

$$= q_b P - 5q_b$$

$$= q_b(200 - q_a - q_b) - .5q_b^2$$

$$= 200q_b - q_a q_b - q_b^2 - .5(q_b)^2$$

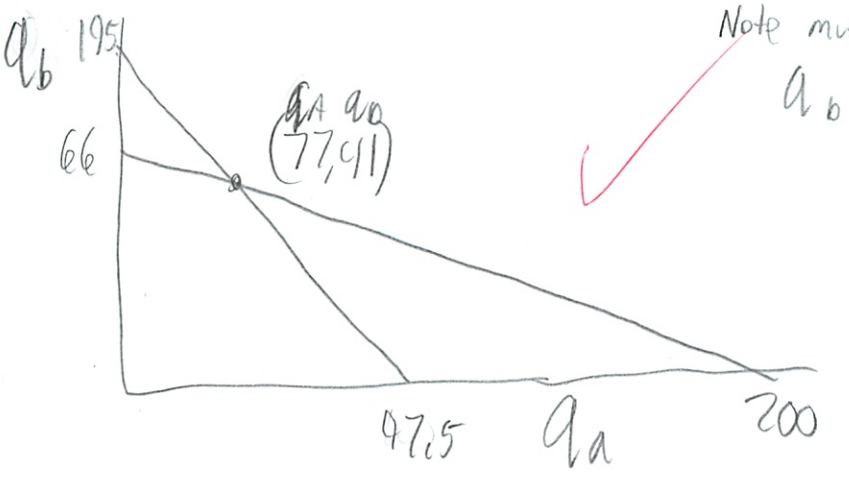
$$MR_B = MC_B$$

$$MR_B = \frac{\partial R_A}{\partial q_B} = 200 - q_a - 2q_b = 2 \cdot \tfrac{1}{2} q_b = \frac{\partial C_B}{\partial q_B} = MC_B$$

$$200 - q_a - 2q_b = q_b$$

$$3q_b = 200 - q_a$$

$$q_b(q_a) = \frac{200 - q_a}{3}$$



Note must rearrange q_a to plot

$q_b = +195 - 2q_a$

(7)

Market price will be

$P = 200 - 77 - 41 = 82$

$\pi_A = q_A \cdot P - 5 q_a$

$= 77 \cdot 82 - 5 \cdot 77$

$= 5929$

$\pi_B = q_B \cdot P - \frac{1}{2}(q_b)^2$

$= 41 \cdot 82 - \frac{1}{2}(41)^2$

$= 2521.5$

b) Now assume A chose how much first (Stackelberg)

start w/ <u>firm2</u> who makes its production decision taking Q_A as a given

- it as same reaction curve as w/ Cournot

$$q_B = \frac{200 - q_a}{3}$$

But firm1 can choose first, knowing B will respond according to the formula (we are assuming it can do that)

$MC = MR$

$R = q_a(200 - q_a - q_b)$

$MR = 200 - 2q_a - q_b = 5 = MC$

(8)

Now firm A must anticipate how much B will produce but knows it must be according to the formula

$$R = 200q_a - q_a^2 - q_a\left(\frac{200-q_a}{3}\right)$$

$$= 200q_a - q_a^2 - \frac{200q_a}{3} + \frac{q_a^2}{3}$$

$$= \frac{400}{3}q_a - \frac{2}{3}q_a^2$$

Now precede like normal

$MR = MC$

$$MR = \frac{400}{3} - \frac{4}{3}q_a = 5 = MC$$

$$q_a = \frac{385}{4} \approx 96.25$$ ✓

So now what see what B actually does

$$q_b = \frac{200-q_a}{3} = \frac{200-96.25}{3} = 34.58$$ ✓

$$P = 200 - Q$$

$$= 200 - 96.25 - 34.58$$ ✓

$$= 69.167$$

(9)

$\pi_A = q_A P - 5q_A$

$= 96.25 \cdot 69.167 - 5(96.25)$

$= 6233.82$

$\pi_B = q_B P - \frac{1}{2}(q_B)^2$

$= 34.58 \cdot 69.167 - \frac{1}{2}(34.58)^2$

$= 1758.83$

c) Now competive outcome (where social welfare maximized)

This is when $P = MC$ $P = MC$ - does not talk about LR

$MC_A = 5$ $MC_B = q_B$

perfectly elastic linear

No this is ~~$AC = MC$~~ can't use 2 firms not identical

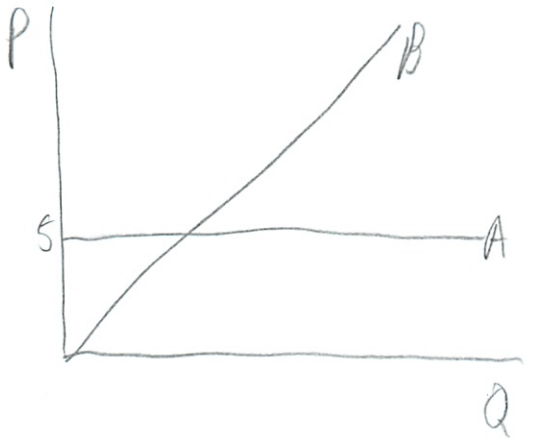
$AC_A = \frac{5q_A}{q_A} = 5$ $AC_B = \frac{.5q_B^2}{q_B} = .5q_B$

So $AC_A = MC_A$ $AC_B = MC_B$

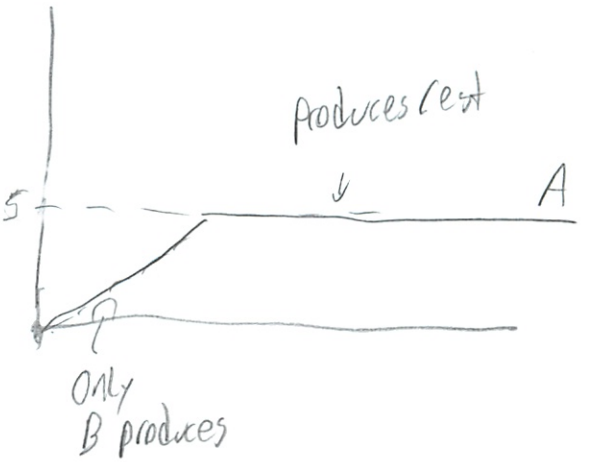
So any outcome level $.5q_B = q_B$

⊗

(10) Instead Graph inverse supply



need to add



$P = 200 - Q = 5$

$P = 5$

$200 - Q = 5$

$Q = 195$ ✓

$Q_A = 195 - 5 = 190$ ✓

$Q_B = 5$

4

d] Compare

	Cournot	Stackelberg	Competive
Q_A	77	96.25	190
Q_B	41	34.58	5
Q	118	130.83	195
P	82	69.167	5
π_a	5929	6233.82	0
π_b	2521.5	1758.83	0

Yes - these make sense. The competive value is suprisingly much lower - due to a flat MC of 45 for A.

-2

(12)

3. Suppose a perfectly competive labor market $L = 120 - 2w$

$L^D = 8w$

i are the variables wrong

I will assume they meant

$L_D = 120 - 2w$

$L_S = 8w$

a) What is =libriem wage + employment

$120 - 2w = 8w$

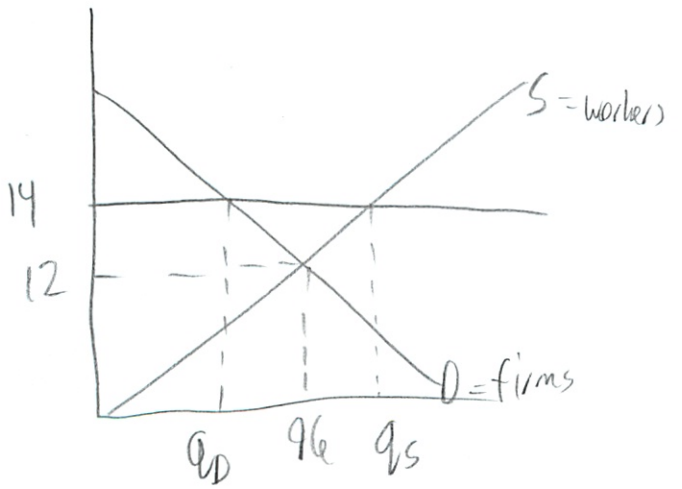
$120 = 10w$

$w = 12$

$L_D = 120 - 2(12)$ $L_S = 8(12)$

$= 96$ $= 96$ ✓

b) Gov sets min wage $w = \$14/hr$ ✓



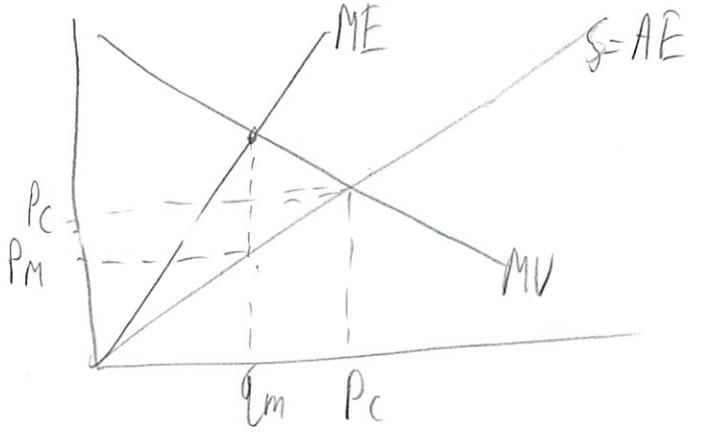
(13)

$q_D = 126 - 2(14)$ $\quad q_S = 8(14)$

$= 92$ $\quad = 112$

W is of course 14

c) Market is a monospony (1 buyer) →
ie 1 employer



So when MV = ME

$E = 8w$

$ME = 8$

$MV = D = 120 - 2Q$

$120 - 2Q = 8$

$-2Q = -112$

$Q = 56$

-4

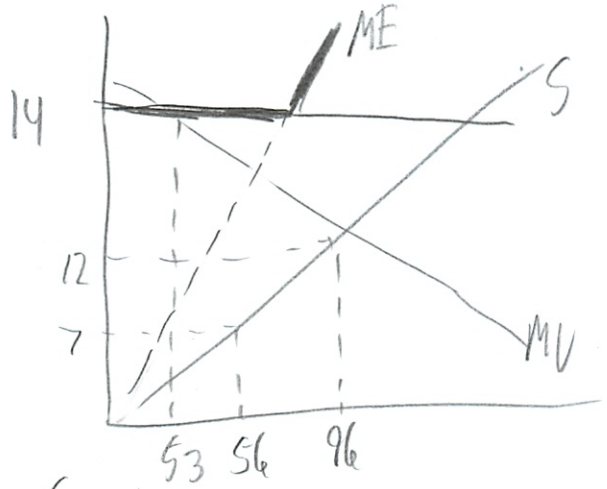
Wage =

$56 = 8(w)$

$w = 7$

(14)

d) Now min wage w/ monopsy



So where MV = ME

$120 - 2Q = 14$

$-106 = -2Q$

$Q = 53$

W=14 of (case)

↑ Is this right

- Not the best outcome for gov

-2

~~bad policy - well would have to look at welfare~~

e) Does the minimum wage ↓ employment?

Yes, under both cases in the scenario a min wage ↓ employment

Competive market	96 → 92
Monopsony	56 → 53

The minimum wage forces the company to pay above market rates for labor. This means the firm needs to get a higher MV from each employee (represented

by a higher position on the demand curve. In this case the situation is the same in both situations. However in the monopsony case if the min wage was set at the competive wage level, it can actually increase employment by removing the "poisoning effect" for monosponists. The gaernment messed this up by setting the minimum wage above the market competive level.

(16)

4. Suppose have the following lotto:

A	$\pi_A = \frac{2}{10}$	+500	
C	$\pi_C = \frac{6}{10}$	—	$W = 400$
F	$\pi_F = \frac{2}{10}$	−300	$U = \sqrt{w}$

a) What is expected utility $E[U]$

-thank you 6.041

$$E[U] = \frac{2}{10} \cdot \sqrt{400+500} + \frac{6}{16}\sqrt{400} + \frac{2}{10} = \sqrt{400-300}$$

$$= 20$$

b) What is the certainty equivilant level of weath (w^*) that is at which a player is indifferent b/w payoff

-So assuming utility is same

$$20 = \sqrt{U^*}$$

$$U^* = 400$$

-So a 0 payoff and not playing game is safest thing

14.01 Problem Set 8 Solutions

1. Suppose that two competing firms, A and B, produce a homogeneous good. Both firms have a marginal cost of $MC = \$50$. Assume linear reaction functions, describe what would happen to output and price in each of the following situations if the firms are at (i) Cournot equilibrium (ii) collusive equilibrium, and (iii) Bertrand equilibrium (price competition).

a. Because Firm A must increase wages, its MC increases to \$80.
b. The marginal cost of both firms increases.
c. The demand curve shifts to the right.

Note: Please give full credit to anyone who answers this question correctly with linear demand curves or linear reaction functions.

a. (i) In a Cournot equilibrium, when firm A has an increase in marginal cost, its reaction function shifts inwards. The quantity produced by firm A will decrease and the quantity produced by firm B will increase. Total quantity produced will decrease and price will increase.

