DEMAND AND SUPPLY OF HEALTH INSURANCE

EE 474 Health Economics

Semester 2/2021

Topics

- What Is Insurance?
- Risk and Insurance
- Demand for Insurance
- Supply of Insurance
- Moral Hazard
- Health Insurance and the Efficient Allocation of Resources
- The New Theory of Demand for Health Insurance

Do You Have Any of these Insurances?

- Health insurance
- Car insurance
- House insurance
- Natural disaster insurance

Example of An Insurance

- There are 100 students in the student union.
- Suppose that 1 out of 100 students *randomly* gets sick and incurs health care costs of $5,000.
- Students worried about potential losses due to illness, so the student union decides to collect $50 from each student and put the $5,000 ($50*100) in the bank.
- If a member becomes ill, the fund is used to pay for the treatment.
- Thus, the $50 is paid to avoid the risk or uncertainty of having to pay $5,000 when ill.

Insurance Terminology (1)

- *Premium, Coverage*
  - Ex: Premium = \$50 (what the insured pays)
  - Ex: Coverage = \$5000 (what insurer pays out)
- *Coinsurance and Copayment*
  - Coinsurance is the *percentage* of loss paid by the insured when the loss occurs.
    - Ex: Suppose the coinsurance rate = 20% and the cost of health care is \$1000. So, the insured would have to pay \$200.
  - Copayment is the *fixed amount* paid by the insured when the loss occurs.
    - Often times, the copayment is fixed, regardless of the amount of loss.
- *Deductible* : Maximum amount the insured needs to pay out-of-pocket before the insurance policy starts.
  - Ex: The deductible is \$400.
    - If total loss = \$350, the insured pays the total amount.
    - If total loss = \$500, the insured pays\$400 and the insurer pays \$100.

Insurance Terminology (2)

- *Exclusions* : Services or conditions not covered by the insurance policy
  - Ex: Cosmetic or experimental treatments.
- *Limitations*: Maximum coverage provided by insurance policies.
  - Ex: A policy may provide a maximum of $3 million lifetime coverage.
- *Pre-Existing Conditions*: Medical problems not covered if the problems existed prior to issuance of insurance policy.
  - Ex: pregnancy, cancer, HIV/AIDS, chronic diseases
- *Loading Fees*: General costs associated with the insurance company doing business, such as sales, advertising, or profit.

Insurance vs. Social Insurance

- In this lecture, we will talk about *private* health insurance.
- (Private) Insurance
  - Provided through markets
  - Buyers buy insurance to protect themselves against rare events with certain probabilities
- Social Insurance- Government is the insurer:
  - Premiums are heavily and often completely subsidized.
  - Participation is constrained according to some eligibility rules.

Risk and Insurance: Expected Value

- Expected value is determined by summing the values of the various outcomes of an event times the probabilities that each outcome will occur.
- Example: the expected value (or expected return) of a coin toss game where you win \$1 if heads appears and \$0 if tails appears is:

$$\begin{aligned} EV &= Prob_{heads} * \$1 + Prob_{tails} * \$0 \\ &= 0.5 * \$1 + 0.5 * \$0 \quad \text{(assuming a fair coin)} \\ &= \$0.5 \end{aligned}$$

Expected Value (In General)

- With *n* outcomes, expected value E is written as:

$$E = p_1R_1 + p_2R_2 + \ldots + p_nR_n$$

  - p_i is the probability of outcome *i*, (i= 1, 2, .., n)
  - R_i is the return if outcome *i* occurs.
  - The sum of the probabilities p_i equals 1.

- St.Petersburg's paradox: How much would you pay to play coin toss game where you win \$1 if H, \$2 if TH, \$4 if TTH, \$8 if TTTH, etc.?

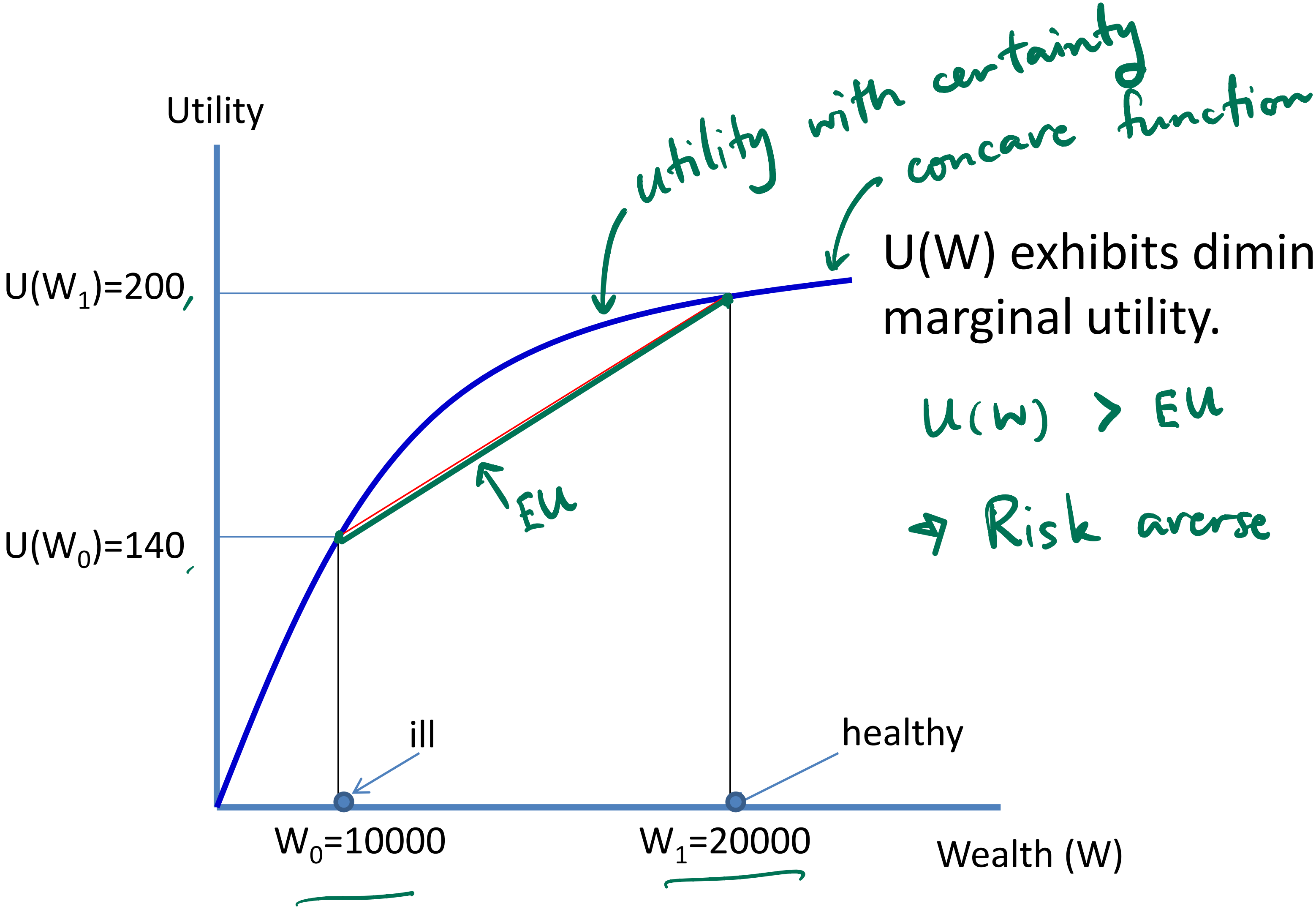
➔EV = (1/2)*\$1 + (1/4)*\$2 + (1/8)*\$4 + (1/16)*\$8 +…

= 0.5 + 0.5 + 0.5 + 0.5 + … = ∞

Marginal Utility of Wealth and Risk Aversion

- Bernoulli's solution was that *money has a different value or utility* depending on *how much you have.*
- From the previous example, if the coin flip yields $100 or nothing, and you now asked to pay $50 to play. Would you still want to play?
  - Perhaps not, why?
  - The utility of an extra $ is worth more if you have less money than the utility of an extra $ is worth when you have more money.
  - ➢ *Diminishing marginal utility*

Utility of Wealth

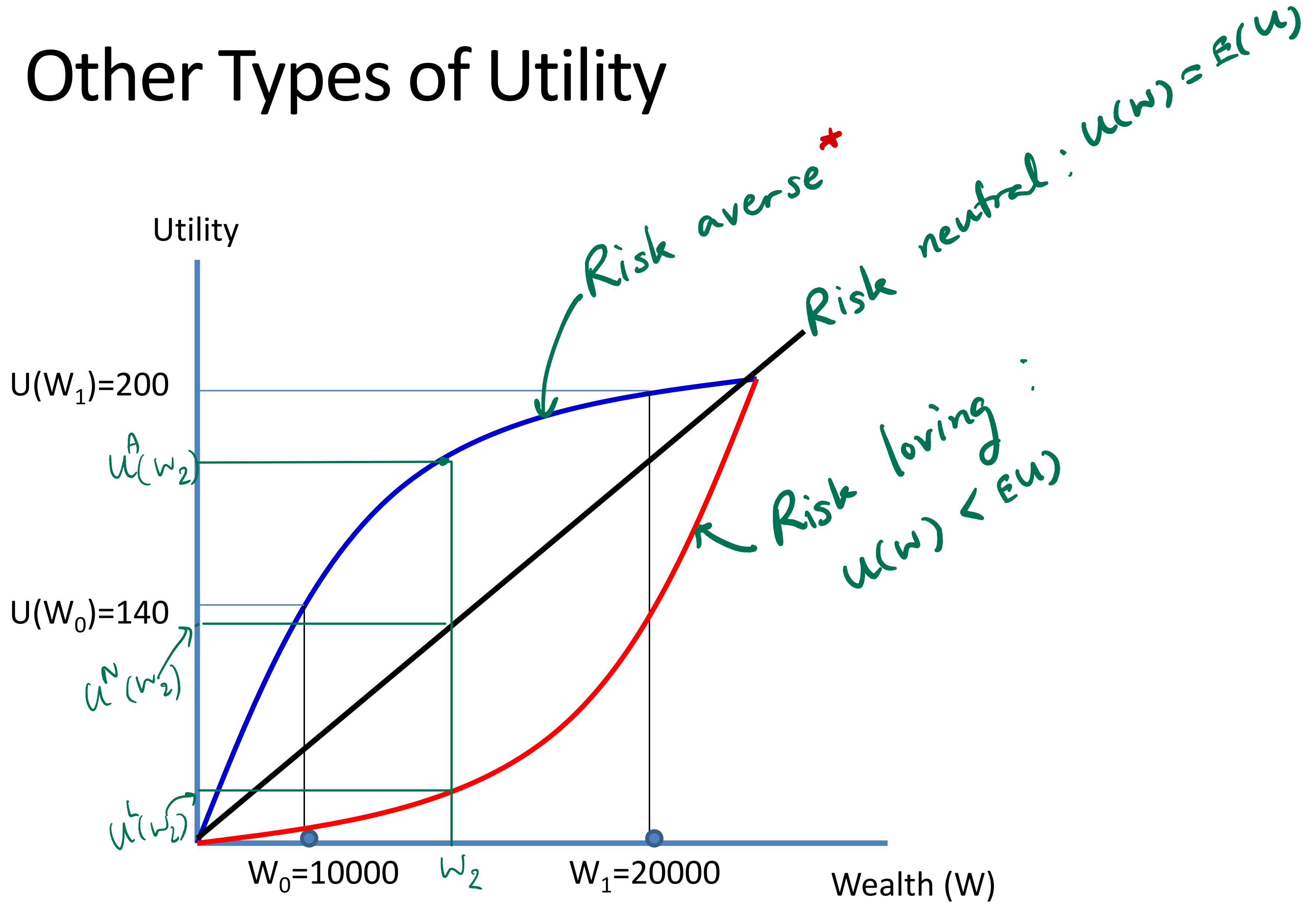


U(W) exhibits diminishing marginal utility.

