Demand and Supply of Health Insurance (Part 1)

EE 474 Health Economics

Semester 1/2012

Topics

- What Is Insurance?
- Risk and Insurance
  - Expected Utility of Wealth
  - Gain from Insurance
- The Demand for Insurance
- The Supply of 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 gets sick and incurs health care costs of $5,000. (This is random.)
- 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.

Insurance Terminology (2)

- *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.
- *Exclusions* : Services or conditions not covered by the insurance policy
  - Ex: Cosmetic or experimental treatments.
- *Limitations*: Maximum coverages provided by insurance policies.
  - Ex: A policy may provide a maximum of $3 million lifetime coverage.

Insurance Terminology (3)

- *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.?

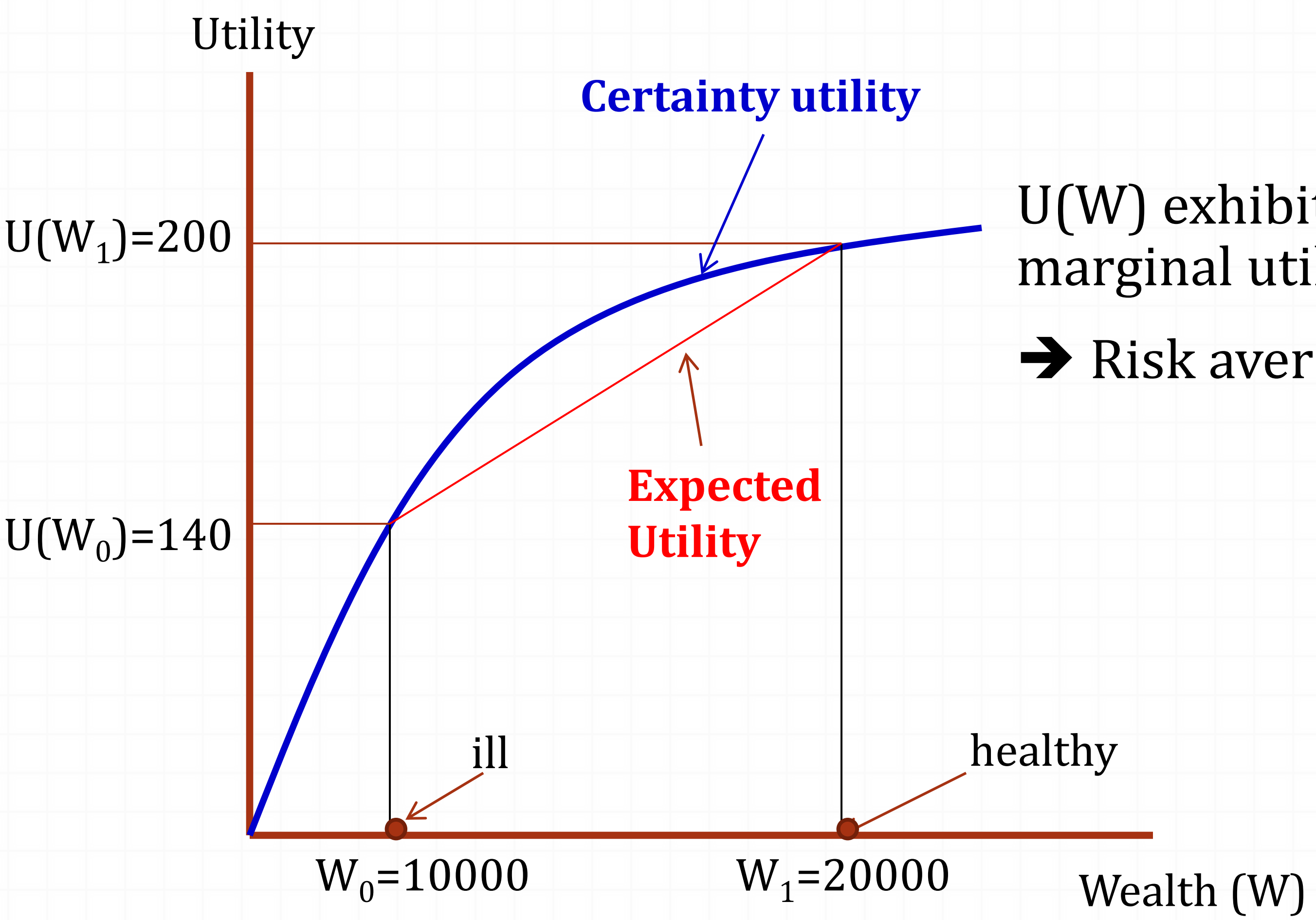
➔ $EV = (1/2)*\$1 + (1/4)*\$2 + (1/8)*\$4 + (1/16)*\$8 + \ldots$