(ii) In a collusive equilibrium, the two firms act like a monopolist. Given the two marginal cost curves, firm B, the lower MC plant, will produce all the output in the market with firm A not producing at all. The overall output stays the same as compared to the case when they both have the same marginal cost.

(iii) Firm A produces where price equals marginal cost and increases price to \$80. If the monopolist's price is less than 80, then the low cost firm B will charge the monopolist's price without worrying about the high cost firm entering. If the monopolist's price is greater than 80, then the low cost firm charges price $80 - \varepsilon$. Assuming firm B can produce enough output, it will supply the entire market.

b. (i) The increase in the marginal cost of both firms shifts both reaction functions inwards. Both firms decrease output, and price will increase.

(ii) When marginal cost increases, both firms will produce less and price will increase, as in the monopoly case.

(iii) Price will increase and quantity produced will decrease.

c. (i) Both reaction functions shift outwards and both firms produce more. Price will increase.

(ii) Both firms will increase output, and price will also increase.

(iii) Both firms will produce more. Because marginal cost is constant, price will not change.

2. Consider a market in which two firms produce a homogeneous product. Market demand is given by $Q_d(P) = 200 - P$. The cost functions for firm A and firm B are $TC_a(q_a) = 5q_a$ and $TC_b(q_b) = 0.5q_b^2$, respectively.

(a) Find the Cournot equilibrium quantities supplied by each firm. Graph your result using reaction functions. Find the market price, and calculate profits for each firm.
To determine the Cournot equilibrium, we first calculate the reaction function for each firm. Firm A's residual demand is $P = 200 - q_a - q_b$ and $MR_a = (200 - q_b) - 2q_a$. By equating MR_a and MC_a and rearranging, we get $q_a = 97.5 - 0.5q_b$, A's reaction function. Similarly for B, $MR_b = (200 - q_a) - 2q_b = MC_b = q_b$. Rearranging, we get $q_b = 66.67 - 0.33q_a$, B's reaction function. With two equations and two unknowns, we substitute for q_b in A's reaction function to solve for q_a. $q_a = 97.5 - 0.5(66.67 - 0.33q_a) \implies q_a = 77$ Substituting q_a into B's reaction function gives us $q_b = 41$.

Substituting q_a and q_b into the demand equation gives us the market price: $P = 200 - 77 - 41$ $P = \$82$

Finally, find firm profits: $\pi_a = (82)(77) - [5(77)] = \$5929$ $\pi_b = (82)(41) - [0.5(41)2] = \$2521.5$

(b) Now suppose that firm A chooses how much to produce before firm B does (i.e. firm A is a Stackelberg leader, B a follower). Calculate quantities, market price and profit for each firm.

Firm A will choose its output q_a to maximize its profits, subject to the reaction function of Firm B. That is, A faces demand $P = 200 - q_a - q_b$, but it also knows B's reaction function. We can plug that into the demand faced by A. $P = 200 - q_a - [66.67 - (1/3)q_a] = 133.33 - (2/3)q_a$ A's MR is therefore: $MR_a = 133.33 - (4/3)q_a$. Setting $MR_a = MC_a$ gives $133.33 - (4/3)q_a = 5$, or $q_a = 96.25$. Substituting q_a into B's reaction function gives $q_b = 34.58$. $P = 200 - 96.25 - 34.85 = 69.2$ $\pi_a = (69.2)(96.25) - [5(96.25)] = \$6179.25$ $\pi_b = (69.2)(34.58) - [0.5(34.58)2] = \$1795$.

(c) Now consider the case where total social welfare is maximized. Find market quantity, quantities supplied by each of the two firms, and market price.

Total welfare is maximized when the price is equal to the marginal cost (the competitive equilibrium where market demand equals market supply). Market supply is a horizontal sum of each firm's supply curve. Firm A's supply curve is $P = 5$ since $MC_a = AC_a = 5$ and Firm B's supply curve is $P = q_b$ since $MC_b = q_b$. Thus market supply is $P = Q_s$ for $Q < 5$ and $P = 5$ for $Q > 5$. Under perfect competition, $Q_s = Q_d$. Using the inverse demand equation we find $200 - Q = 5$, yielding a total quantity $Q = 195$ and $P = \$5$. Since B's costs are lower for quantity < 5, B produces the first 5 units of output and A produces the rest. If Firm A produces all of the output alone there will be no producer surplus and we lose the surplus that can be obtained by allowing Firm B to produce 5 units of output. $q_a = 190$ $q_b = 5$ $p_a = 0$ $p_b = (5)(5) - [0.5(5)2] = \$12.5$

(d) Compare firm output, total output and price for parts (a) through (c). Do your values make sense?
As expected, we observe more production and a lower price when social welfare is maximized. When Firm A can move first it produces more than it does in the Cournot case, implying a first-mover advantage. We find a similar effect if B moved first compared to the Cournot case.

3. Suppose a perfectly competitive labor market has a demand curve of $L^D = 120 - 2w$ and a supply curve of $L^S = 8w$, where w is the wage rate is dollars per hour and L is the quantity of labor in person-hours.

a) What are the equilibrium values of the wage and employment? Setting supply equal to demand gives $w = 12$ and $L = 96$.

b) Suppose the government imposed a minimum wage of \$14 per hour. Now what are the equilibrium values of the wage and employment? If the wage were required to be \$14, firms would hire $L = 120 - 2 * 14 = 92$. And, of course, w=14.

c) Repeat part a, assuming now that the market is a monopsony.
The total expenditure on labor, or $w(L) * L$ (where $w(L)$ is the inverse supply of labor) is $L^2/8$. Thus, the marginal expenditure on labor is $L/4$. Setting marginal expenditure equal to marginal benefit (the inverse of the original labor demand) gives $L/4 = 60 - L/2$, or $L = 80$. The wage rate is found where $L = 80$ is on the labor supply curve, which is at $w = 10$.

d) Repeat part b, assuming now that the market is a monopsony.
The total expenditure on labor is $14L$ when the minimum wage is binding (i.e., values of L for which the inverse labor supply is less than the minimum wage of 14), which occurs when $L \leq 112$; and the total expenditure on labor is $L^2/8$ when the minimum wage is not binding, which occurs when $L \geq 112$. Thus, the marginal expenditure on labor is 14 for $L < 112$ and $L/4$ for $L > 112$. Setting the marginal expenditure on labor equal to the marginal benefit $60 - L/2$ gives $L = 92$. And, of course, $w = 14$.

e) Does the imposition of the minimum wage decrease employment here under perfect competition? What about under monopsony? Give a brief intuitive explanation for your answer and why it may be different under the two different market structures.

Imposing the minimum wage decreases employment under perfect competition but actually increases it in this case under monopsony. Monopsonists try to keep employment down to keep wages low, and imposing a minimum wage that forces wages to be high reduces their incentives to keep employment down. But the minimum wage reduces employment under perfect competition for the usual reason that firms will not be willing to pay for labor that has a value that is less than its price.

4. Suppose you face the following lottery. You can earn 1 of 3 possible grades in this class: an "A", a "C", or an "F", with the following probabilities: $\pi_A = \frac{2}{10}, \pi_C = \frac{6}{10}$, and $\pi_F = \frac{2}{10}$. Your current wealth (w) is \$400. If you receive an "A", you gain (e.g. I pay you) \$500. However, if you get an "F", you lose (e.e. you pay the) \$300. If you receiv a "C", you DO NOT GAIN OR LOSE anything. Assume your utility function, defined over wealth, is $U(w) = \sqrt{(w)}$.

(a) What is your expected utility (EU). [Hint: be sure to calculate your total wealth in each "state"]

$EU = \pi_A U(w_A) + \pi_C U(w_C) + \pi_F U(w_F)$
$w_A = 400 + 500 = 900$
$w_C = 400 + 0 = 400$
$w_F = 400 - 300 = 100$

$EU = \frac{2}{10}\sqrt{900} + \frac{6}{10}\sqrt{400} + \frac{2}{10}\sqrt{100} = 20$

(b) What is the certainty equivalent level of wealth ($w*$), that is, the guaranteed payoff at which a person is "indifferent" between accepting the guaranteed payoff and his expected utility from (a).
$U(w^*) = EU \longrightarrow \sqrt{w^*} = 20 \longrightarrow w^* = 400$

Recitation

11/19

P-Set 9 last one due 12/03/10
P-Set 8 review
Exam 11

#1. At first both have same MC

a) $MC_A = \$80$
$MC_B = \$50$

i) Cournot equilibrium
need to look how A's reaction function

$MR_A(Q_A, Q_B) = MC_A$
↑ if ↑ output MR will fall
both Qs will adjust

example
$Q = 100 - P$
$P = 100 - Q_A - Q_B$
$TR_A = Q_A(100 - Q_A - Q_B)$
$MR_A = (100 - Q_B) - 2Q_A$

$MR_A(Q_A, Q_B) = MC_A$
$(100 - Q_B) - 2Q_A = 50$

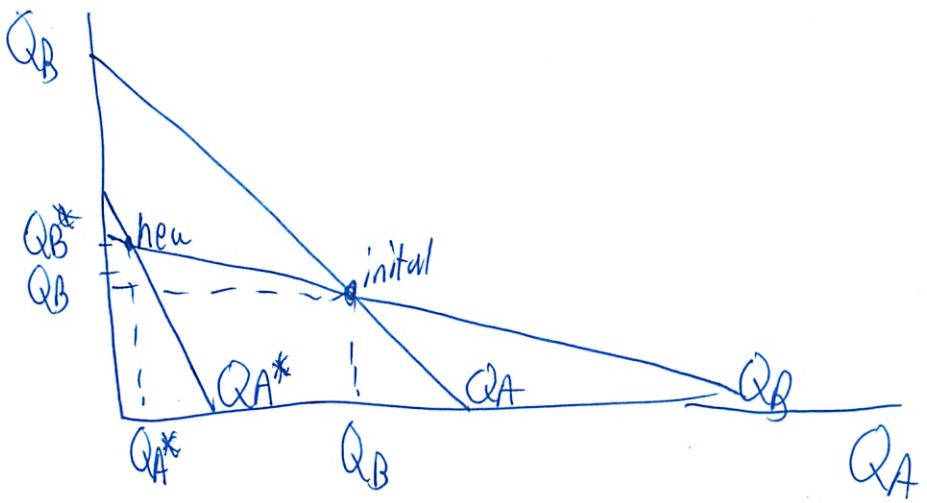
(2)

$Q_A = 25 - \frac{1}{2} Q_B$

$(100 - Q_B) - 2Q_A = 80$

So Q_A must fall

$Q_A = 10 - \frac{1}{2} Q_B$



Total output ↓

so price ↑

b) Collusive

Again, same example

$P = 100 - Q$

$MC = 50$

$MR = 100 - 2Q = 50$

$Q^M = 25 \quad P^M = 75$

(3)

$P = 100 - Q$

$MC_B = 50 \qquad MR_A = 80$

↑ Monopolist would shut this plant down

So nothing changes in this case

Note! Not in all cases: Monopolist w/ 2 plants if MC = linear

$MC_A(Q_A) = Q$ "Monopolist" wants to maximize profits

$MC_B(Q_B) = 2Q$

$\Pi(Q_1, Q_2) = (Q_1 + Q_2) \cdot P(Q_1 + Q_2) - \int_0^{Q_1} Q_1 \, dQ_1 - \int_0^{Q_2} Q_2 \, dQ_2$

What is profit maximizing decision

$MR(Q_1, Q_2) = MC_1(Q_1)$ So make decision for each plant

$MR(Q_1, Q_2) = MC_2(Q_2)$

---

iii) Bertrand

$P_A = 80$

$P_B = \$80 - \varepsilon \qquad \varepsilon > 0$

↑ very small

And everyone would buy from B

Part a was hardest

(4)

b) Suppose MC for both firms ↑

i) Cournot
- both reaction curves shift in
- both ↓ Q
- so ↑ P

ii) Collusive
- MR = MC
- Q ↓
- P ↑

iii) Bertand
- ~~P~~ P = 80
- both Q ↓
- both producing evenly

c) Demand curve shifts to the right (all assume linear demand curve)

i) Cournot
- both reaction functions shift out
- both firms produce more
- price ↑ ~~(in linear case)~~

ii) Collusive
- Q ↑ P ↑

iii) Bertrand ~~firms~~ firms still produce at MC

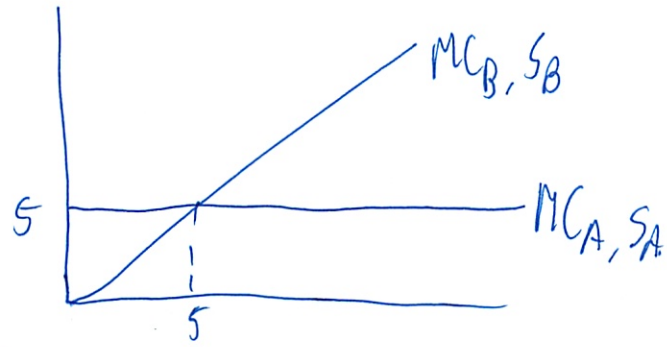
(5)