$U(W) > EU$

→ Risk averse

Other Types of Utility



Expected Wealth and Expected Utility if Uninsured

$W_H = \$20,000$, $W_I = \$20,000 - \$10,000 = \$10,000$; $U(W_I) = 140$

$U(W_H) = 200$

- Suppose the probability of being ill is 0.1 (probability of being healthy = 0.9), and the illness incurs a $10,000 expense.
- **Expected value** of wealth:

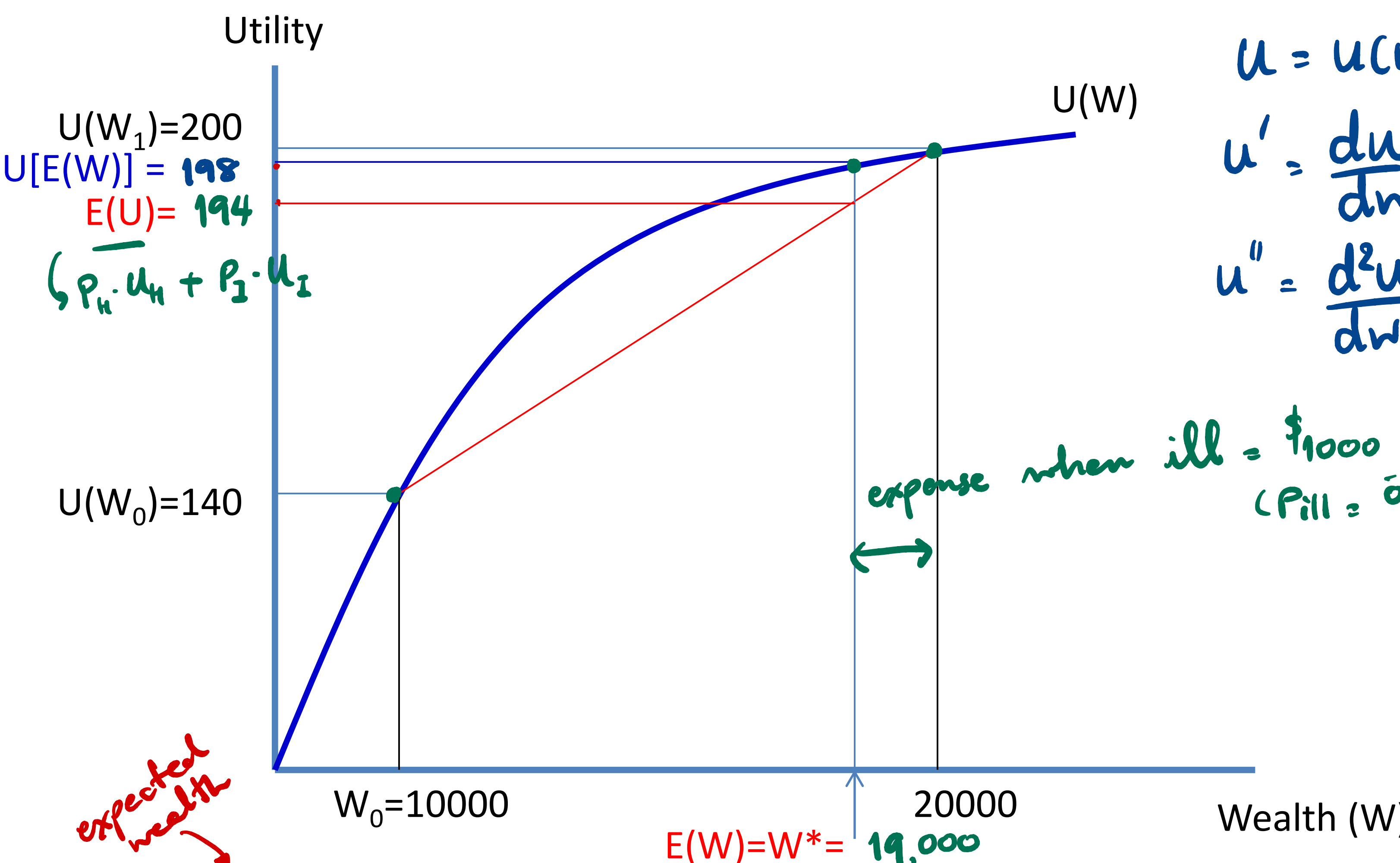
$$E(W^{uninsured}) = (Prob_{healthy} * W_{healthy}) + (Prob_{ill} * W_{ill})$$
$$= (0.9 \times 20,000) + (0.1 \times 10,000)$$
$$\bar{W} = E(W^u) = 18,000 + 1,000 = \$19,000$$

- **Expected utility** of wealth:

$$E(U^{uninsured}) = (Prob_{healthy} * U_{healthy}) + (Prob_{ill} * U_{ill})$$
$$= (0.9 \times 200) + (0.1 \times 140)$$
$$= 180 + 14$$
$$E(U^u) = 194 \text{ utils}$$

Expected Utility if Uninsured

Given info, $u = 198$ when wealth is \$19,000. ✓



$u = u(w)$

$u' = \frac{du}{dw} > 0$ ✓

$u'' = \frac{d^2u}{dw^2} < 0$ ✓

expected wealth

$\Rightarrow u(w^*) > EU$

Actuarially Fair Insurance Policy

- An *actuarially fair insurance policy:* When the expected benefits paid out by the insurance company are equal to the premiums taken in by the company.
  - The consumer pays the actuarially fair premium (AFP).
- The insurer will pay out ($W_1 – W_0 = 10000$), but that only occurs when the consumer becomes ill (ie. Prob = 0.1)
  - ✓ ✓ AFP = $Prob_{ill} * (W_1 – W_0) = 0.1 * (20000-10000) =$ \$1000
  - The consumer pays \$1000 up front, to indicate that he purchased insurance. ← pays no matter what
  - AFP changes the consumer's wealth by $W_1 – W^* = W_1 – E(W)$

= 20,000 − 19,000 = \$1,000

Expected Utility if Insured

pays AFP whether ill or healthy

- **Wealth** when *insured*:
  - If healthy: $W_{healthy} = W_1 - \overset{AFP}{(W_1 - W^*)} = W^*$
    - $W_{healthy} =$ 20,000 - 1,000 = \$19,000
  - If ill: $W_{ill} = W_1 - \underbrace{(W_1 - W_0)}_{\text{loss due to illness}} - \overset{AFP}{(W_1 - W^*)} + \overset{\text{coverage}}{(W_1 - W_0)} = W^*$
    - $W_{ill} =$ 20,000 - ~~10,000~~ - 1,000 + ~~10,000~~ = \$19,000
- **Expected value of wealth** if insured:

$$E(W^{insured}) = (Prob_{healthy} * \overset{19,000}{W^*}) + (Prob_{ill} * \overset{19,000}{W^*}) = W^* = \underline{19,000}$$

- **Expected utility** if insured:

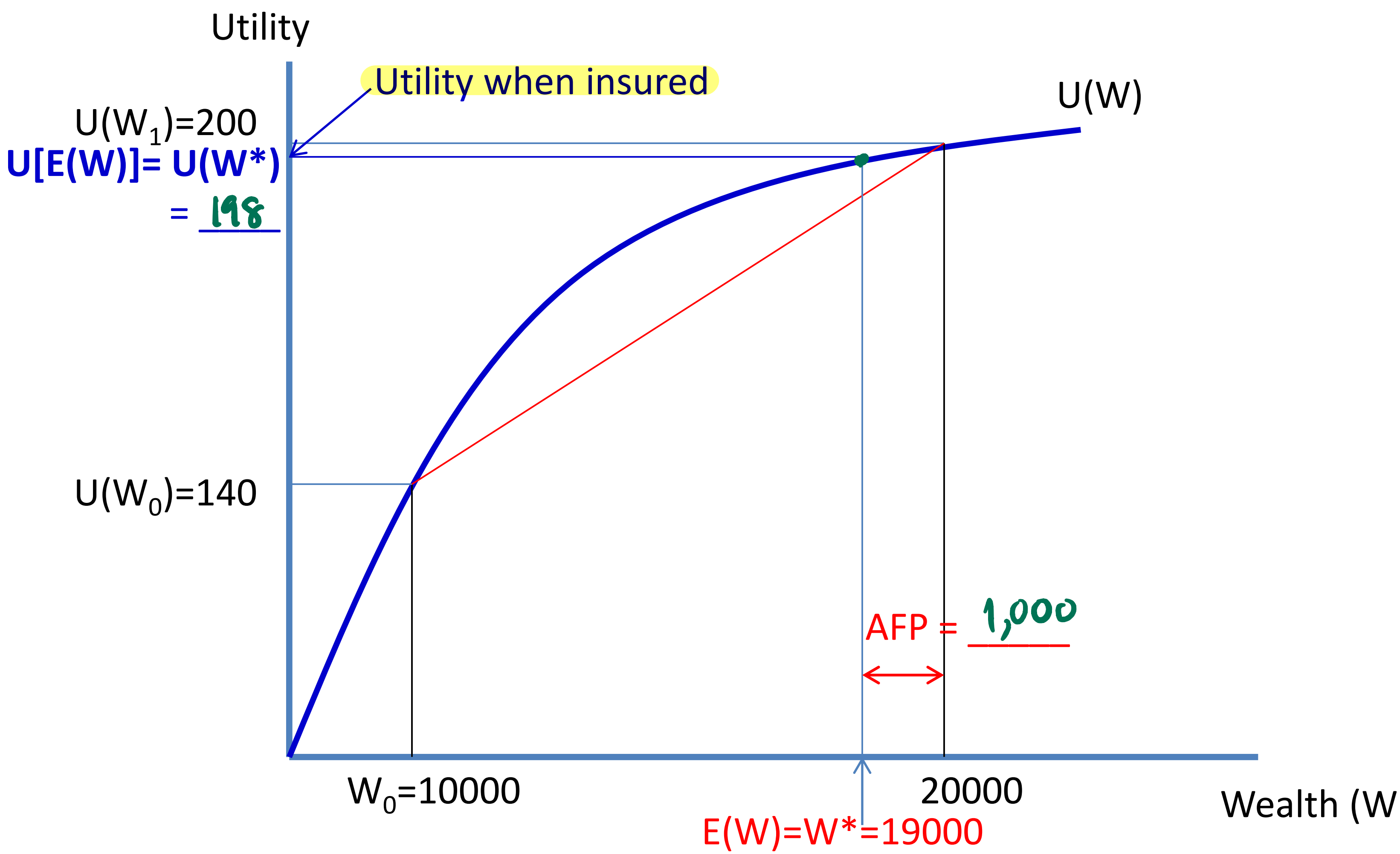
$$E(U^{insured}) = (Prob_{healthy} * \overset{u(19,000)}{U(W^*)}) + (Prob_{ill} * \overset{u(19,000)}{U(W^*)}) = \underline{198} = u(W^*)$$

  - Expected utility if insured is certain!