$= 0.5 + 0.5 + 0.5 + 0.5 + \ldots = \infty$

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*

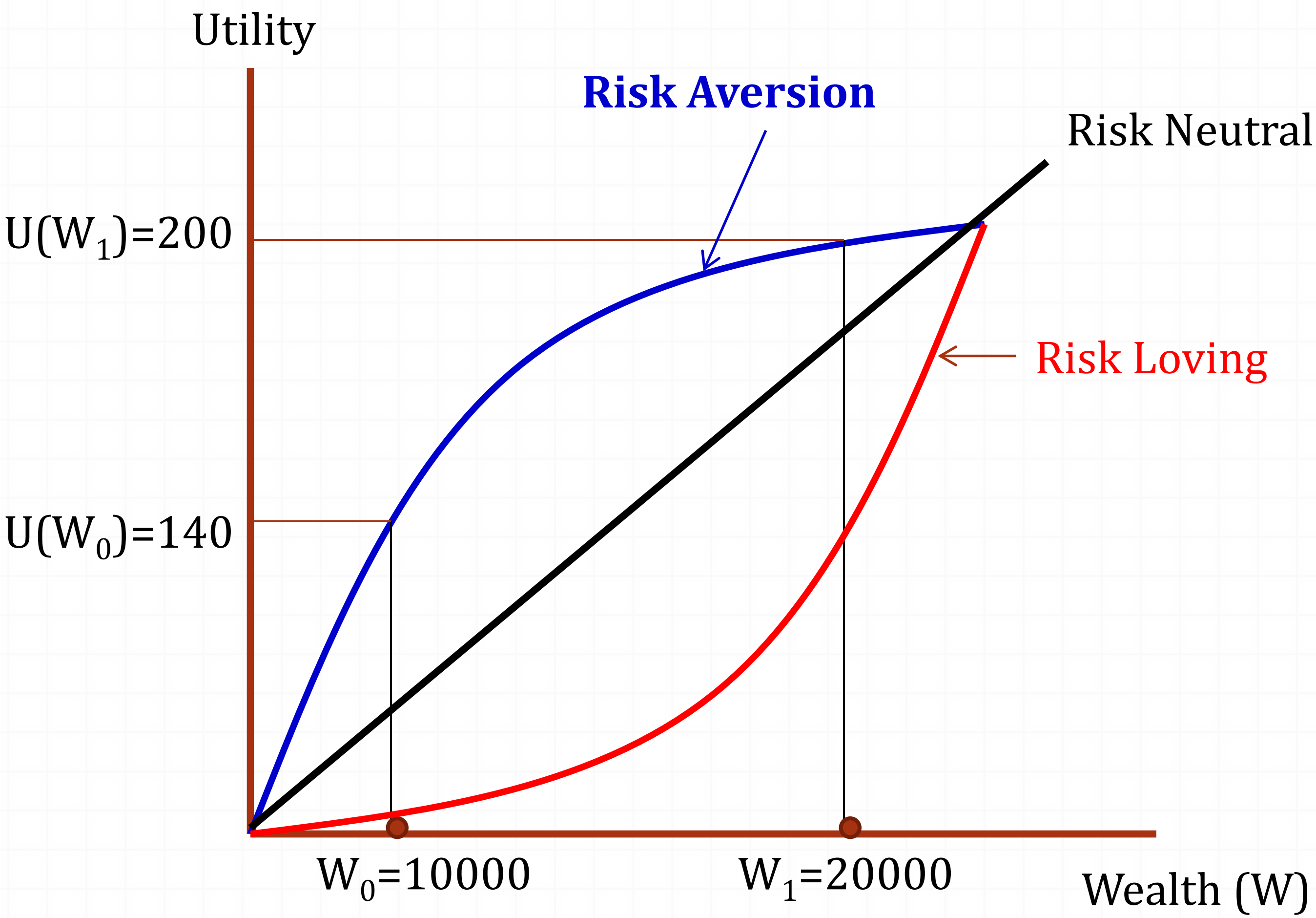
Utility of Wealth



U(W) exhibits diminishing marginal utility.