2c) A+B fairly standard
(I asked this in OH)

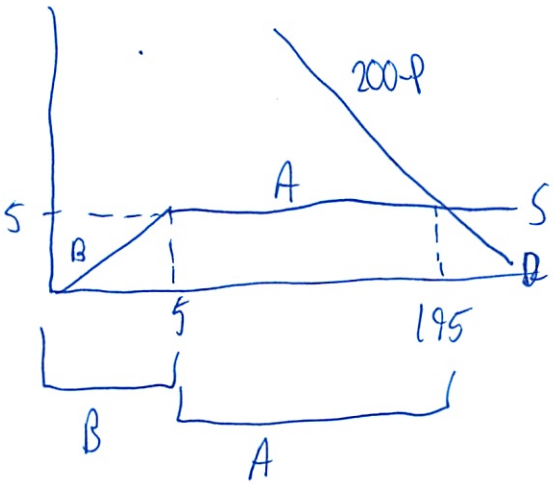
$MC_A = 5$

$MC_B = q_B$

- price takers what if



So then market supply
- add the curves



$Q_B = 5$ $Q_A = 190$

(6)

3. $L = 120 - 2w$

$L_s = 8w$

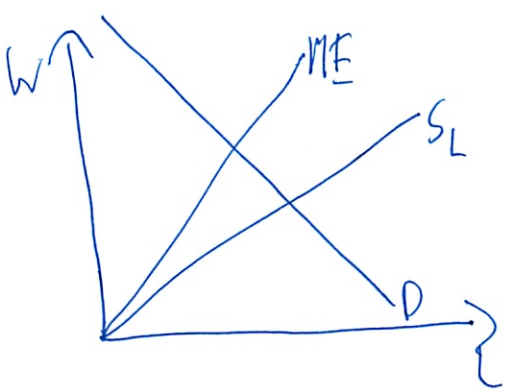
Find profit maximizing decision of monoposint

$w = 60 - \frac{1}{2}L$ inverse ~~supply~~ demand

$w = \frac{1}{8}L$ inverse supply

$TE(L) = \frac{1}{8}L \cdot L = \frac{1}{8}L^2$

$ME = \frac{1}{4}L$



$ME = \frac{1}{4}L = 60 - \frac{1}{2}L$

$\frac{3}{4}L = 60$

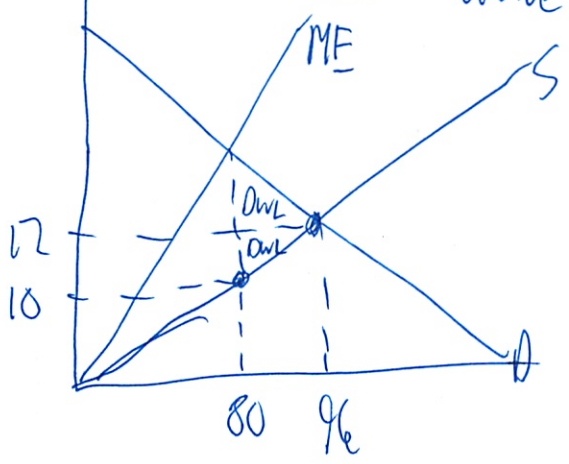
$L^m = 80$

$w = 10$

(7)

b) Add min wage

- Can decrease distortion
- But isn't min above Competitive

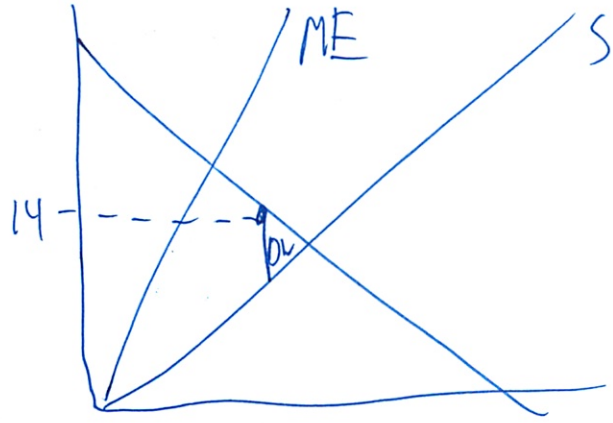


DWL = DWL from Monopsonist

Min wage set at 14

Would demand 92

DWL lowered



DWL exists, but smaller

- same as competive amount

$12 would have been better

So now DWL(Competive, $14 min wage) = DWL(monopsonist $14 min wage)

(8)

What if min wage at $11

- no competive D/L → below min wage market wage → no effect
- ~~makes monopsonist over~~
- Monopsonist, would demand more than it can get "labor shortage"

---

4. Risky income stream

$\frac{2}{10}$ $w = 900$

$\frac{6}{10}$ $w = 0$

$\frac{2}{10}$ $w = 100$

$u(w) = \sqrt{w}$

$E[u] = \frac{2}{10}\sqrt{900} + \frac{6}{10}\sqrt{400} + \frac{2}{10}\sqrt{100}$

$= 20$ "utils"

$u(w^*) = E[u]$

$\sqrt{w^*} = 20$

$w^* = 400$ ← indifferent in 400 check + risky income stream

(9)

Exam #2 part a

$$Y = f(x) = \begin{cases} 0 & x=0 \\ 8 & x=4 \\ 9 & x=7 \\ 16 & x=12 \end{cases}$$

$$C(y) = \begin{cases} 0 & y=0 \\ 4 & y=8 \\ 7 & y=9 \\ 12 & y=16 \end{cases}$$

b) Find individual supply curve

$p = MC$

? but is none

can't differentiate

~~Only works for~~

? get this from profit maximing equtions

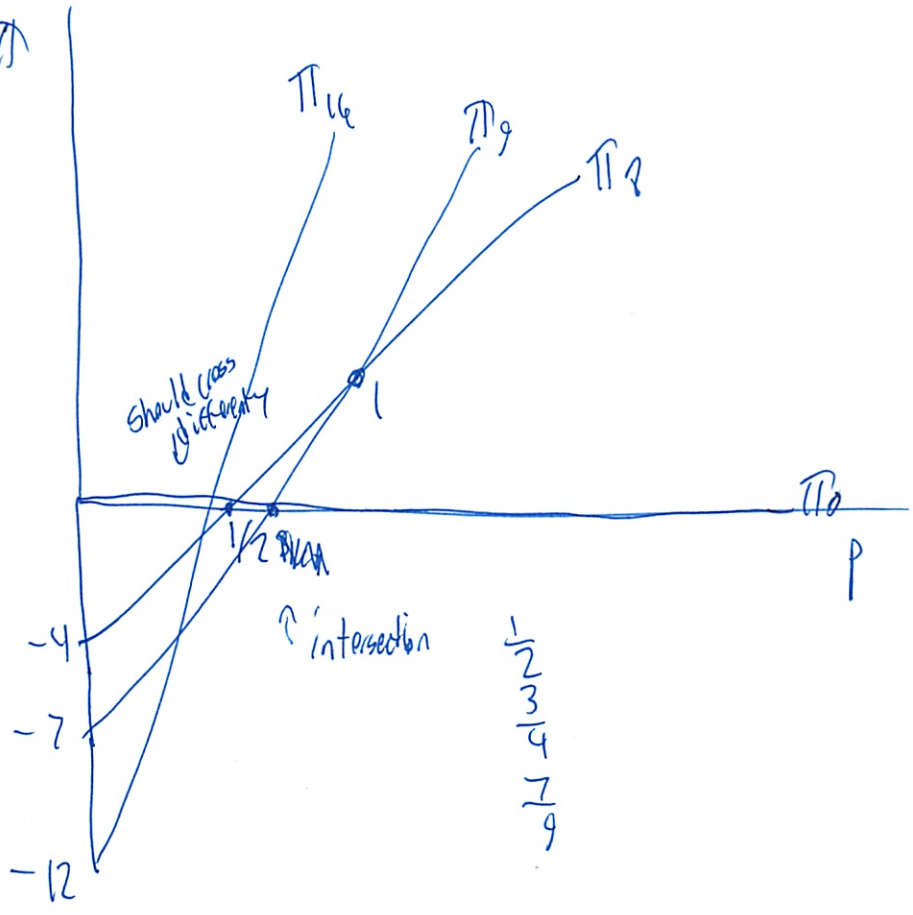
$\pi_0 = 0 - 0 = 0$

$\pi_8 = 8p - 4$

$\pi_9 = 9p - 7$

$\pi_{16} = 16p - 12$

(10)



will never produce 9 units

$$S(p) = \begin{cases} 0 & p < \frac{1}{2} \\ 8 & \frac{1}{2} \le p \le 1 \\ 16 & p > 1 \end{cases}$$

Michael E Plasmeier

From: Plamen Toshkov Nenov <nenov@MIT.EDU>
Sent: Friday, November 19, 2010 12:45 PM
To: Plamen Toshkov Nenov
Subject: [Friday 10] monopsony and minimum wage

Hi all,

In class today we talked briefly about what happens to the monopsonist demand for labor when the minimum wage is set below the perfectly competitive wage level. I told you that the monopsonist would demand more labor than would be supplied at that minimum wage and there would be a shortage. That's not quite so, the monopsonist would actually demand as much labor as it is supplied at the minimum wage. The reason is that with a minimum wage, the monopsonist's marginal expenditure curve becomes constant at the minimum wage up to the quantity of labor supplied at that minimum wage. At that point it jumps to the original marginal expenditure curve of the monopsonist (without the minimum wage) since in order to higher one more worker the monopsonist now has to increase the wage rate above the minimum wage for all the workers he's hired up to that point, which greatly increases the additional expenditure on the next worker. However that section of the marginal expenditure curve is above the demand curve of the monopsonist. As a result the monopsonist demands labor only up to the quantity of labor supplied at the minimum wage. I'll go over this again next time.

Have a good weekend and a good Thanksgiving break.

Plamen

Lecture 21: Capital

11/22

- input to production function
- more about where capital comes from: take finance classes 15.401
- Capital * diversion of current consumption to future production + consumption
- first example: planting grain seeds
- capital market - pool of capital firms can tap into
  - comes from household's decisions on how much to save
- capital: built up from household savings
  drawn down by firms investing
- downward demand, upward supply → like normal
- price = i the interest rate "the price of money"
- at high i, high supply, low demand
- equilibrium money in = money out of pool
- w/ producer theory: we found what k^* should be

Intertemporal Choice - for households

Consumption today vs consumption tomorrow
like 2 different goods
save

(2)

Savings - loan $ at to companies
get it back with interest rate

But you don't loan out $ directly
- go via banks (financial intermediaries)
- you "loan" $ to the bank
- can purchase stocks, mutual funds
- bonds - a direct loan
- assuming stock is sold direct from company

→ Simplify: get effective interest i

For every $1 I divert today, I get back $(1+i)$ next year

Figure 21-2

Wage = price of leasure

i = price of current/first period consumption
- we don't model savings - since its a bad
- so model consumption

Figure 21-3 - interest rate ↑

Substitution + income effect (see graph)

Can tell which is stronger

Unlike goods, we don't really know - empirical econ does not know
↑ w/ giffin goods

(3)

How capital markets work?

Present Value (PV)

- a $ today is worth more than a $ tomorrow
- have the opportunity to save

* Can't just add up $ amts over time *

must "discount" / "translate" future $ to PV

- value of any future $ valued today
- will always be < 1

$i = 10\% = .1$

Want 100 in period 2

$PV_1 = PV(1+i)$

$= PV(1.1)$

$100/1.1 = 90.9$ after periodicity of interest rate (usually year)

$$PV = \frac{FV}{(1+i)^t}$$ ← year get the $

interest rate is the converter function

$$PV_{\text{Annuity}} = f\left[\frac{1}{(1+i)} + \frac{1}{(1+i)^2} + \dots + \frac{1}{(1+i)^t}\right]$$

(4)

Easier to write if payments go on forever
- perpituity

$$PV_{\text{Perpitily}} = \frac{f}{i}$$ (just taking the ∞ sum)

Flip around to Future Value (FV)
value of
- getting a stream of payments
- what will it be worth?
- you are able to save it along the way
  - get interest on principal + interest on interest
    ↑ Companding

$$FV = f \cdot (1+i)^t$$

- [redacted]
- Companding: the more you save now, the more ya will have later

---

Inflation
- we talked about the nominal interest rate
  - the posted dat
- real - how much it can buy
  - how many goods can your $ buy