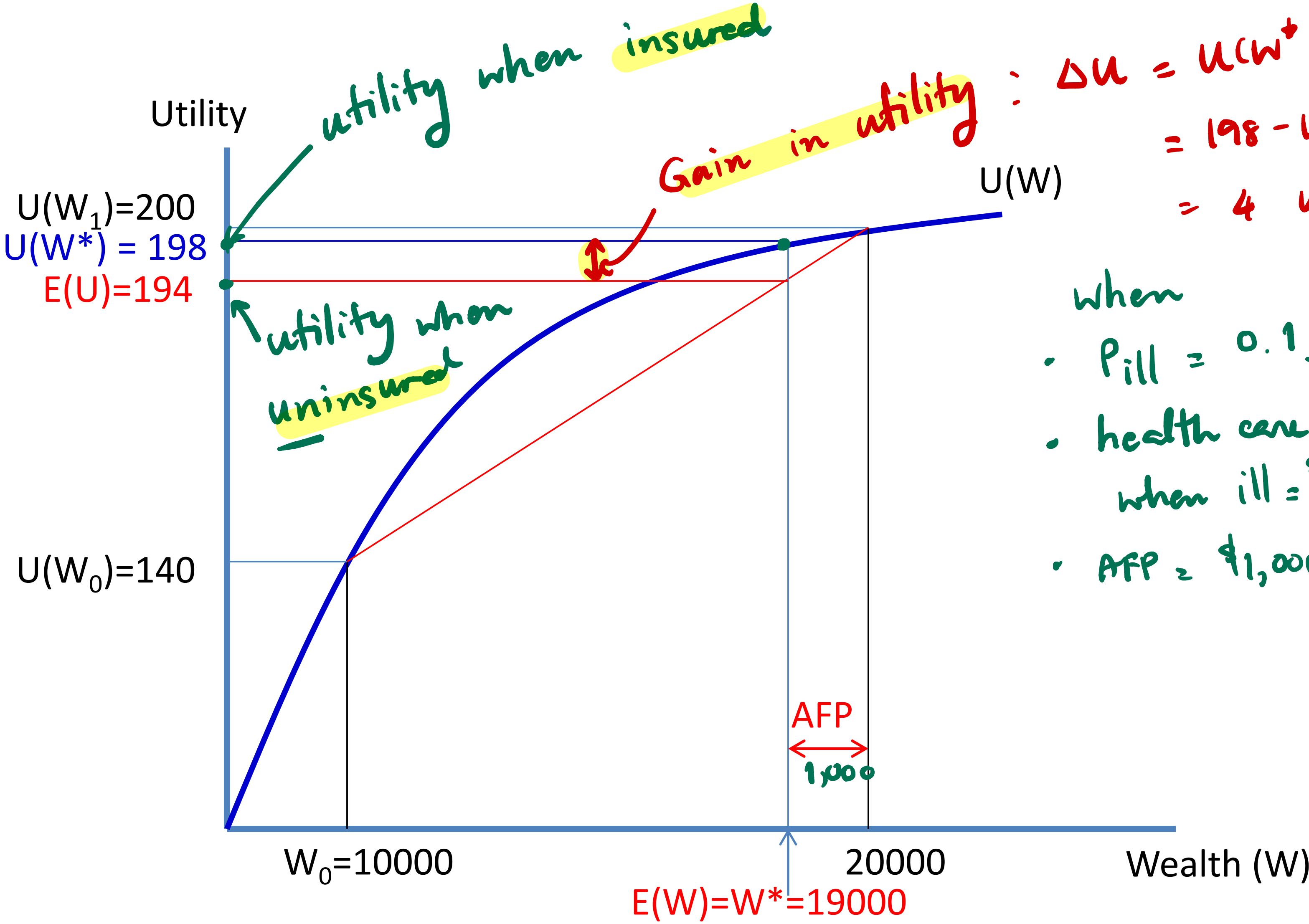
$$EU^{insured} = u[E(W)] = u(W^*)$$

Expected Utility if Insured : $E(u^{insured}) = u(w^*)$

Uninsured : $E(u^{uninsured}) < u(w^*)$



Expected Utility if Insured and Uninsured



: $\Delta U = U(W^*) - E(U)$

$= 198 - 194$

$= 4$ utils

when
- $P_{ill} = 0.1$.
- health care cost when ill = $1,000
- AFP = $1,000.

Expected Utility if Insured and Uninsured

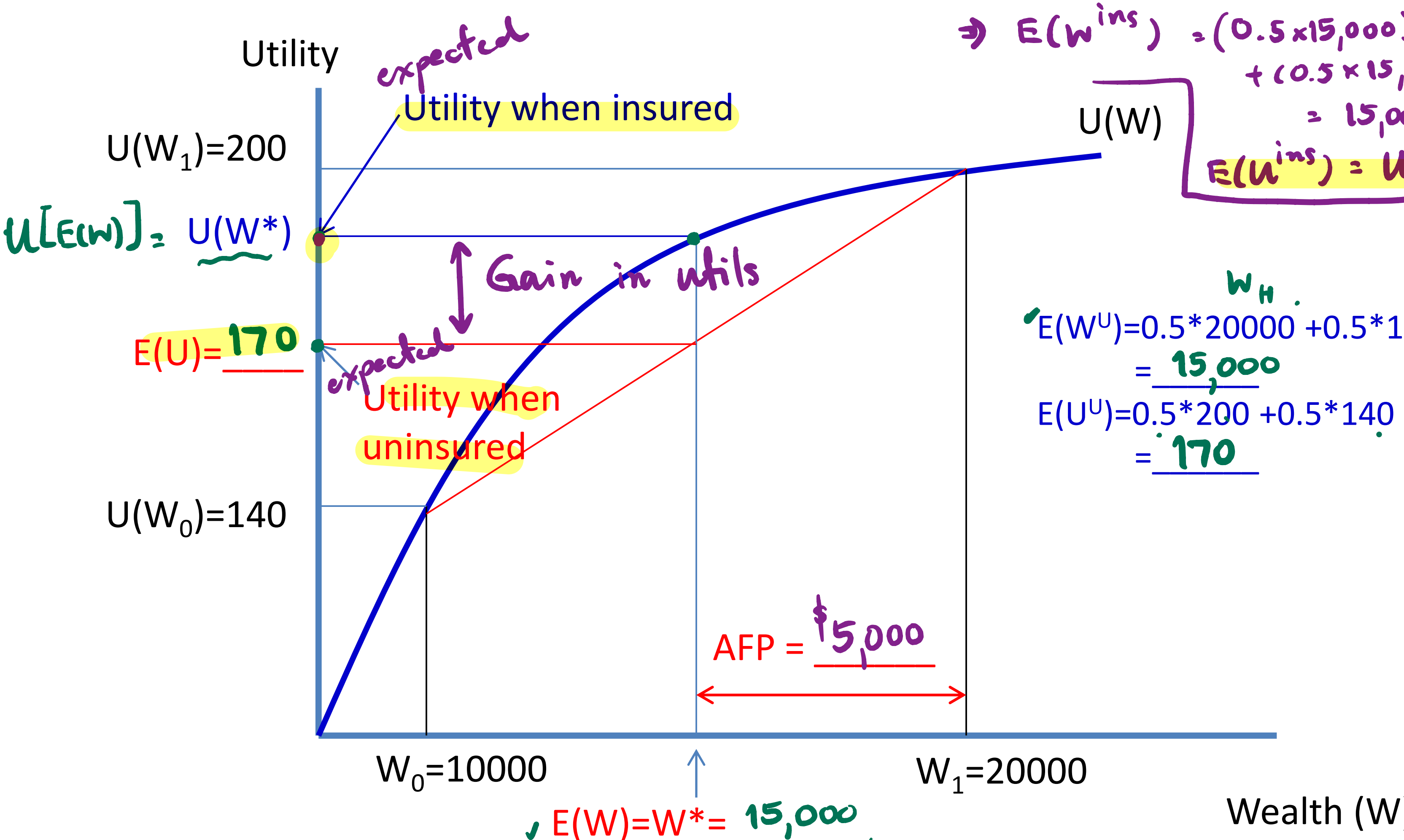
(when P_{ill}=0.5)