➔ Risk averse utility

Other Types of Utility



Expected Wealth and Expected Utility if Uninsured

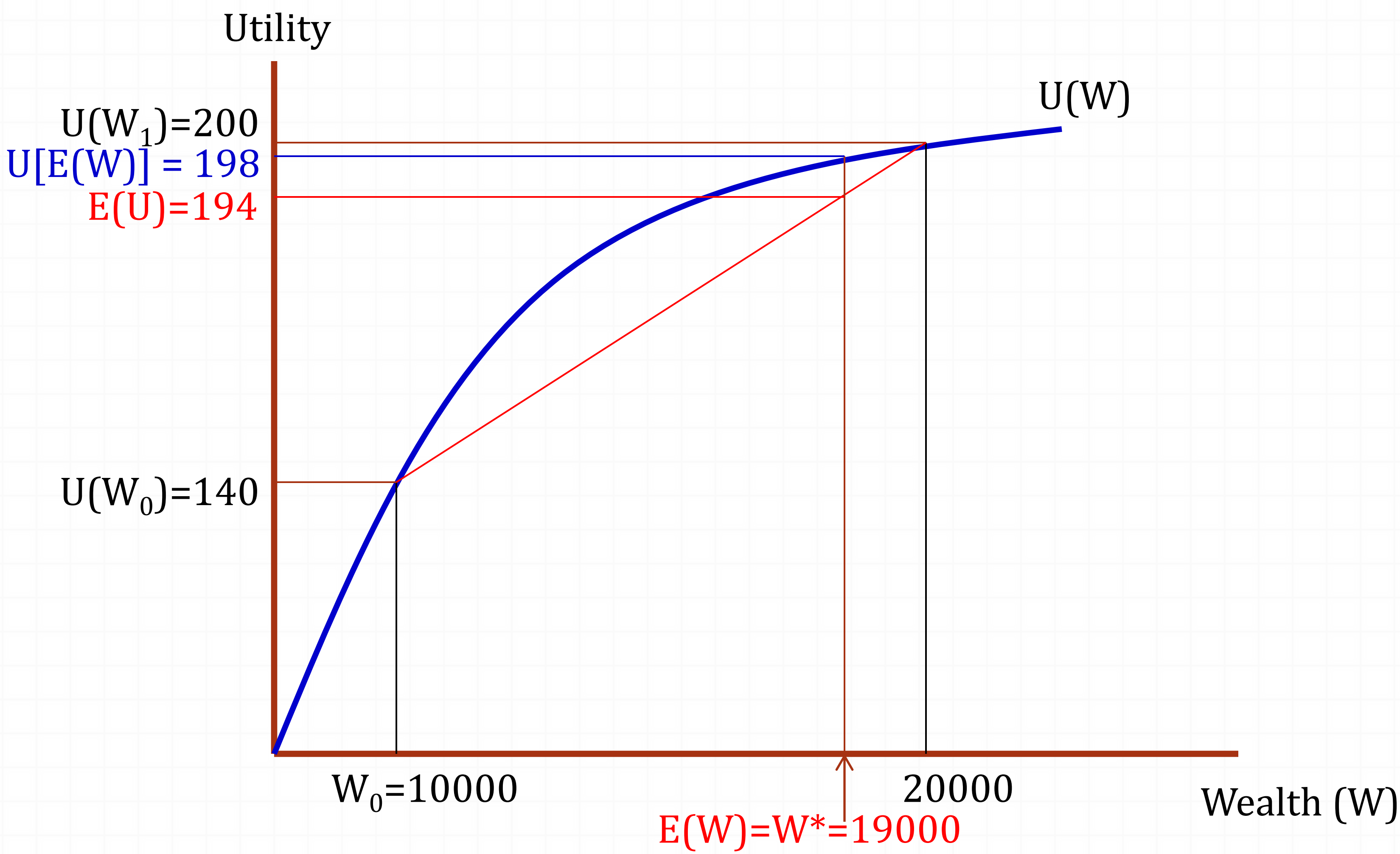
- Suppose the probability of being ill is 0.1 (probability of being healthy = 0.9), and the illness incurs a $10,000 expense.
- **Expected value** of wealth:

$$E(W^{uninsured}) = (Prob_{healthy} * W_{healthy}) + (Prob_{ill} * W_{ill})$$
$$= (0.9*20000) + (0.1*10000)$$
$$= \$19,000$$

- **Expected utility** of wealth:

$$E(U^{uninsured}) = (Prob_{healthy} * U_{healthy}) + (Prob_{ill} * U_{ill})$$
$$= (0.9*200) + (0.1*140)$$
$$= 194$$