(5)

if everything costs 10% more, then your 10% interest rate means real change = 0

real = nominal − inflation

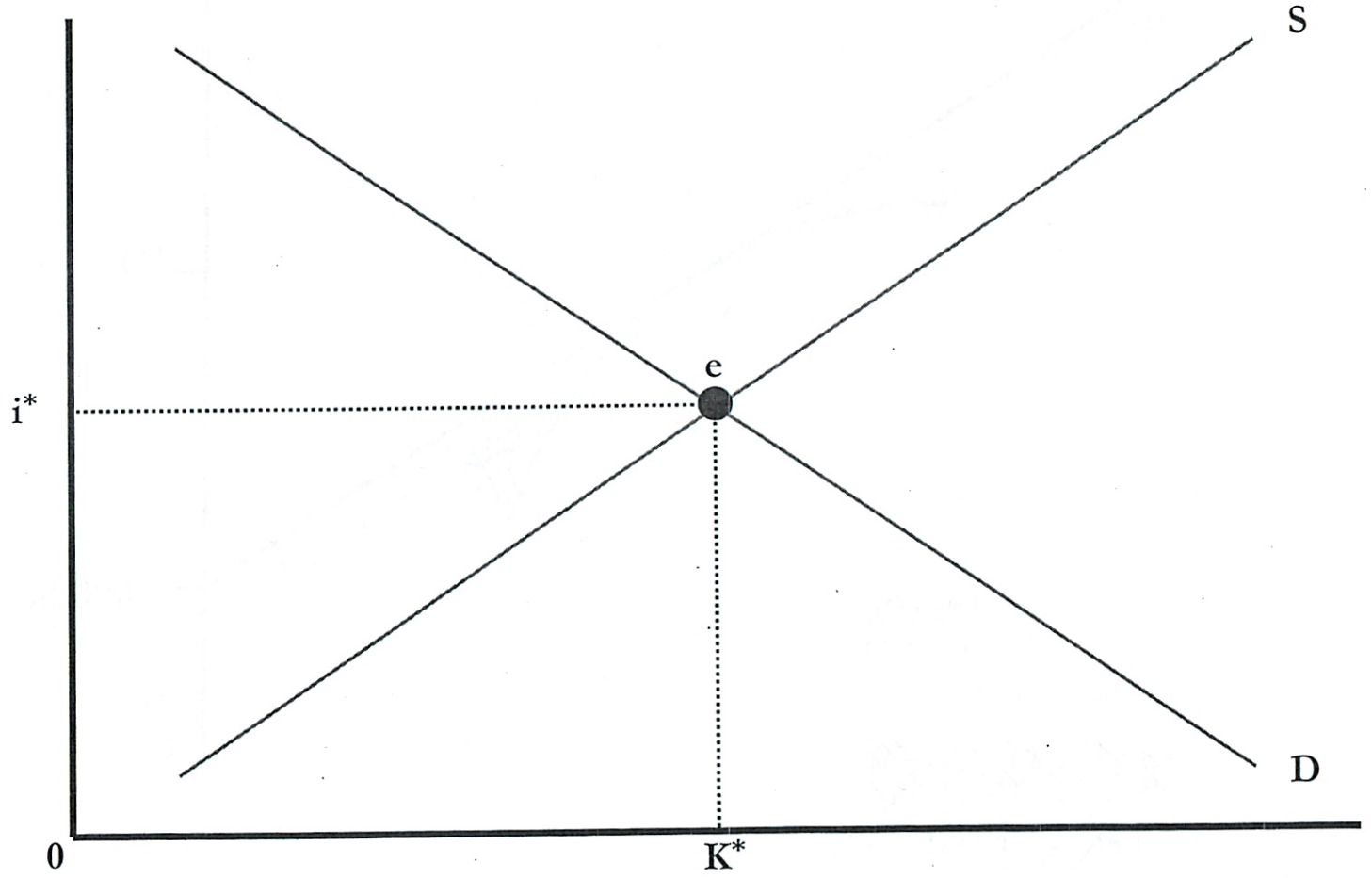
~~So primary~~ primary diver of bank interest (↓nominal) = inflation rate

today inflation ~ 0

~~So nominal interest rate~~

11/22

Figure 21-1: Equilibrium in capital markets



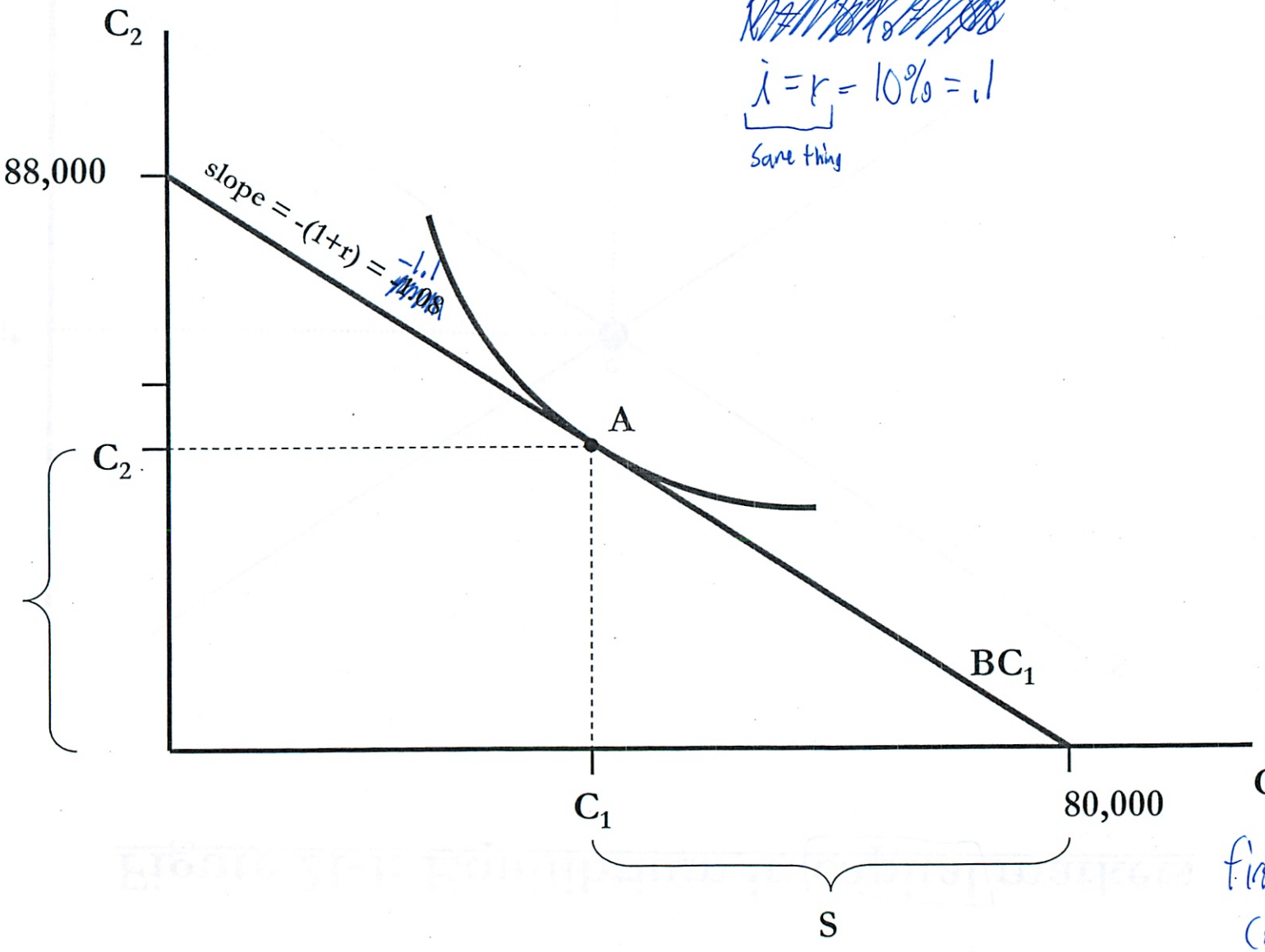
Lecture 21

Figure 21-2: Intertemporal substitution

here period = year

$i = r = 10\% = .1$

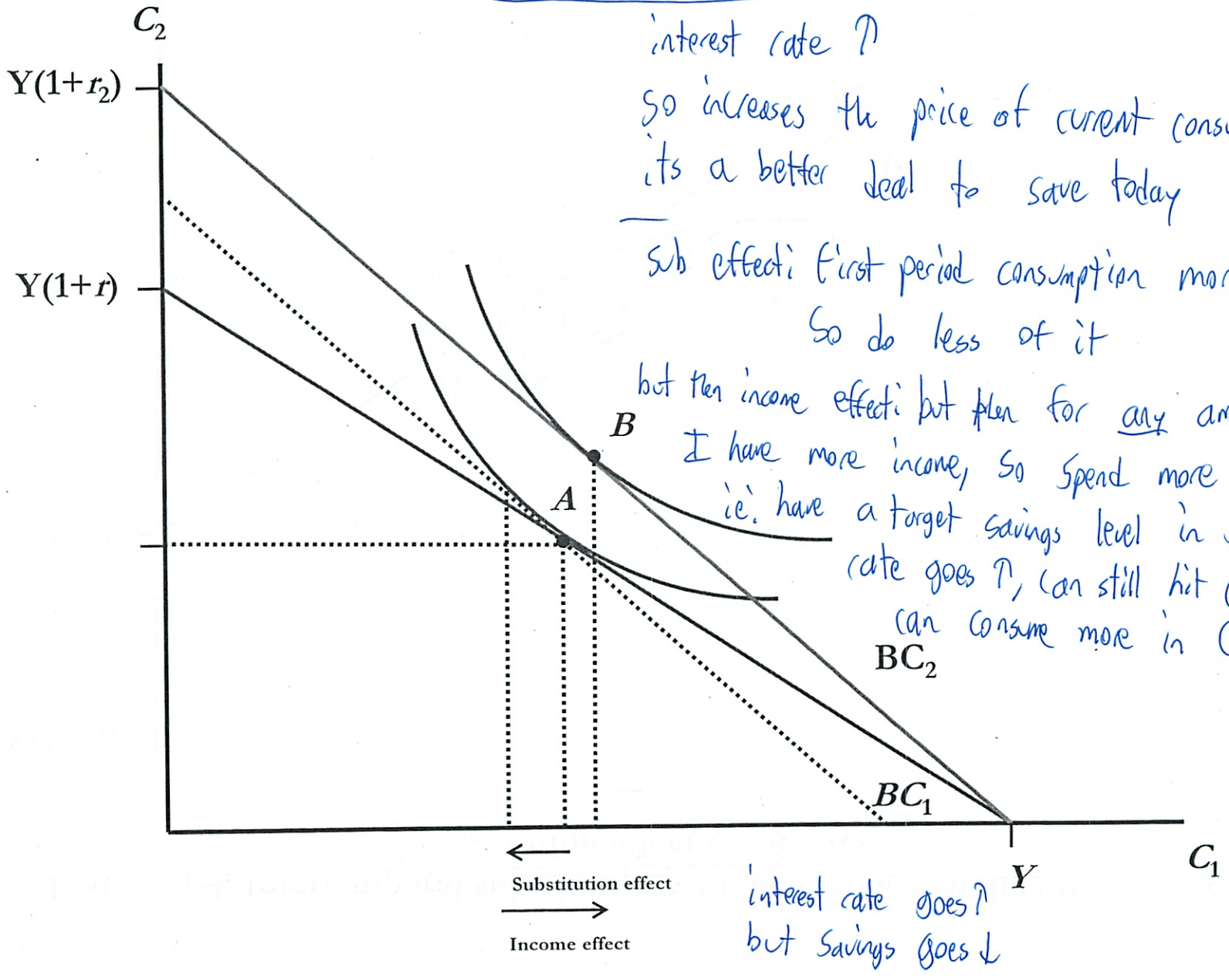
same thing



2nd period

first period consumption

Figure 21-3: Intertemporal substitution with an increase in the interest rate: income effect dominates