Given $W_H = 20{,}000$, $W_I = 10{,}000$

when insured, AFP = 0.5× 10,000 = \$5,000

⇒ $E(W^{ins}) = (0.5 \times 15{,}000) + (0.5 \times 15{,}000) = 15{,}000$

$E(U^{ins}) = U(W^*)$



W_H W_I

$E(W^U)=0.5*20000 +0.5*10000$

= 15,000

$E(U^U)=0.5*200 +0.5*140$

= 170

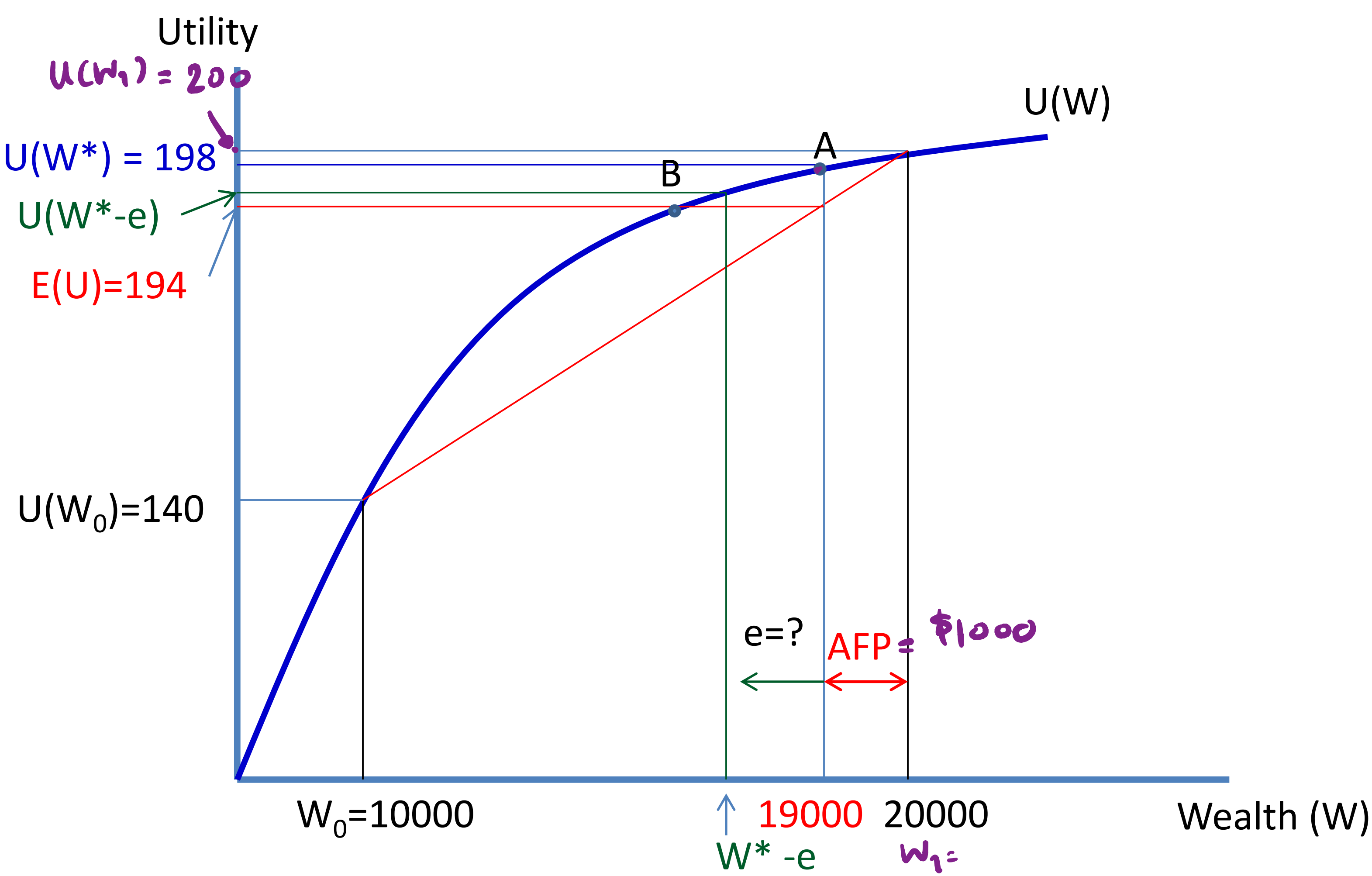
Gain from Insurance in Utility

- If insured, $EU^{ins} = U(W^*)$, and if uninsured, $EU^{unins} = E(U^{unins}) < u(w^*)$
  - ➢ Gain from insurance is $U(W^*) - E(U^{unins})$ in utility terms
  - ➢ In our example, gain from insurance = 198 − 194 = 4 utils.
- Conventional theory of the demand for health insurance :
  - Insurance is a choice between certainty and uncertainty (Friedman and Savage, JPE, 1948)
  - Consumers buy insurance because they prefer certain loss (the premium) to uncertain loss (medical care expenses if ill) of the same expected magnitude.
  - ➢ *Consumers are risk averse.*
- "Preference for certainty" ~ "risk avoidance"

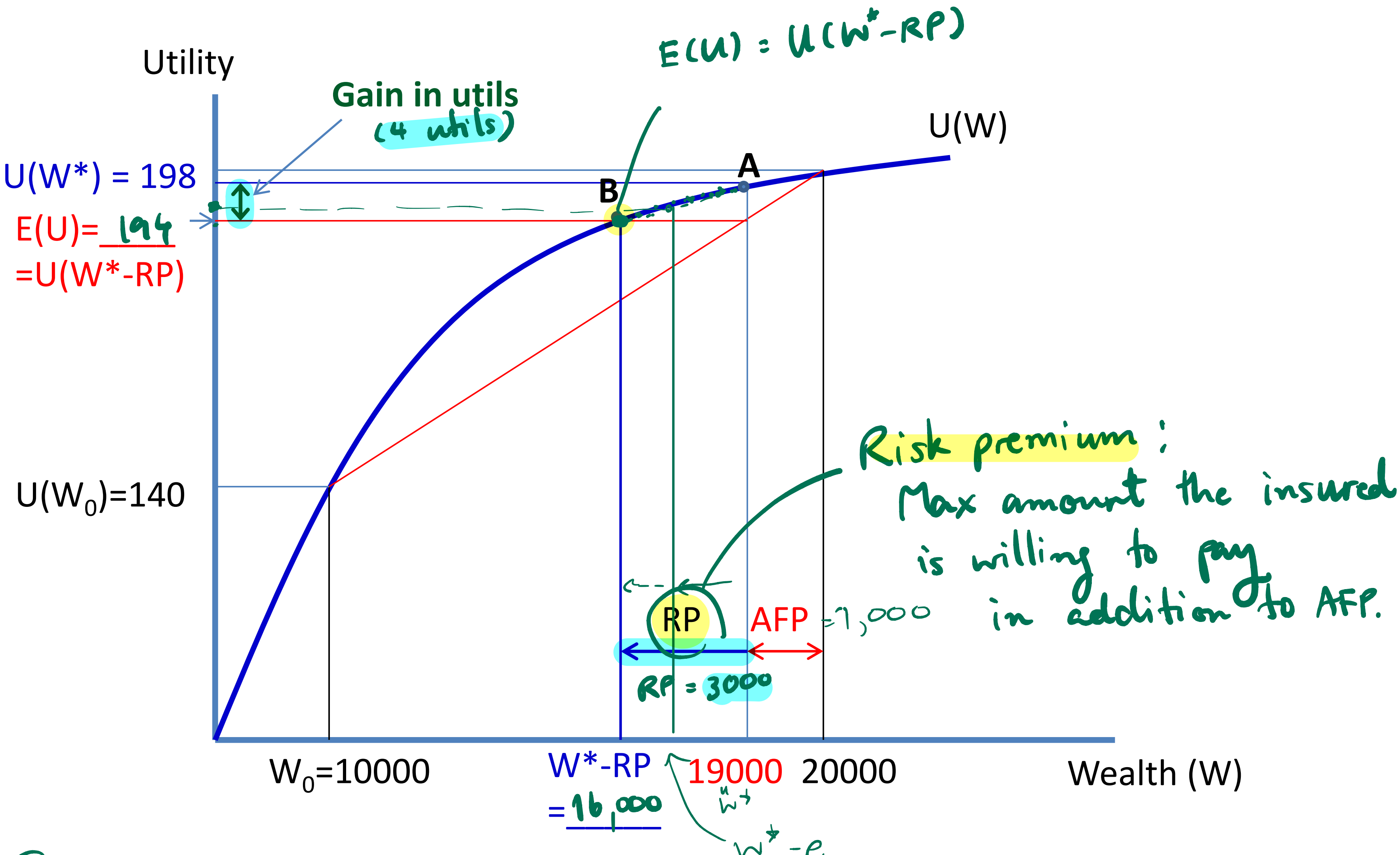
Gain from Insurance in Dollars

- The gain from EU to U(W*) is in utility terms.
- What about the gain in *dollar* terms?
  - We know that AFP is the amount the consumer would expect to pay with or without insurance.
  - What is the maximum amount that the consumer would be willing to pay for insurance (i.e. how much more than the AFP)?
  - The additional amount the consumer would be willing to pay is the value of insurance.

Gain from Insurance in Dollars (P_{ill} = 0.1)



Gain from Insurance in Dollars



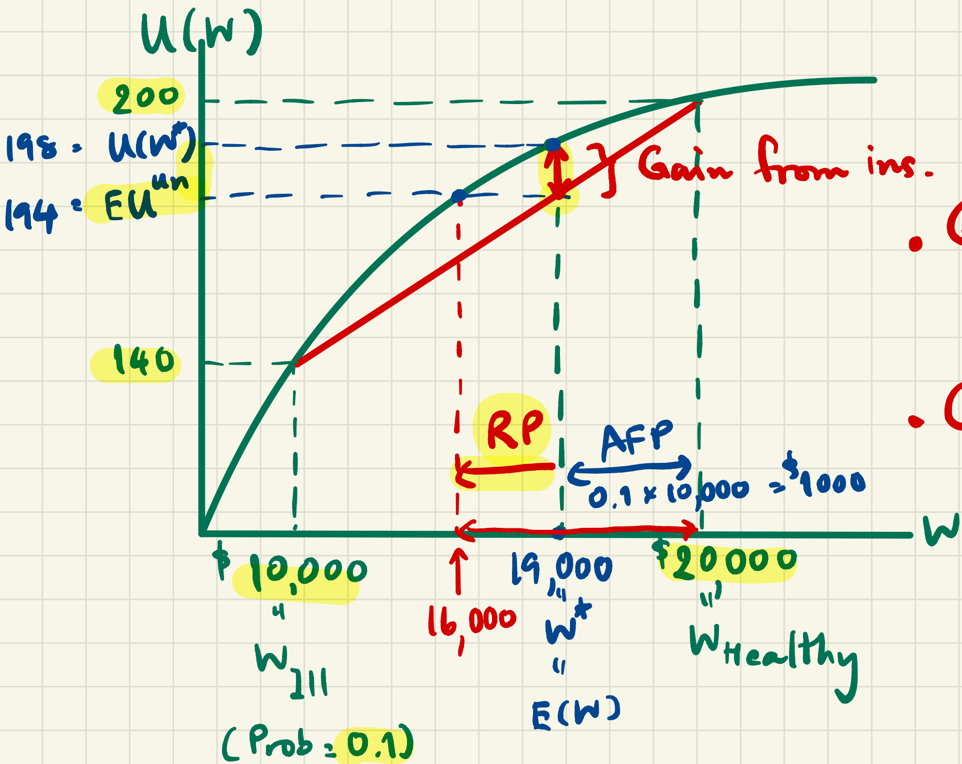
Suppose U = 194 when w = 16,000

Value of Insurance

- The risk premium (RP) is the maximum amount over and above the AFP that the consumer would be willing to pay for insurance. (b/c $u(w^*) \geq Eu$)
- If the consumer pays AFP + RP for insurance, he would be *indifferent* to being insured or uninsured. (Point B)
- The *welfare gain* from risk avoidance is measured in dollars by the risk premium and represents the value of the welfare gain from being insured.
  - Example: The consumer would be willing to pay up to \$4,000. Thus, the welfare gain is equal to \$4000-\$1000 = \$3000.
  - Note: 4,000= 20,000-16,000, where 16,000 is wealth associated with U(W)=194.

Part II : Health Insurance

Review : Gain from Insurance



$u = u(w)$

→ risk-averse

- Gain in utility:

$= u(w^*) - EU^{unins.}$

- Gain in $.