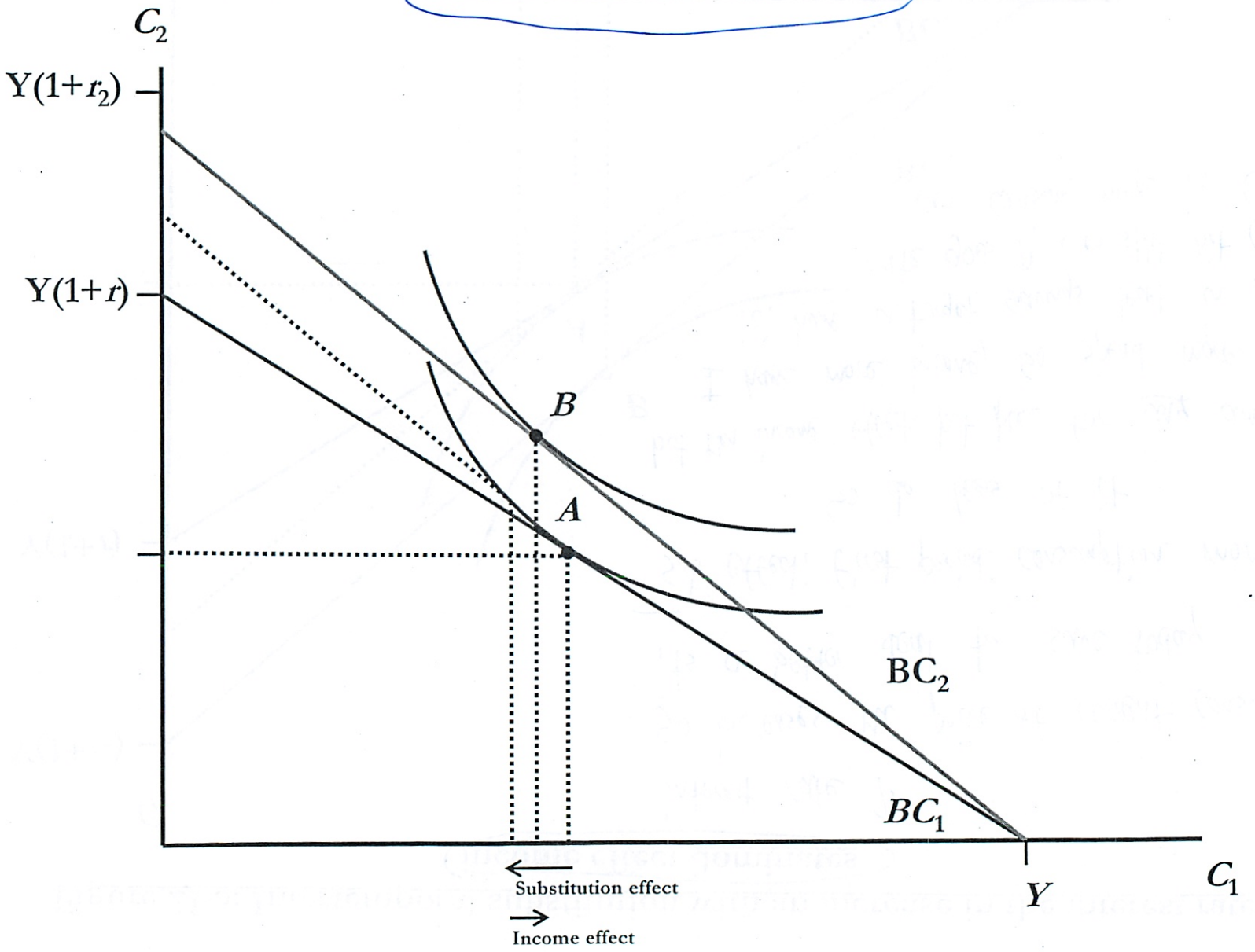
interest rate ↑
so increases the price of current consumption
its a better deal to save today

sub effect: first period consumption more expensive, so do less of it

but then income effect: but then for any amt of savings, I have more income, so spend more
ie. have a target savings level in $ amt, if rate goes ↑, can still hit C_2 $, but can consume more in C_1

interest rate goes ↑
but savings goes ↓

Figure 21-4: Intertemporal substitution with an increase in the interest rate: substitution effect dominates



Lecture 22 Capital Cont

11/24

talked about financial capital

today: Making choices over time

* must compare their PV
- future value of $ always less

Athlete offered 2 contracts

A = $1 million today

B = $.5 " " , $2 mill 2 years

$$PV = 1 \text{ million}$$

$$PV_B = 500{,}000 + \frac{2}{(1+r)^{16}}$$

Does depend on what you think interest rate will be

if $r = 5\%$ PV $1.73 million

$r = 20\%$ PV $.82 million

If you win the lotto, it turns at to be less than you think it will be. Must discount on PV.

How big a deal it is depends on interest rate

(2)

How do firms + individuals make investment decisions?

- Compare cost vs benefit
- net present value
  - must layout $ up front
    debt now vs credits in the future

$$\rightarrow NPV = (R_0 - C_0) + \frac{(R_1 - C_1)}{(1+r)} + \cdots + \frac{(R_t - C_t)}{(1+r)^t}$$

- basically if > 0 → good investment
- Chart

Year	Revenue
1	−100 ← buy
2	200 −50 (↑ maintenance, ↑ earn)

$$NPV = -100 + \frac{(200 - 50)}{(1+r)}$$

Now it depends on what the interest rate is?

* Different firms get different interest rates
  - called the opportunity cost of $ to firm
  - what is the next best use for the firm

(3)

So you list at investment opportunities best to worse
Fund them going down the list

If they need to borrow $ then the cost is what the bank charges you.

Firm considers all possible sources of lending $

Prof Gruber's Non-Insulated House

- Current heating bill $2000/year
- insulation costs $4000/year
- would save $500/year

$$PV = -4000 + \frac{500}{(1+r)} + \frac{500}{(1+r)^2} + \dots$$

(-4000: no savings year 1)

- what are other uses of $
- how long will have house for?
  - ↳ if forever $-4000 + \frac{500}{r}$
- or if you sell the house

$$-4000 + \frac{500}{(1+r)} + 10000$$

↑ in a perfect world, with house ∞ then people would pay this

- how will heating bills change?

Investing in Human Capital

- People investing in education
- to invest in long-term productivity?
- if don't go to college 18-70
- " " " " 22-70
- College costs $10,000/year
- Cost twofold: pay cost + forgo earnings
- HS Diploma $20,000
- College " $30,000
- figure 22-1
- What is the discount rate you face -
  - opportunity cost of $
  - saved at some interest rate
    - very low now
  - have to borrow in addition
  - with today's interest rates, it makes good sense to go to college

(5)

Increasing Savings

- Why do we care about it
- Savings is engine of capital in the US

S↑ = shifts out capital market supply curve

so r↓ (lowers price of borrowing)

So more people invest

all investments have a higher NPV

more people willing to invest

Engine of growth

The problem is we don't save much in US

US 3% -was negitive for a while

China 30%

of disposable income

China has grown much faster than US

So huge public policy to encourage savings

- lots of subsidies to retirement savings
- interest rate in bank is taxed
- helps raise $ for gov so ~~net~~ net effects unclear

Gov deficit included ✓ b/c

(6)

Assume substitution effects dominate

So would make sense for gov to encourage savings w/ tax

Retirement plans are tax deffered

- pay taxes later

Paying taxes in future is better than paying taxes today

Example

70 year old

will save for 1 year

Gets $100

Can put in bank or pension

$r = .10$

$t = .25$

bank: $100 - (100 \cdot .25) + (75 \cdot .10) - (75 \cdot .10 \cdot .25)$

(tax; interest; tax on interest)

$100 - 25 + 7.50 - 1.88 = 80.22$

pension $100 - 0 + (100 \cdot .10) - (110 \cdot .25)$

(tax; interest; tax on total)

$100 + 10 - \quad = 82.50$

(7)

In 30 years - could have 2x amt of $

Do you earn interest on a pension?

3 retirement plans

- pension - they control investment
- 401(k) - you control investment

< defined benefits - old style
defined contributions - what he described - almost all firms have this

- IRA - operate outside employment setting
  - just a lable for retirement savings
  - can have anything in there
  - if income > 75,000 don't get the tax break

Is it worth it?

- if you take out before retire, then tax penalty
- need different types of savings
- don't leave yourself w/ no $ in the bank

In real world savings depend on lots of stuff

- precaution - w/ lots of risk you save more
- people save less w/ gov programs that protect risks
- if default sign up

(8)

Some firms automatically sign people up, unless yn say no

Before inital sign up rate 25%

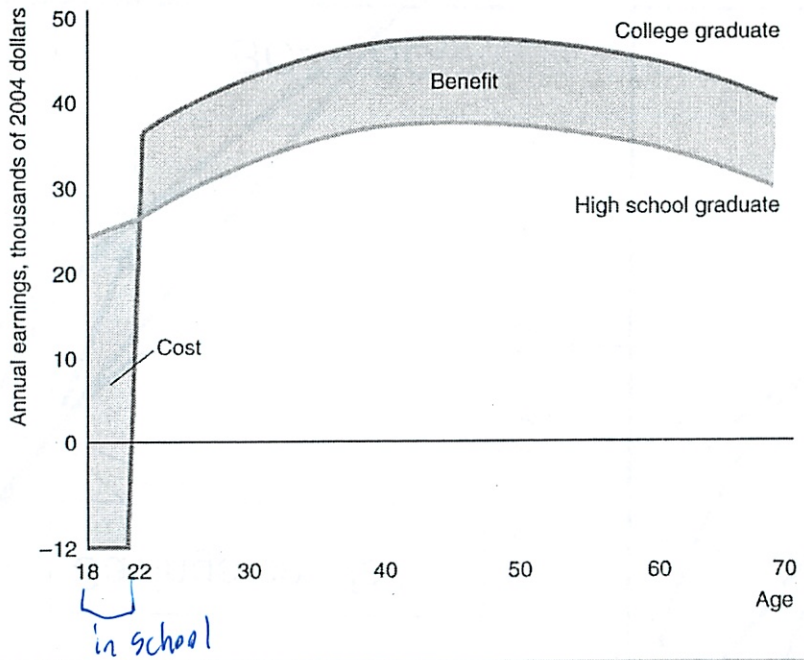
after 75%

Econ more than prices - also psychology

Behavioral factors

Could raise savings and save gov a lot of $

Figure 22-1: Present value of education



in school

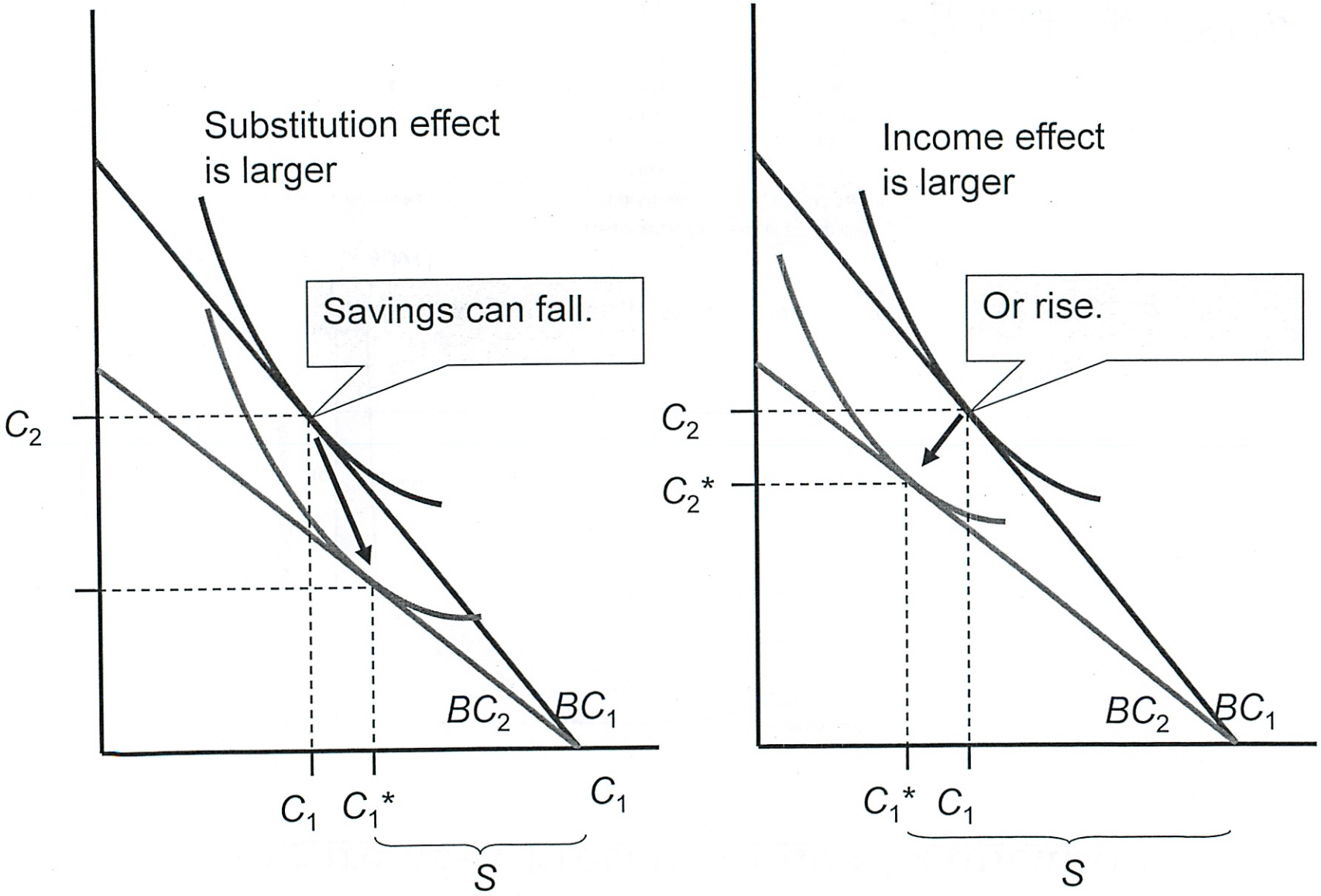
Discount Rate, %	Present Value, Thousands of 2004 Dollars	
	High School	College
0	2,088	2,583
1	1,506	1,807
2	1,126	1,302
3	871	965
4	694	733
5	568	569
5.1	560	560
6	475	450
7	406	362
8	352	295
9	310	243
10	276	202

- If discount rate is >5.1, then it does not make sense to college
  - Upfront benefits now so high
  - distant effects not much

Lecture 22

12/11

Figure 22-2: Tax subsidy to savings



Lecture 23

11/29

- Late 8 min

- Equity - Efficency Tradeoff

"Choosing b/w people"
- before choice over time
over consumption/leasure
over products

- Value transfers
- [redacted] facts
- Sources of leakage
- what gov decides

Socially optimal allocation of resource

Social welfare $= f(U_1, U_2, \ldots U_{350\text{ million}})$

Can make same indifference curve
- figure 23-1
- Same as previous curve

Jeremy Benthem Utilitarianism $SU = U_1 + U_2 + \ldots + U_{350\text{ million}}$
- linear
- Can maximize social welfare by giving it to the person who has highest utility
- is it fair? Just add up utilities
- but set MU =
  - is actually very radical; lots of redistribution
  - equalize income in society if individuals identical

(2)

The left does not like

Perfer Rawlsian function

- Maximize the well being of the worst off person in society

$SU = \min(U_1, U_2, \ldots)$

If everyone same → would have same effect

But if income not =, very radical

- Only cares about poorest guys

Nozichian

- On the right
- what should matter → = distribution of opportunities
  - what they do with it, is up to them
- How can a voluntary transaction lower social welfare?
- lots of merits
- but most of outcomes in society are due to luck
  - or unmeasurable things

- Depends on how we think income is distributed
  - skill
  - opportunities
  - luck

- No right answer here

(3)

Commodity egalitarianism

- mix of Rawls + Nozick
- Once you are past ~~poor~~ a minimum, we should not care
- absolty people at bottom have decent standard of living
- that you have enough to live a socially minimum acceptably life

---

w/ social welfare → lot more open ended

- akward
- How do we feel about that?

Society does have a very uneven distribution of income

- figure 23-2

Esp in the US

- figure 23-3
- Second most unequal nation - behind Mexico

Societies are always unequal

- Question of <u>how</u> unequal

Should we worry we are not maximing Utility?

Commodity egalitarianism ~~does~~ does not care about this ~~instead~~

↳ instead <u>Federal Poverty Line</u>

(9)

Looks at cost of market basket of enough food to live a nutritionally good life

Figure 23-4

Depends a lot on location

Has not taken care that people's consumption baskets change

Share of people in poverty

Figure 23-5

So by every standard (except Nozickian - hard to measure) we are failing in the US

Lots of reasons might want income distribution

And we are fairly un=, so might be good idea"

Most talk about it -> 4 frameworks

- under all would be uncomfortable w/ distribution

How to deal with?

- Redistribute!
- but leak in the bucket/tradeoff
  - shrinks the total size of social welfare
- 2 sources of leakage
  - rich people work less hard when they tax
  - poor people quit jobs to qualify

(5)

Lets say have society where everyone is ↓in taste =, all earn $20/week
- but may work diff # of hours
- not looking now at what reason is

Will give people a transfer

$$T = \max(0, 10{,}000 - Y)$$

↑ Income

↑ Brings people up to 10,000
Commodity eg alitarianism

Finance program w/ tax rate

$$T = \begin{cases} 0 \text{ if } Y < 20{,}000 \\ 20\% \text{ if } Y > 20{,}000 \end{cases}$$

Figure 23-6

Massively ↓ amt of labor supplied in society

Figure 23-7

Caused a DWL as both rich + poor work less hard

→ Is it worth it?
- solve the social welfare function
- after deciding which to use

6

Next time: what does the gov actually do?
what are the effects

11/29

Lecture 23

Figure 23-1: Isowelfare curves

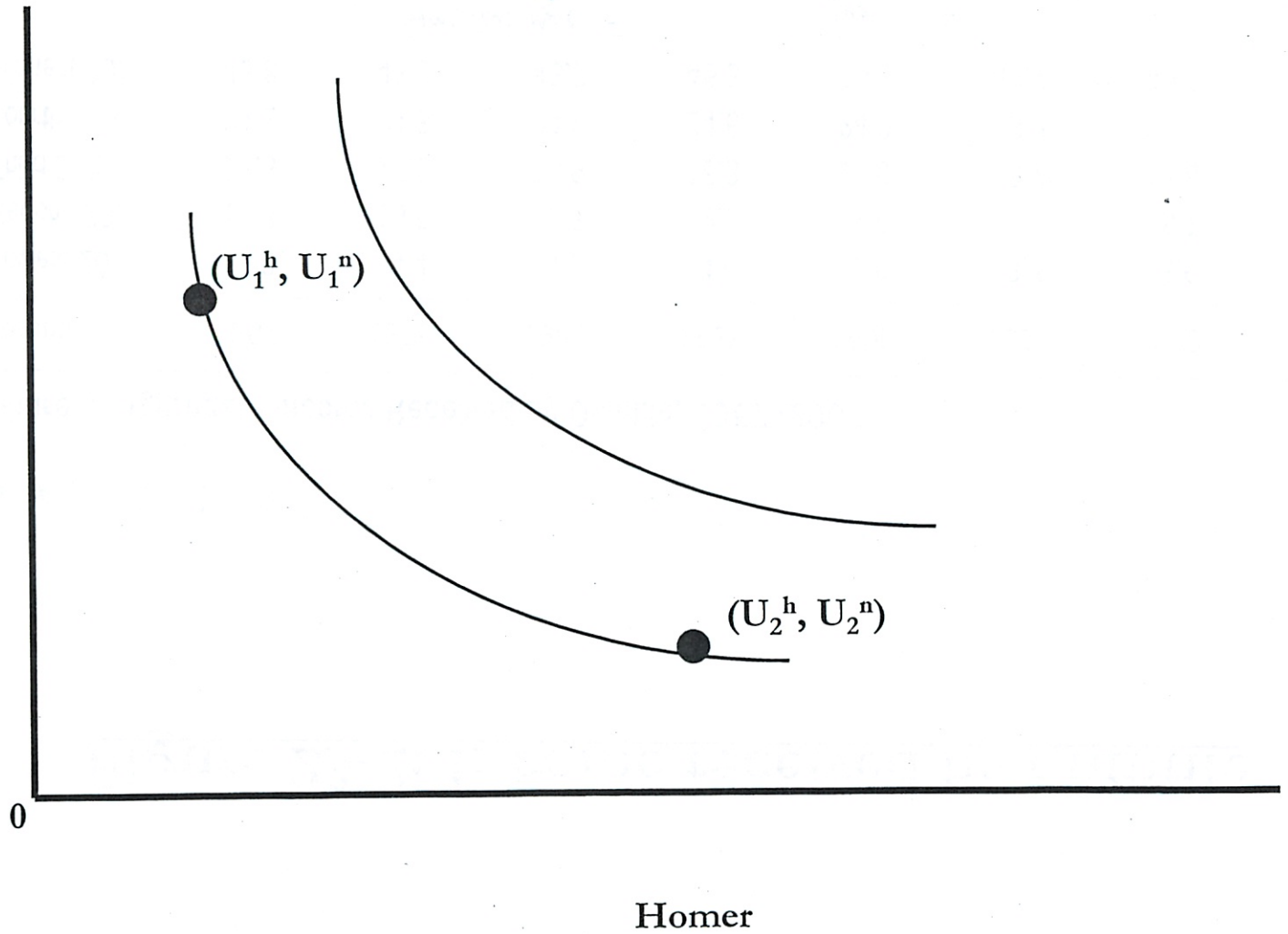


Figure 23-2: Income received by quintile

■ TABLE 17-1

Share of Aggregate Income Received by Quintile, 1967–2007

Income	1967	1975	1980	1985	1990	1995	2000	2007
Lowest 20%	4.0	4.4	4.3	4.0	3.9	3.7	3.6	3.4
Second 20%	10.8	10.5	10.3	9.7	9.6	9.1	8.9	9.7
Third 20%	17.3	17.1	16.9	16.3	15.9	15.2	14.8	14.8
Fourth 20%	24.2	24.8	24.9	24.6	24.0	23.3	23.0	22.4
Highest 20%	43.8	43.2	43.7	45.3	46.6	48.7	49.8	49.7

Somewhat more = less =

In 1967, the poorest 20% of households received 4% of the national income, and the richest 20% received almost 44%. Forty years later, the poorest 20% received 3.4% of the national income, and the richest 20% received nearly 50%.

unequal distribution

Figure 23-3: Income distribution in the OECD

■ TABLE 17-2

Share of Aggregate Income Received by Quintile of Households for OECD Nations

Country (year)	Income Quintile				
	Lowest	Second	Third	Fourth	Highest
Austria (2000)	8.6%	13.3%	17.4%	22.9%	37.8%
Belgium (2000)	8.5	13.0	16.3	20.8	41.1
Canada (2000)	7.2	12.7	17.2	23.0	39.9
Czech Republic (1996)	10.3	14.5	17.7	21.7	35.9
Denmark (1997)	8.3	14.7	18.2	22.9	35.8
Finland (2000)	9.6	14.1	17.5	22.1	36.7
France (1995)	7.2	12.6	17.2	22.8	40.2
Germany (2000)	8.5	13.7	17.8	23.1	36.9
Greece (2000)	6.7	11.9	16.8	23.0	41.5
Hungary (2002)	9.5	13.9	17.6	22.4	36.5
Italy (2000)	6.5	12.0	16.8	22.8	42.0
Korea (1998)	7.9	13.6	18.0	23.1	37.5
Luxembourg (2000)	8.4	12.9	17.1	22.7	38.9
Mexico (2002)	4.3	8.3	12.6	19.7	55.1
New Zealand (1997)	6.4	11.4	15.8	22.6	43.8
Norway (2000)	9.6	14.0	17.2	22.0	37.2
Poland (2002)	7.5	11.9	16.1	22.2	42.2
Portugal (1997)	5.8	11.0	15.5	21.9	45.9
Slovak Republic (1996)	8.8	14.9	18.7	22.8	34.8
Sweden (2000)	9.1	14.0	17.6	22.7	36.6
Turkey (2003)	5.3	9.7	14.2	21.0	49.7
United Kingdom (1999)	6.1	11.4	16.0	22.5	44.0
Unweighted average	7.7	12.7	16.8	22.3	40.5
United States (2004)	3.4	9.7	14.8	22.4	49.7

Figure 23-4: Poverty line

■ TABLE 17-3

Poverty Lines by Family Size (2006)

Size of family unit	Poverty line
1	$10,830
2	$14,570
3	$18,310
4	$22,050
5	$25,790
6	$29,530
7	$33,270
8	$37,010
For each additional person, add	$3,740

A family of four with an income of less than $22,050 per year is considered to be living below a minimum acceptable standard in the United States.