= risk-premium

= $3000

Optimal Level of Health Insurance

- Demand for health insurance.
- Supply of health insurance.

Demand for Insurance

gain from coverage. paying premium.

- Apply the concepts of marginal benefits (MB) and marginal costs (MC) to determine health insurance choice.

$w_H = \$20,000$, $w_I = \$10,000$

- Suppose that the insurance coverage = \$500, and the consumer must pay a 20% premium (20%*500 = \$100).

HC cost premium coverage $\Delta W_{ill} = +\$400 \rightarrow MB_{500}$

- New wealth when ill: $W_I' = 20,000 - 10,000 - 100 + 500 = 10,400$
- New wealth when healthy: $W_I' = 20,000 - 100 = 19,900$
  - $MB_{500} = E[MU_{400}]$
  - $MC_{500} = E[MU_{100}]$

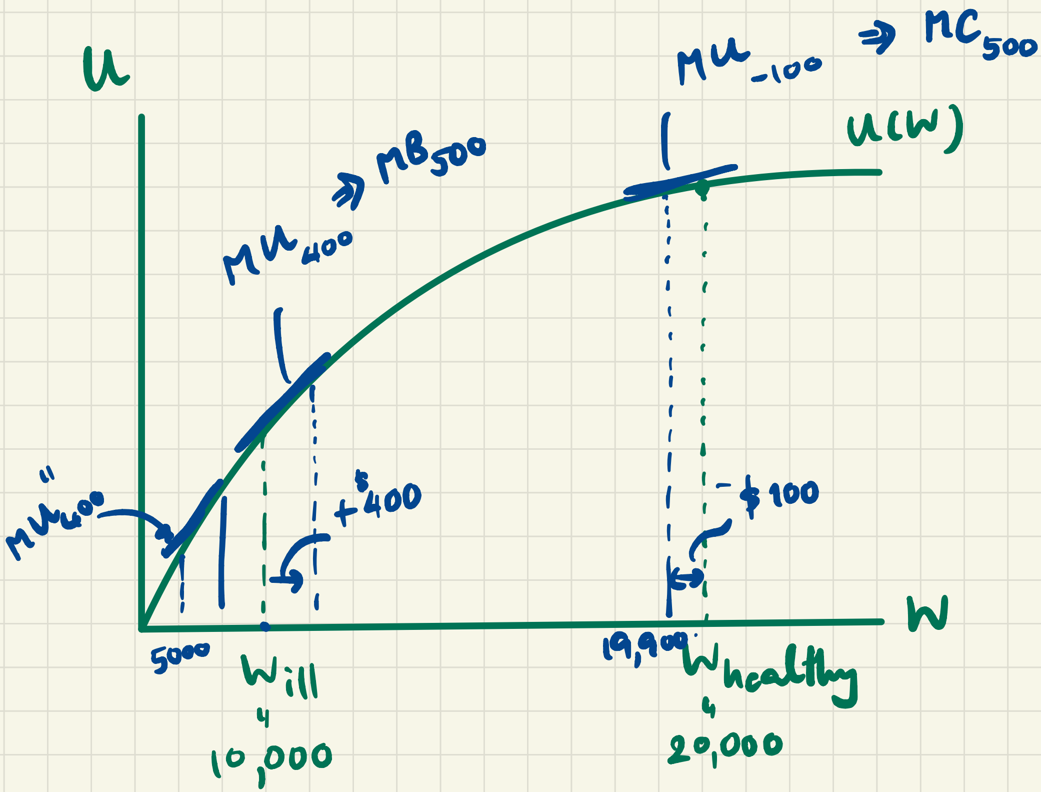
$MB_{500} > MC_{500}$

premium $\rightarrow \Delta W_H = -\$100 \rightarrow MC_{500}$

- If purchase an additional \$500 insurance, then:
  - $MB_{1000} < MB_{500}$
  - $MC_{1000} > MC_{500}$

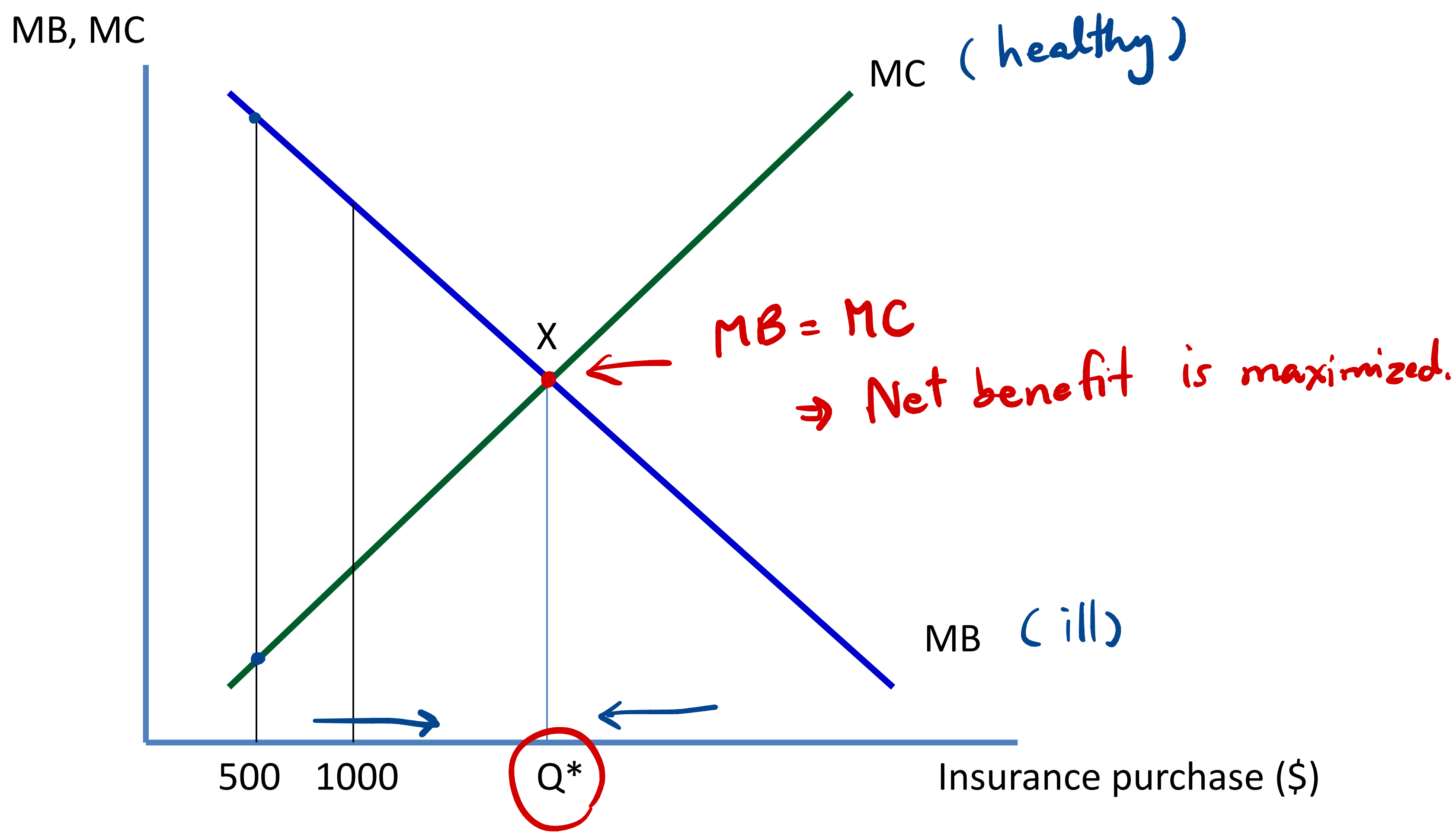
b/c of diminishing marginal utility of wealth

Buy more HI as long as MB > MC!

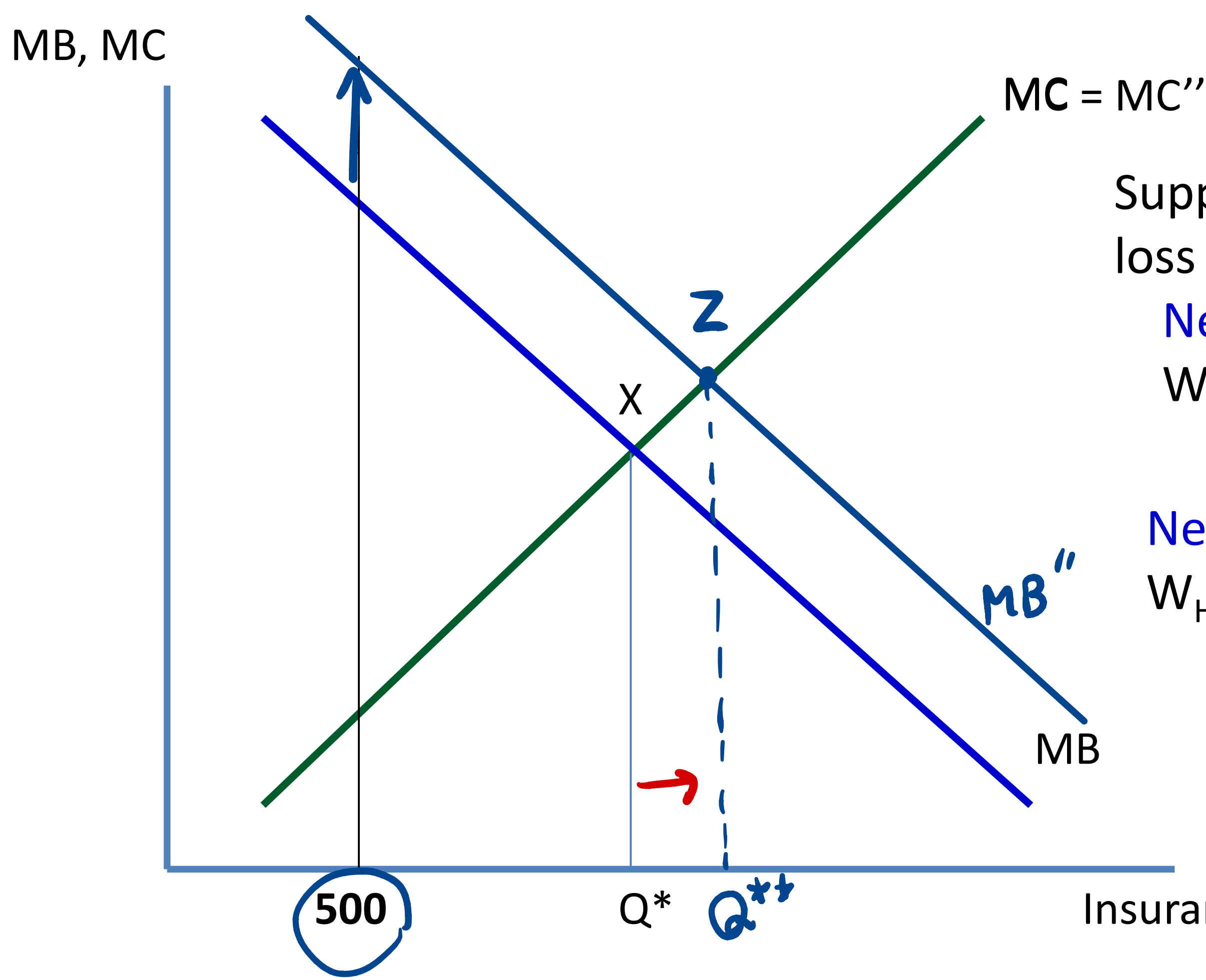


$\Rightarrow \quad MB_{500} > MC_{500} \Rightarrow$ should buy HI.

Optimal Amount of Insurance



Optimal Amount of Insurance:
Expected Loss Increases



HC_0 = $10,000

Suppose that the expected loss increases to $15000.

New wealth when ill:

W_I' = 20,000 − 15,000 − 100 + 500 = $5,400

New wealth when healthy:

W_H' = $20,000 − $100 = 19,900

Supply of Insurance

- Insurer's profit: Profit = Total Revenue – Total Cost
- Previous example:
  - Revenues = $100 per policy (20%) 20% x $500
  - Costs:
    - Insurance coverage = $500 (with Prob =0.1)
    - Processing cost (a.k.a. loading fee)= $8
  - For insured who *do not get sick* (Prob = 0.9), the insurer's cost is $8.
  - For insured who *do get sick* (Prob = 0.1), the insurer's cost is $500+ $8 =$508.
- Insurer's profit = $100 – $\underbrace{[(0.9*8) + (0.1*508)]}_{\text{expected cost}}$ = $42 > 0 +ve π.

Role of Competition in Insurance Market

- Since there are positive profits ($42), other firms have incentive to enter the market and offer a lower premium (e.g. 15% = $75). $0.15 \times \$500 = \$75$
  - Profit = $\$75 - [(0.9 \times 8) + (0.1 \times 508)] = \$17 > 0$
- Eventually, the entry into the market would continue until excess profit is driven away, i.e. profit= 0 (perfect competition condition).

- What is the premium rate under perfect competition?
  - Try premium rate = 11.6% !

Competitive Premium

- Let a = premium rate, q = amount of payout (coverage), t = processing cost, and p= probability of payout.
  - $Profit = aq - pq - t$
- Under perfect competition: $Profit = aq - pq - t = 0$

$$\boxed{a = \frac{t}{q} + p}$$

$$aq = t + pq$$
$$a = \frac{t}{q} + p$$

- When t=0, the premium is the actually fair rate
  - ➔ $a = p$.

eg. p = 10 % (Prob of ill) ⇒ AFP rate = 10 %.

- Example: p = 0.1, t= 8, q=500
  - ➔ $a^* = (8/500) + 0.1 = 0.116$ (11.6 %)

Optimal Level of Coverage

$t = 0$

- Suppose no loading costs and the insurance market is perfectly competitive.
- To maximize utility, the consumer will chose the coverage level that equates her *expected wealth when healthy* to her *expected wealth when ill.*
- Same example (P_{ill} = 0.1, loss =10,000):
  - $W_{healthy}$ = \$20,000 – $(a*q)$
  - W_{ill} = \$20,000 – \$10,000 – $(a*q) + q$

premium ← coverage

$W_H = W_{ill}$

$20{,}000 - \cancel{aq} = 10{,}000 - \cancel{aq} + q$

$q^* = 10{,}000$

➔ $q^* =$ \$10,000

➔Optimal coverage is equal to the health care cost (in the absence of loading fees).

➔Not necessarily the case!

Part III

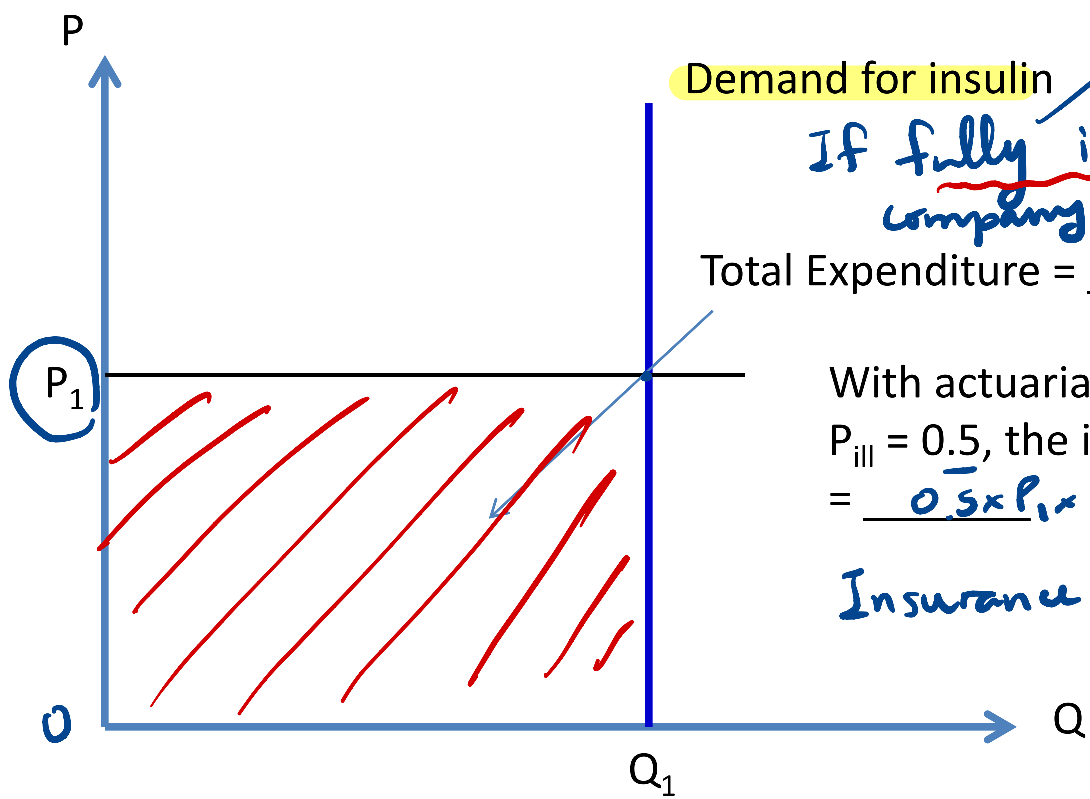
What is Moral Hazard?

- Moral hazard is the change in behavior that is associated with becoming insured
- * *Ex post* moral hazard refers to the change in behavior *after* you become ill

  excessive health care use
  - An increase in health care consumption by the insured consumers
- *Ex ante* moral hazard refers to the change in behavior *before* you become ill → less careful.
  - An increase in the probability of illness of the insured consumers because they have fewer incentives to take care of themselves.

Demand for Care and Moral Hazard

(Perfectly Inelastic Demand)



insured pay \$0.

If fully insured, insurance company pays = P_1Q_1

Total Expenditure = $\underline{P_1 Q_1}$

With actuarially fair insurance and P_{ill} = 0.5, the insured pays = $\underline{0.5 \times P_1 \times Q_1}$

Insurance com. pays $0.5\, P_1 Q_1$

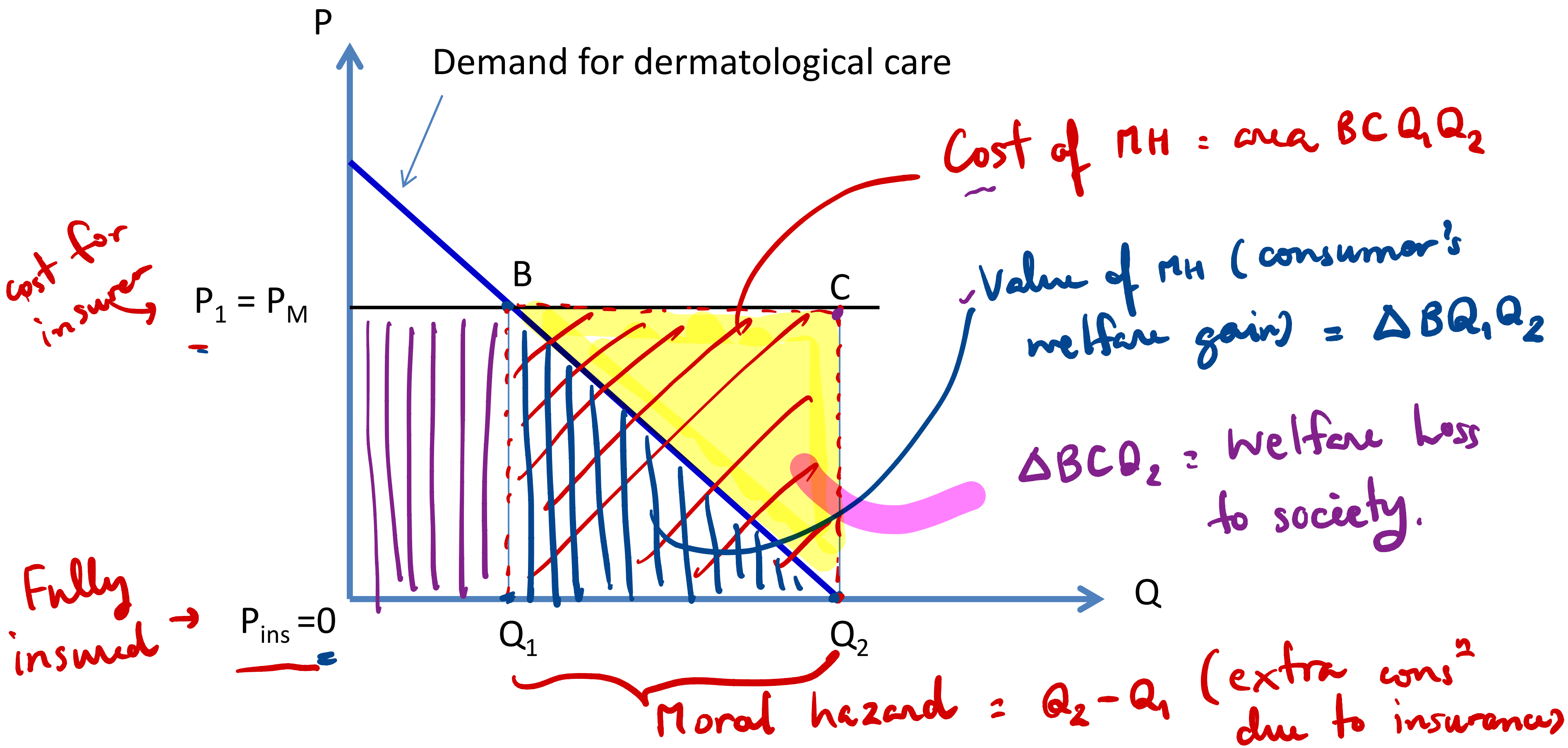
$P_{ins} = 0 \rightarrow$ 0

No welfare loss!