Figure 23-5: Poverty rates over time

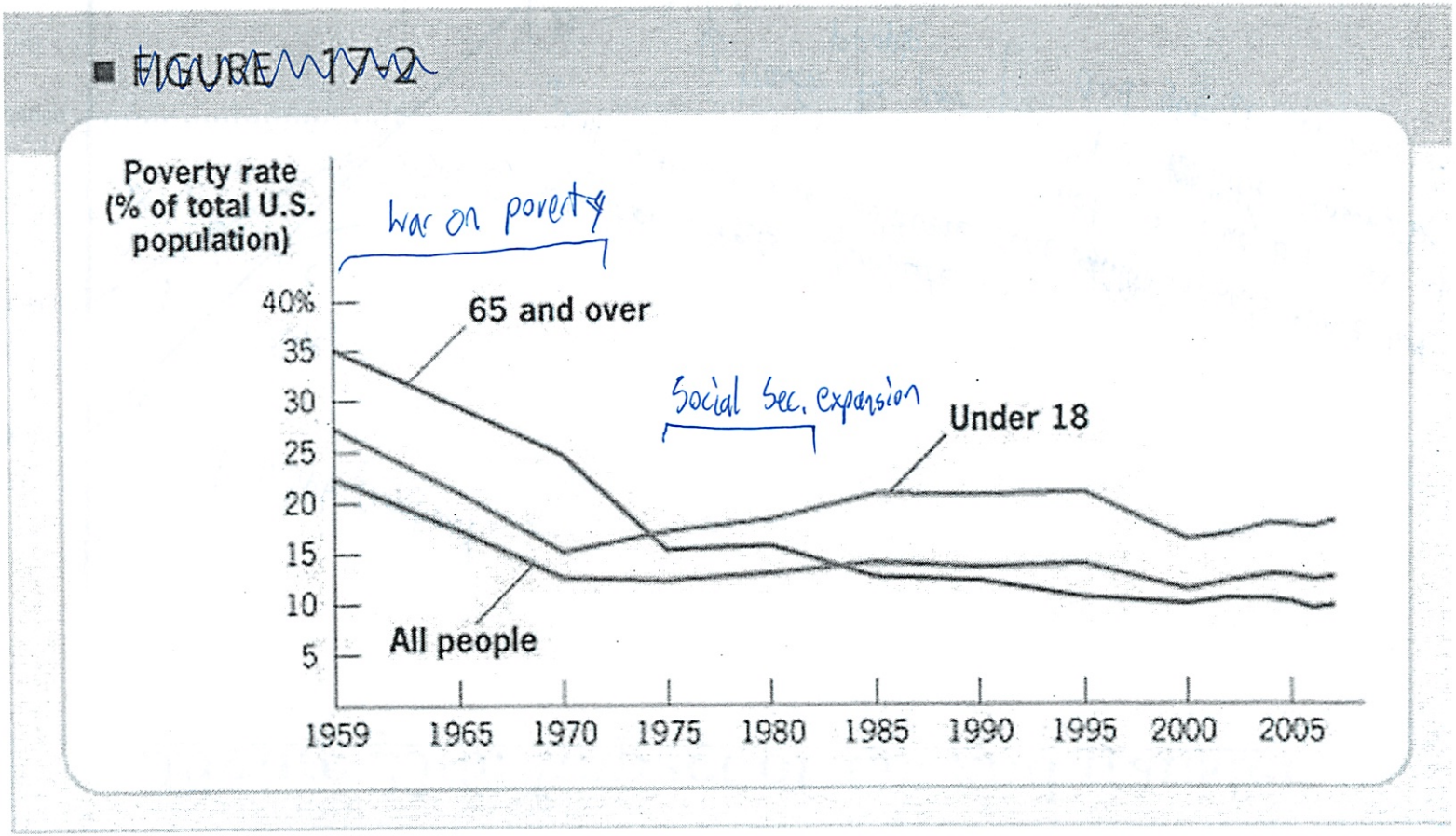


Figure 23-6: Impact of tax and transfer

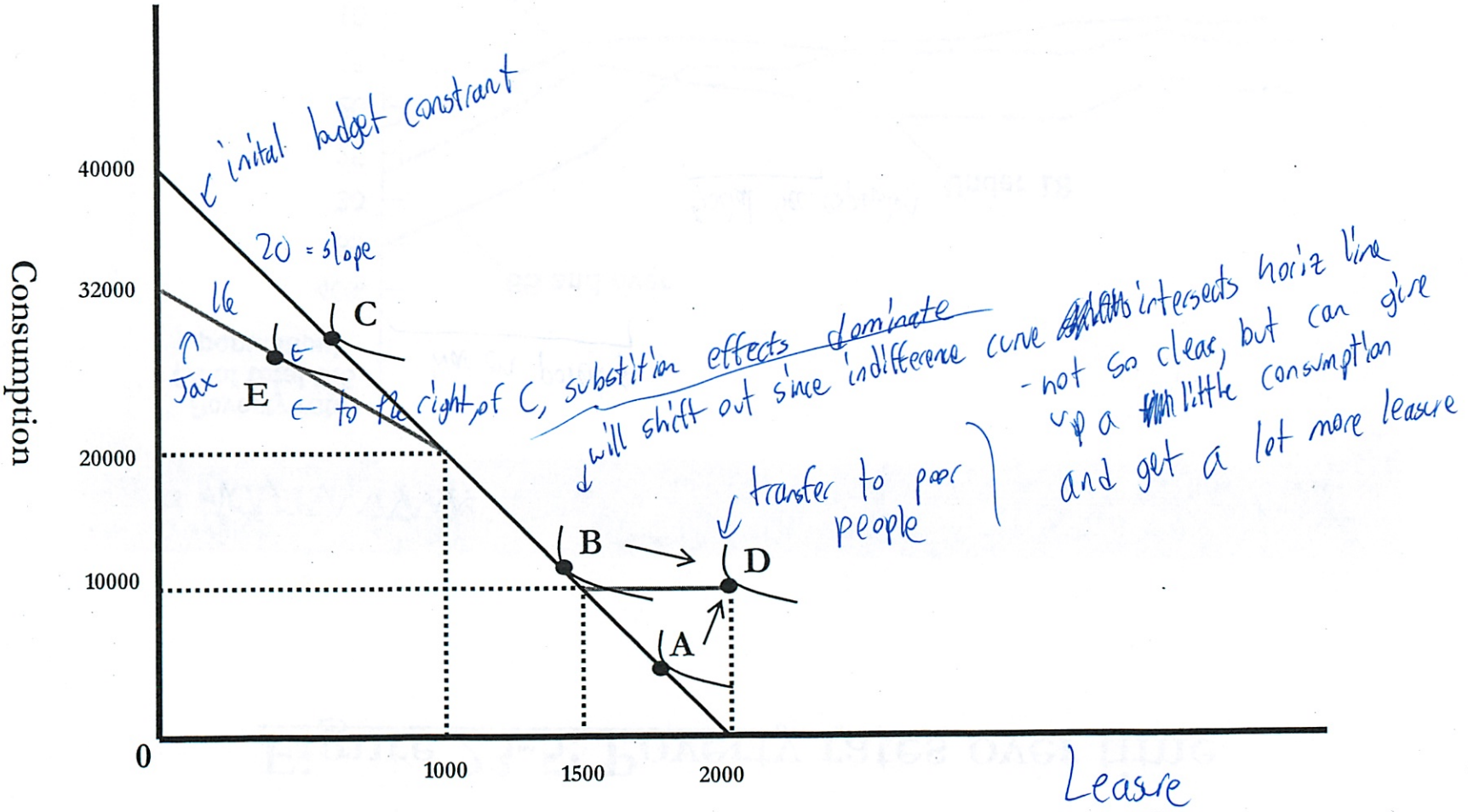
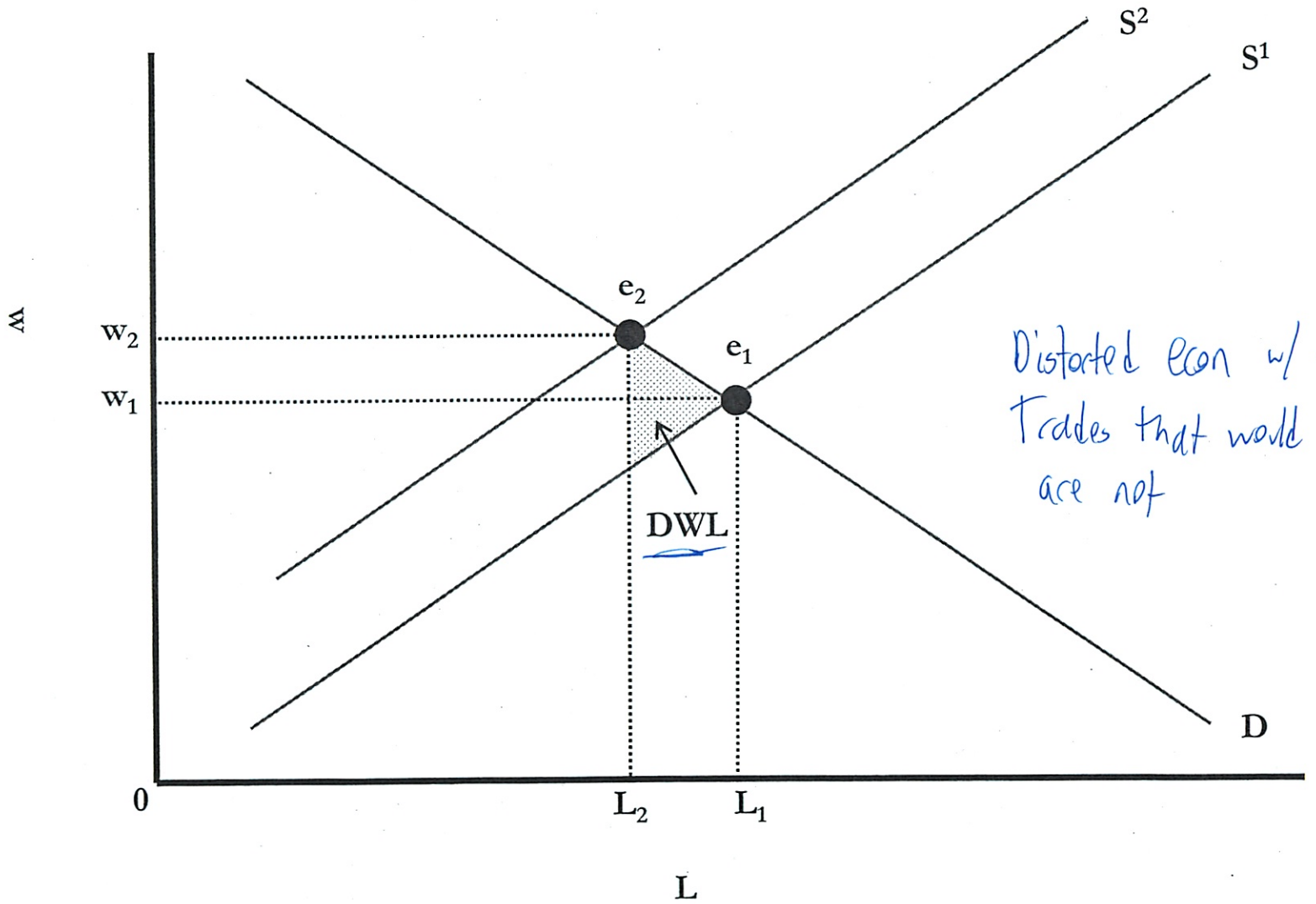


Figure 23-7: Labor market



Distorted econ w/ transfer system
Trades that would have happened are not

Lecture 24 Equity + Fairness Pt 2

12/1

- What govs do to redistribute wealth
- half the semester in 14.431
- Money in → tax
  - break down figure 24-1
- progressive - the richer you are, the higher share you pay
  - what you want if want to redistribute wealth
- Marginal tax rate 24-2
- payroll tax → Social insurance system
- consumption taxes → "indirect" - since taxed as use income
  - not when you make income
- property tax → based on wealth
- corporate tax
- In US ~20% of income paid to gov
  - varies widly though
- Gov spending ~24%
  - some structural → medical care so expensive
  - cyclical - in recession gov spends a lot, revenue down
- What should we tax?
  - Europe - mostly through consumption tax (VAT)
- Major argument for taxing consumption: promotes savings

(2)

Assuming substitution effects dominate, it will promote savings

Many economists like a consumption tax

Why not?

- equity / efficiency - falls very hard on the poor
  - rich people save a lot
  - poor + middle class generally sperd what they earn

In Europe they address this by progressivly spending

More subtile → excise taxiation of "sin" goods

- alchol
- cig
- gas
- goods that produce negitive externalities
  - hurt society by doing it
  - just hurting you → not a externality
  - second hand smoke
  - alcohol → drunk driving
  - Obesity - most interesting one going forward
    1/3 in our nation are obese
- since society bears cost, has right to impose tax

"corrective taxation"

(3)

If you think people don't understand full costs, then perhaps need tax to help them

- people not rational
- gov helping people help themselves
  - behavioral economics
    - new area
    - dangerous role of econ
    - 14.13 - 14.431 discuss

How much should we tax?

- what should tax rate be?
- big issue now w/ Bush tax cuts
- they expire in 1 month
- politicians very worried
- "I don't know if people are"
- Should we grab the extra tax $?
- What is income on economy?
  - Could be such a large issue that gov actually hurt
  - Laffer curve - figure 24-3
  - But what side are you on???
  - We are clearly on the correct size
  - DWL of taxation is 40%
    - leak in the bucket

(4)

Laffer curve wrong side would be > 100%

But now still some leak

How do we feel about equity vs efficiency

Democrats → raise for > 250,000

- raise $700. billion
- but would lose 40 cents on the dollar
- is it worth it for society?

Taking $ Out

Transfers

- Several types
- Categorical cash transfers "welfare"
  - $ sent to poor people
  - in US don't just send $
  - other qualifiers
  - TANF - need only 1 parent and poor
  - SSI - poor and disabled
- Why do we do this targeting?
  - Hazzards of just giving $ to poor people
  - People will become poor to qualify

(5)

If people would not change behavior, would be no inefficacy
So find things correlated w/ low earning ability
The trick is finding the targeting mechinism
- correlates w/ poor
- ideally i unchangable

Disability + single motherhood are fairly good targeting

Biggest issue i worker comp
- easy to fake getting hurt on the job

Disability today actually - many hard to measure
- back pain
- mental
- hardish to test

- Clear winner <u>EITC</u>
- transfer conditional on their work.
- the more you work, the more you get from gov
- figure 24-4
- targeted conditional tax credit
- rewards work
- effects complicated
-

(6)

Someone at $16,400 income

$16,400 + 5028 - 21428

but then earns $100 more) does not earn $100 more

$16,500 + 5007 = 21507

(MIT fin aid like this too)

If target, must somehow take it away

Here at the $16,400

Must look at empirical evidence

Has changed differently for # of kids you have

So can study

Goal part worked

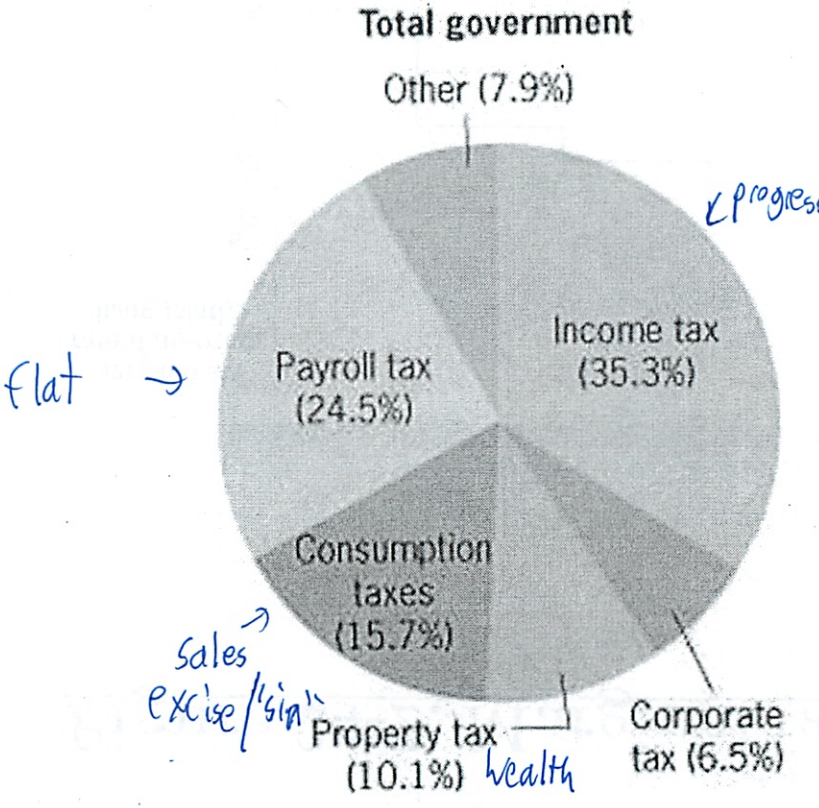
Downhill part has not hurt very much

- Why?
  - People don't control how much they work
    - boss picks your hrs
  - People don't really know how the program works
- Has maybe even added # to bucket at bottom
  - as people work
- But need to do better evaluating who truly can not work