Demand for Care and Moral Hazard

(Relatively Elastic Demand) & Full Insurance.

↳ $P_{cons} = 0$



Predictions on the Types of Health Insurance

- More inelastic demand health care services
  - More complete coverage
- More elastic demand health care services
  - Less complete coverage or no insurance
- To reduce moral hazard, insurance companies use the following policies:
  - Deductibles
  - Coinsurance

Efficient Allocation of Resources

- The efficient allocation of society's scarce resources occurs when marginal cost (MC) equals marginal benefits (MB).
  - insurer MC = The incremental cost of bringing the resources to market
  - insured MB = The valuation to those who buy the resources
- If MB ≠ MC, society's welfare could be improved by re-allocating resources.
  - If MB > MC, allocate *more* resource to the individual or sector and *less* resources to others.
  - If MB < MC, allocate *less* resource to the individual or sector *more* resources to others.
- Moral hazard induced by health insurance can lead to inefficient allocation of resources.
  - MC > MB → Welfare loss to society

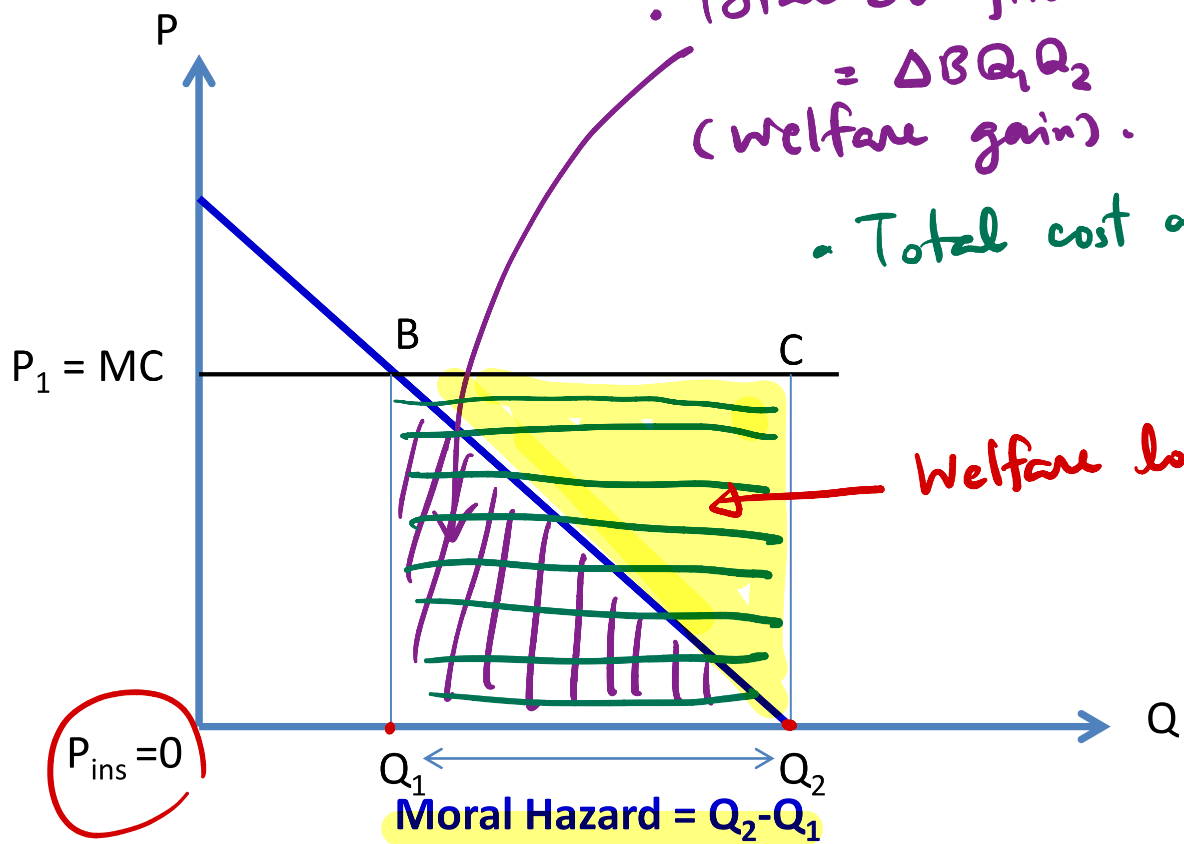
Moral Hazard and Welfare Loss

(Full Insurance)

0% coinsurance rate

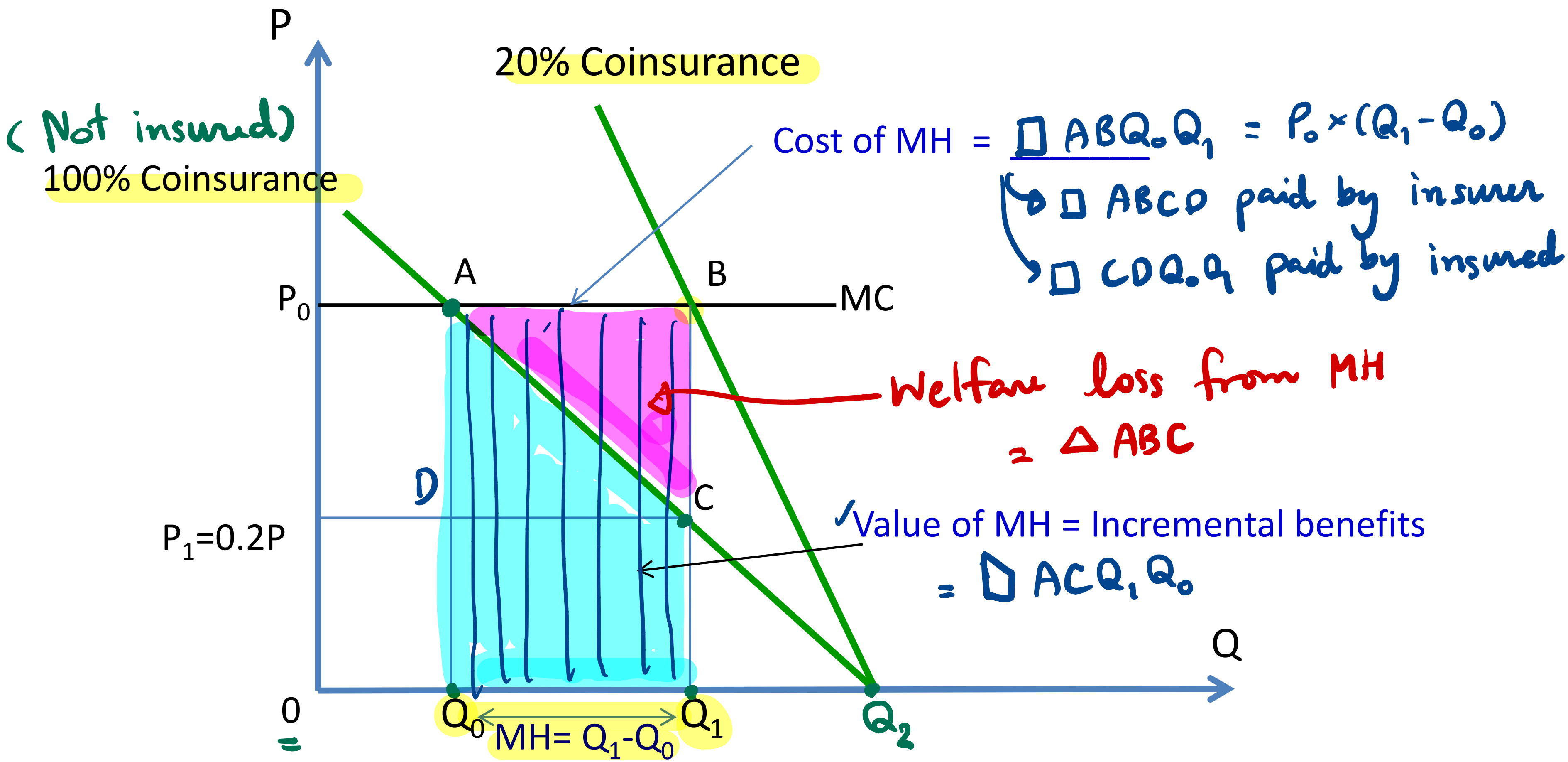
- Total benefits (value of MH) = ΔBQ_1Q_2 (welfare gain).
- Total cost of MH = $\square BCQ_1Q_2$

Welfare loss = ΔBCQ_2



Moral Hazard and Welfare Loss

(20% Co-insurance)



Two-tiers Insurance

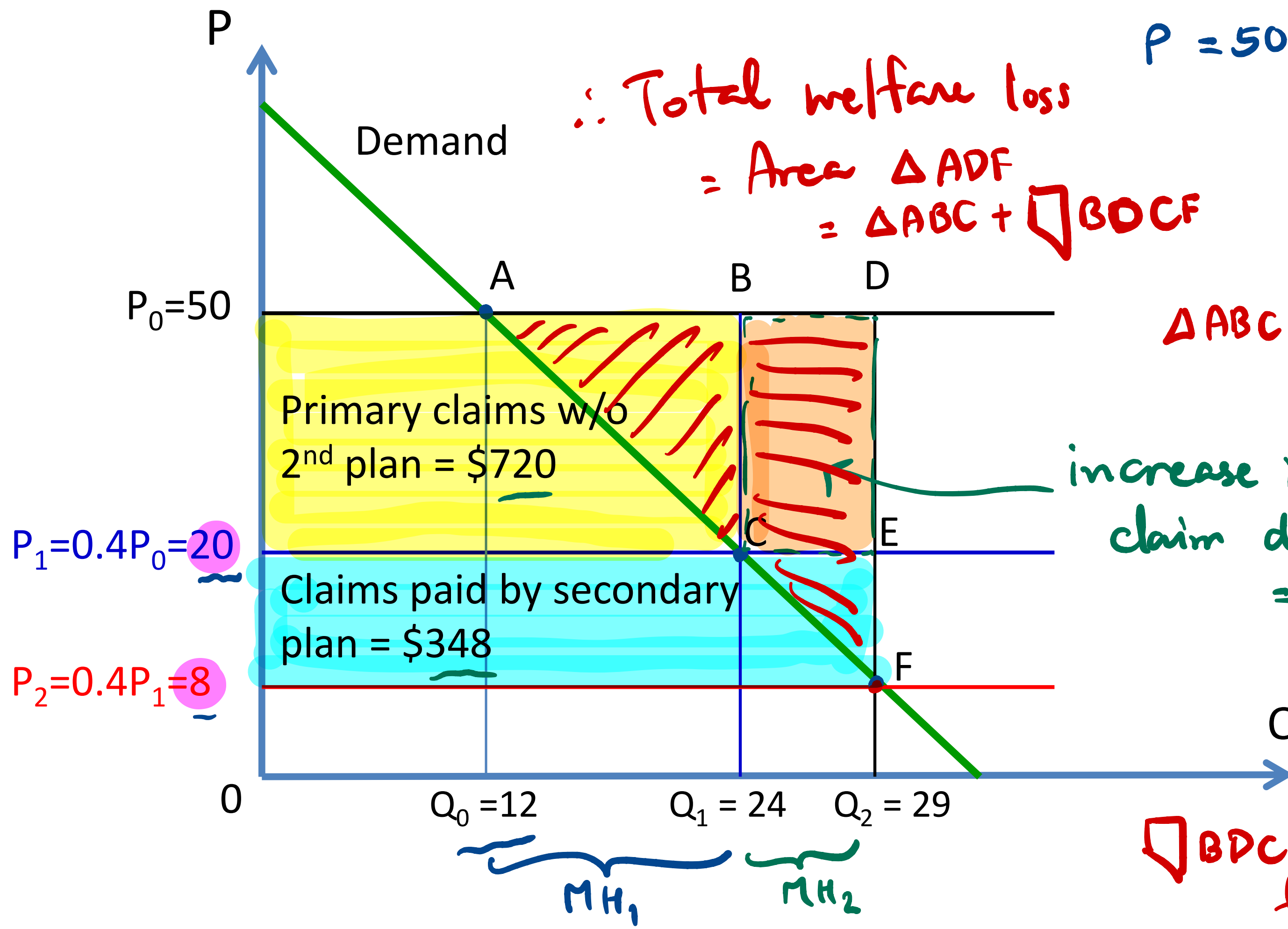
(Primary Plan – 60% of total cost & Secondary plan– 60% of the rest)

↳ coins rate = 40%. ↳ coins rate = 40%.

$P = 50 \rightarrow 1^{st}: P_1^c = 0.4 \times 50 = \$20$

↳ $2^{nd}: P_2^c = 0.4 \times 20 = \$8$

∴ Total welfare loss = Area △ADF = △ABC + ▱BDCF

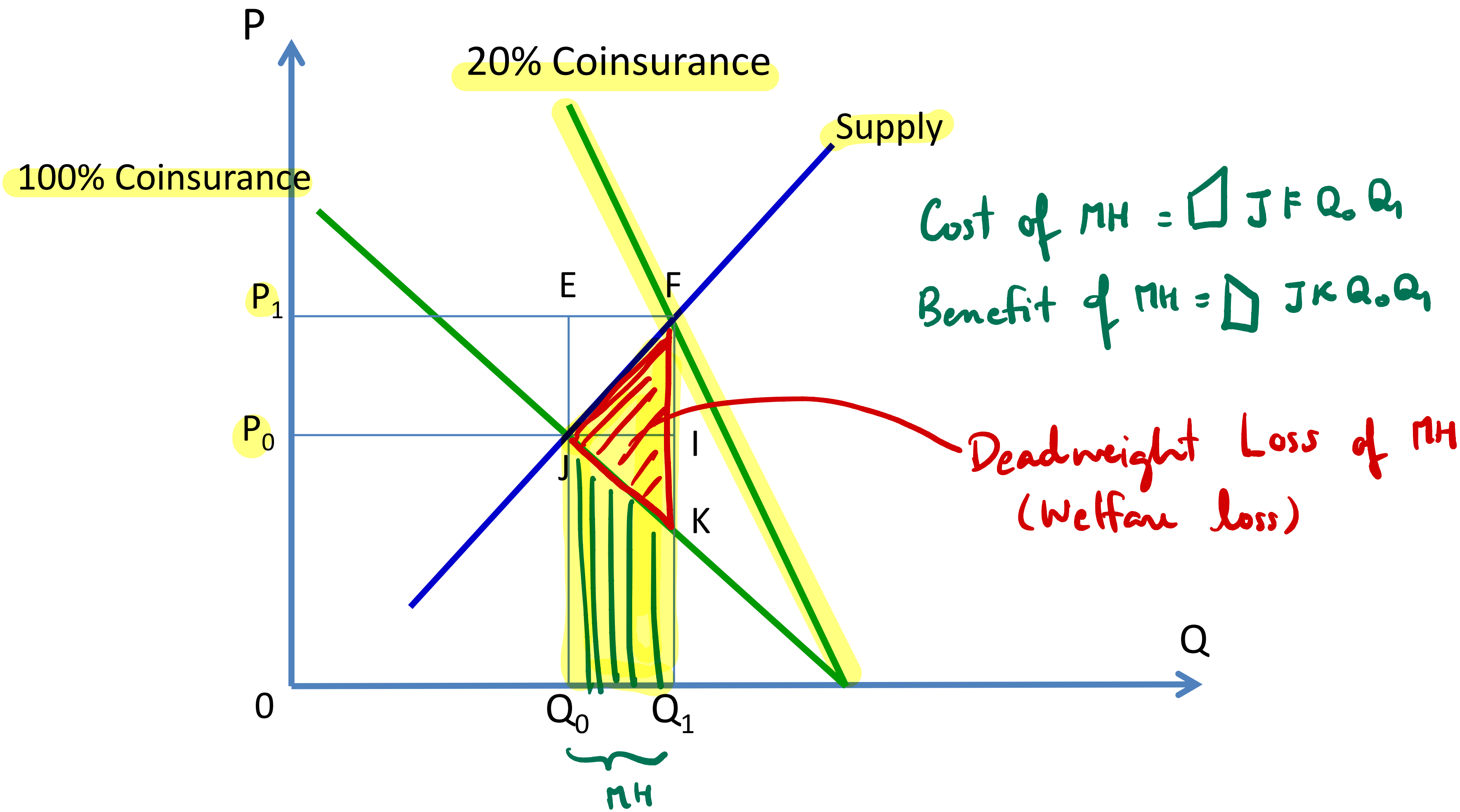


△ABC = welfare loss from MH_1

increase in primary claim due to 2^{nd} plan.
$= \$(50-20) \times 5$
$= \$150$

▱BDCF = welfare loss from MH_2

Welfare Loss (MC is not constant)



The (New) Theory of Demand for Health Insurance

- So far, we have learned about the *conventional insurance theory*, which suggests that health insurance always creates a welfare loss.
- John Nyman's (1999) new theory of demand for health insurance:
  - Health insurance is demanded in order to obtain an transfer of income when ill (income transfers from those who remain healthy to those who become ill).
  - Health insurance generally increases welfare, mainly because of moral hazard which represents access to health care that would otherwise be unaffordable.

Nyman's Model

- Some notations:
  - m_i is total medical care cost when illness occurs $10,000
  - r is the premium
  - π is the probability of illness. 10 %
  - c = coinsurance rate (Note: we've assumed c=0 previously.) AFP = 10% x $10,000 = $1,000 (w/o coinsurance)
- Insurer sets a premium, r, at the actuarially fair level:

$$r = \pi(1-c)m_i$$

- The payoff (coverage) that the insurer pays to the beneficiary who becomes ill is equal to $(1-c)m_i$.

If c = 0, coverage = m_i

Nyman's Model

- Income transfers are the portion of the payoff to the ill that is paid for by those who purchase insurance and remain healthy:
  - *Payoff* to ill: $(1\text{-}c)m_i$
  - *Premium* paid by each insured: $\pi(1\text{-}c)m_i$
  - *Income transfers* to ill: $(1\text{-}\pi)(1\text{-}c)m_i$
- <u>Example</u>: Medical spending with insurance is $10,000, ✓ coinsurance rate is 20%, and probability of illness is 0.02.
  - Each insured pays: $c{*}m_i$ = $2,000 *out of pocket* 20% × 10,000
  - ✓ Insurer pays: $(1\text{-}c)m_i$ = (1 − 0.02) × $10,000 = $8,000
  - → AFP: $r = \pi(1\text{-}c)m_i$ = 0.02 × $8,000 = $160
  - Income transfers are: $(1-\pi)(1-c)m_i$ = $8000 − $160 = $7,840

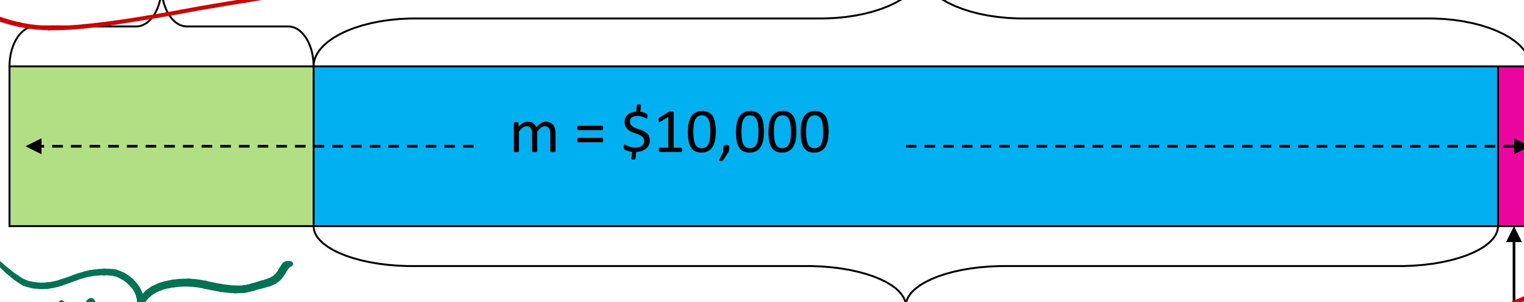
Diagram of c, π, and m in Nyman's Model

coinsurance } insured.
premium
rest paid by insurer

- Example
  - m = $10,000 : medical cost.
  - c=20% ⇒ 20% × $10,000 = $2,000
  - π=2% : Prob of ill

c*m = $ 2,000

(1-c)m = $ 8,000



paid by insured

(1-π)(1-c)m = $ 7,840

income transfer (from healthy)

π(1-c)m = $ 160

premium

Elizabeth Example

- Elizabeth is diagnosed with breast cancer.
- *Without insurance,* she purchases
  - Mastectomy for $20,000

Spending without insurance

- *With insurance* that pays for all her care, she receives the
  - Mastectomy for $20,000,
  - A breast reconstruction for $20,000
  - 2 extra days in the hospital for $4,000

MH (extra HC)

Spending with insurance = 44,000

- Moral hazard spending:
  - $44,000 – $20,000 = $24,000 for breast reconstruction and hospital days

Elizabeth Example

- Question: Is the $44,000 spending efficient?
- Assume that, if she had been paid off with a lump sum payment equal to the amount the insurer paid for her care ($44,000), she would have purchased the mastectomy and the breast reconstruction, but not the 2 extra days in the hospital.

  necessary   not necessary.
- Conclusion:
  - The breast reconstruction is *efficient* and welfare increasing because Elizabeth would have purchased that with the income transfer.
  - The 2 extra days in the hospital are *inefficient* and welfare decreasing because she only purchases them because the insurer had distorted the price.

Illustration of Elizabeth's Welfare Gain