12/1

Figure 24-1: Revenue by type of tax

Where get $ from



progressive

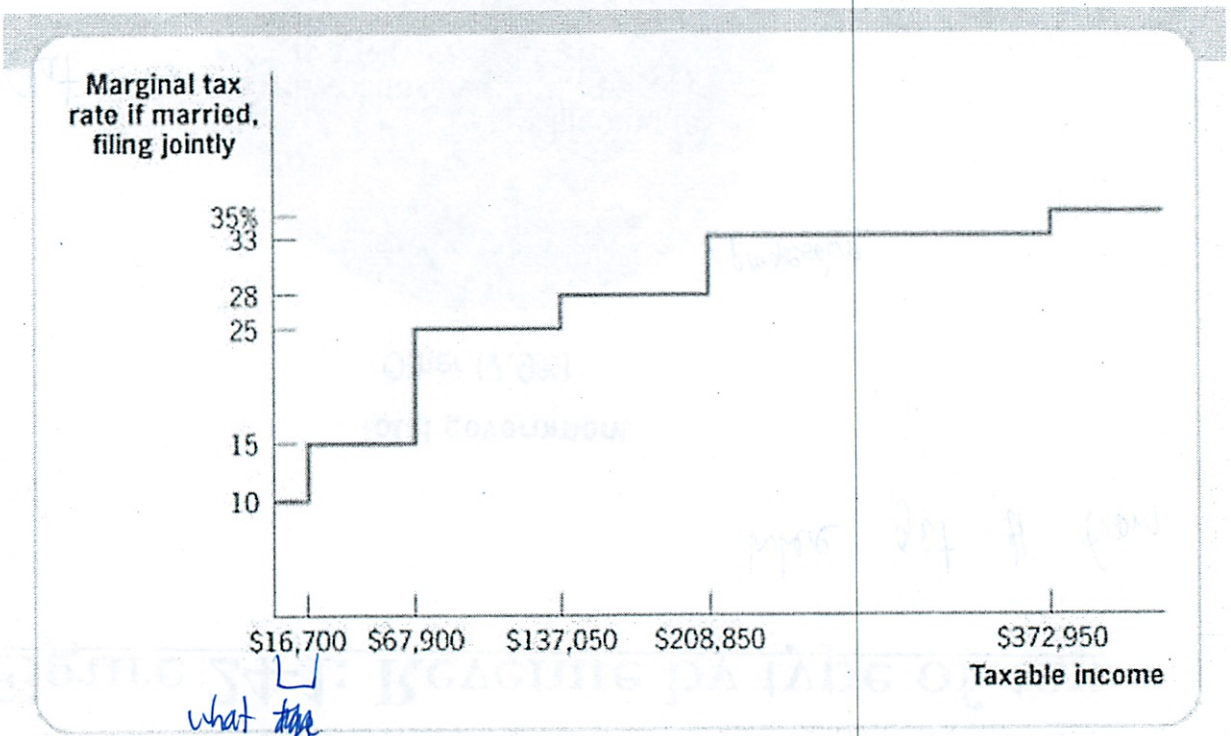
flat →

sales
excise/"sin"

wealth

Lecture 24

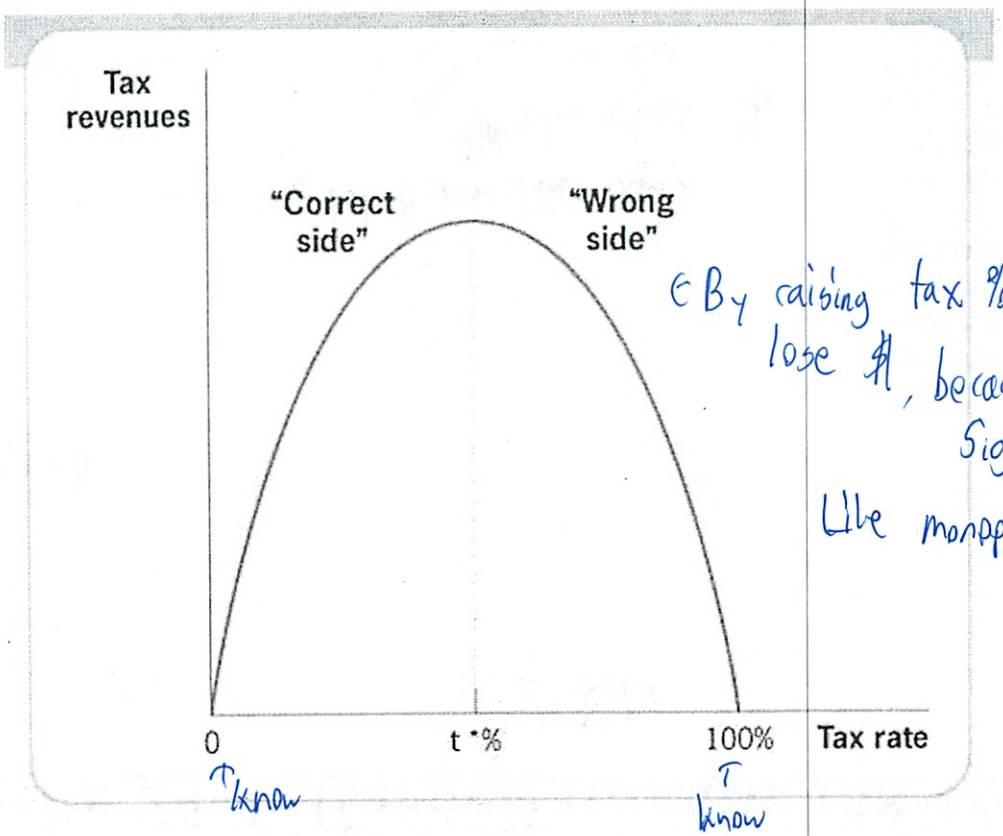
Figure 24-2: Marginal tax rates



Basic → marginal tax rate

what you pay on first 16,700

Figure 24-3: Laffer curve



↑ know

↑ know

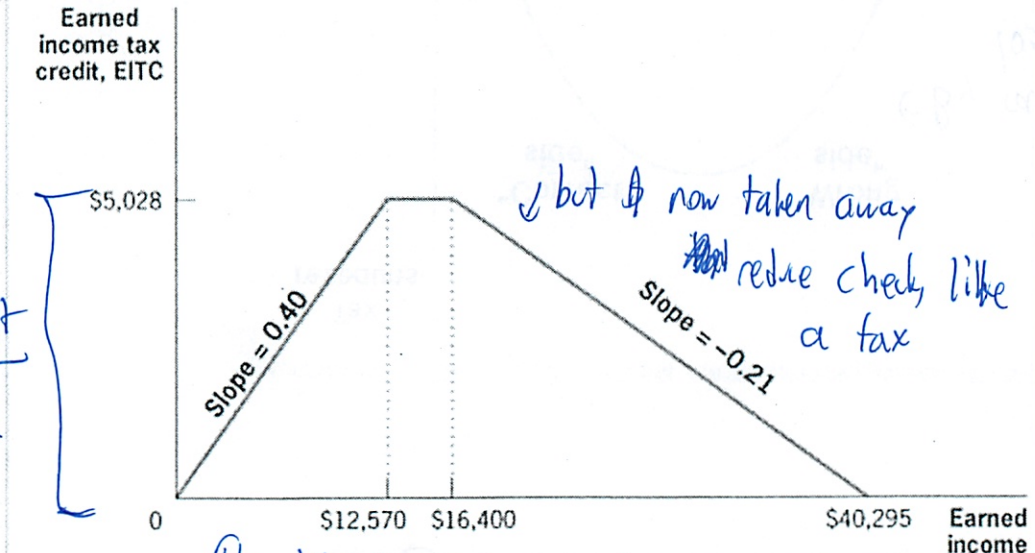
∈ By raising tax %, lose $, because tax base shrinks significantly

Like monopolist poisoning effect

Figure 24-4: Earned income tax credit

w/ 2 kids

■ FIGURE 21-5



payment check

✓ but $ now taken away reduce check, like a tax

? negitive tax get a subsidy actually

The Earned Income Tax Credit • For the first $12,570 of earned income, Stacey receives an EITC payment of 40¢ per dollar of earnings, to a maximum of $5,028. Between $12,570 and $16,400 of earnings, the EITC payment is flat at $5,028. From $16,400 to $40,295 of earnings, the EITC payment falls by 21¢ per dollar earned, until it reaches zero.

Michael Plesnia

12/3

14.01 Problem Set 9

1. (28 points) R&D and effect of government borrowing

A pharmaceutical company is considering whether to invest in the research and development of a new drug. It will incur a cost of $100 million starting in this year for 10 years, and it will get a patent that is worth $1.5 billion at the beginning of the 11th year. Alternatively to the R&D project the firm can expand advertising for an already existing drug, which will increase its profits by $10 million forever. The interest rate in the economy is 5% and is constant over time.

1. (7 points) What's the present value of the project? Write an expression for the net present value?
2. (7 points) Suppose that the internal rate of return on the project is 5.28%. Will the project be undertaken? Why?
3. (7 points) The government is considering increasing government consumption. Suppose that the market supply of funds is given by $Q_S = i$, where Q_S is funds supplied per year (in billion) and i is the interest rate. Market demand for funds is given by $Q_D = 10 - i$. The government is considering permanently increasing annual borrowing by $1 billion. Will the project get undertaken now? Why?
4. (7 points) Given your results in part (c) discuss why a fiscal expansion could hurt productivity growth in the long run.

2. (28 points) Intertemporal consumption and savings supply

Suppose that there are only 10 individuals in the economy each with the following utility function over present and future consumption:

$$U(c_1, c_2) = c_1 + c_2$$

where c_1 is consumption today, and c_2 is consumption tomorrow. Buying 1 unit of consumption today costs $1 today and buying 1 unit of consumption tomorrow costs $1 tomorrow. All individuals have income of $10 dollars today and no income tomorrow (they are retired tomorrow) but they can save at the market interest rate $r \geq 0$.

1. (7 points) What is the price today of one unit of consumption tomorrow? Why?
2. (7 point) Write an expression for an individual's budget constraint in terms of today's and tomorrow's consumption expenditure.
3. (7 points) How much of his income would an individual consume and how much would they save given the interest rate of r?
4. (7 points) Suppose that the market demand for funds is given by $Q_D = 100 - i$. What is the market supply for funds? What is the equilibrium interest rate that clears the capital market? What is aggregate consumption at that interest rate?

3. (15 points) Demand for flu shots

The demand for flu shots this season is given by: $P = 13 - 0.0005Q$. The marginal cost of a flu shot is \$8.

a) (5 points) In a competitive market, what are the equilibrium price and quantity of flu shots?

b) (5 points) The social benefit of flu shots is $SB = 13Q - 0.0005\frac{Q^2}{4}$ What is the socially optimal quantity in the market? Compare your result here to the quantity in part a) Explain any differences you see.

c) (5 points) What government policies could be implemented to achieve the social optimum in this case?

4. (29 points) Government Redistribution and Social Welfare

Consider an economy with only one good, food. There are three people in the economy, A, B and C. A has 400 units of food, B has 100 units and C has only 16 units. All have the same utility, $U_i = \sqrt{f}$ for $i = A, B, C$. The social welfare function for this society is the sum of the utilities of the three individuals.

a) (6 points) If each agent simply consumes his own endowment, what is the utility level for A, B and C? Find the social welfare level.

b) (8 points) The government decides to redistribute food more equally, so it takes 175 units from A and gives them to B. However, the government spoils 79 of these units in transportation, so B ultimately gets only 96 units of food. What is each persons utility level now? Find the social welfare level in this case.

c) (8 points) Assume now that the government considers a different redistribution scheme. Starting with the original endowments, the government takes 175 units from A. This time it wishes to give them to C, but in transportation it destroys 91units, so C only gets 84 of these extra units. What is each persons utility level now? Find the social welfare level in this case.

d) (7 points) Compare parts b) and c) in terms of social welfare. Note that the government is more wasteful in c) and explain your result.