Expected Utility if Uninsured



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.
  - ➢ AFP changes the consumer's wealth by $W_1 – W^* = W_1 – E(W)$

Expected Utility if Insured

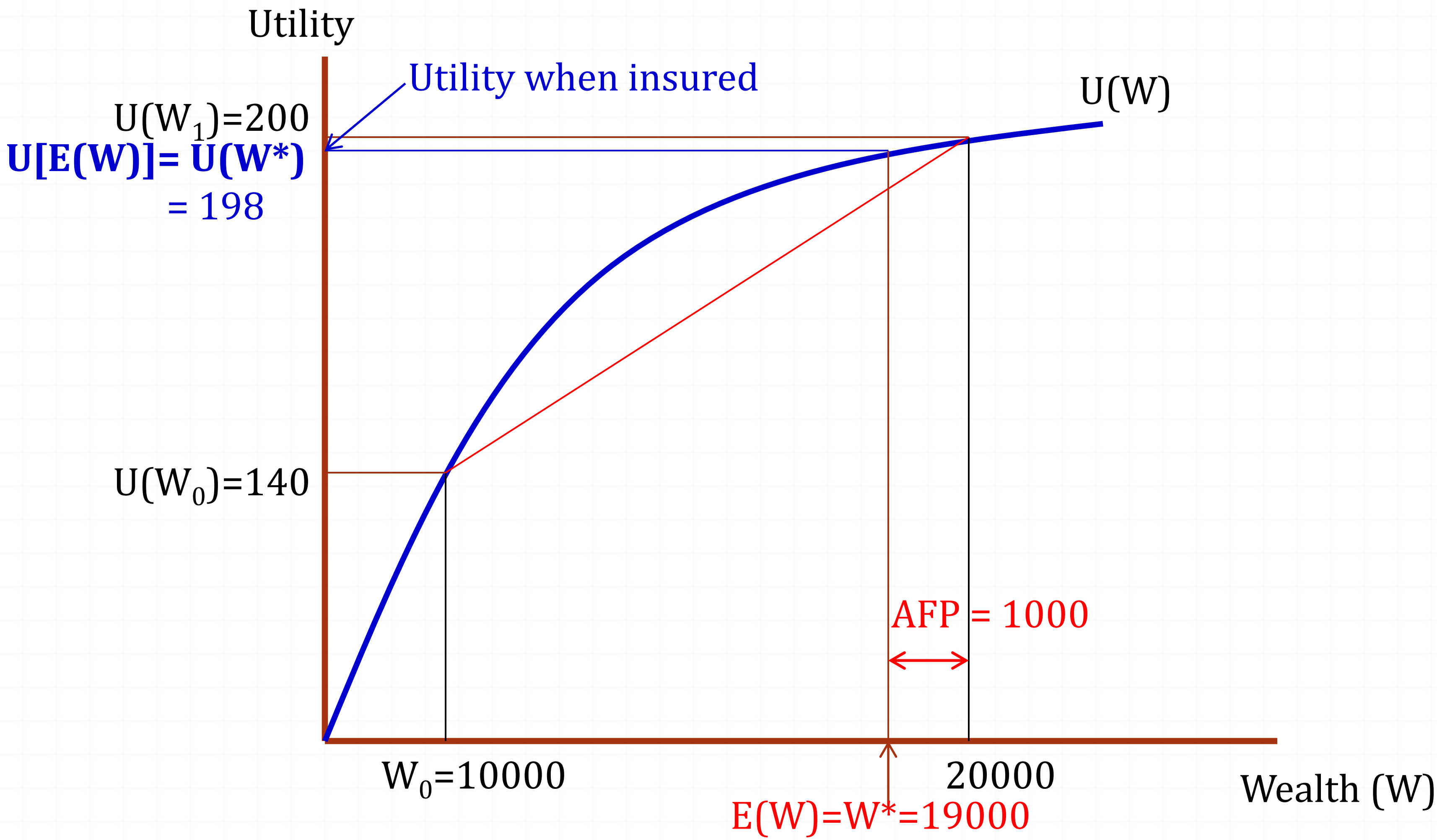
- **Wealth** when *insured*:
  - If healthy: $W_{healthy} = W_1 \underbrace{\boxed{- (W_1 - W^*)}}_{\text{AFP}} = W^*$
    - $W_{healthy} = 19,000$
  - If ill: $W_{ill} = W_1 \underbrace{\boxed{- (W_1 - W_0)}}_{\text{Loss due to illness}} \underbrace{\boxed{- (W_1 - W^*)}}_{\text{AFP}} \underbrace{\boxed{+ (W_1 - W_0)}}_{\text{Insurance benefits}} = W^*$
    - $W_{ill} = 19,000$
- **Expected value of wealth** if insured:

  $E(W^{insured}) = (Prob_{healthy} * W^*) + (Prob_{ill} * W^*) = W^* = 19,000$
- **Expected utility** if insured:

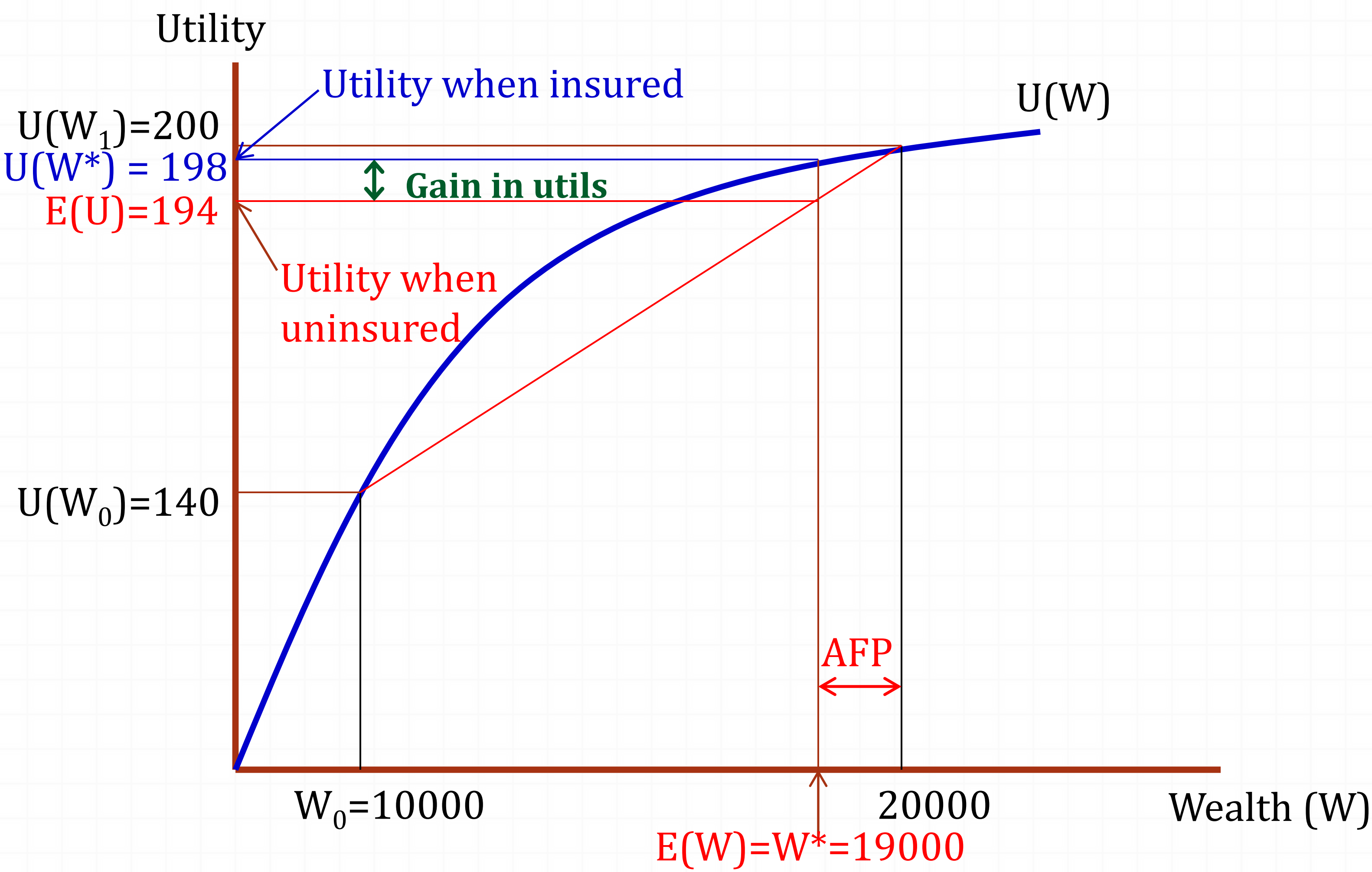
  $E(U^{insured}) = (Prob_{healthy} * U(W^*)) + (Prob_{ill} * U(W^*)) = U(W^*)$

  - Expected utility if insured is certain!

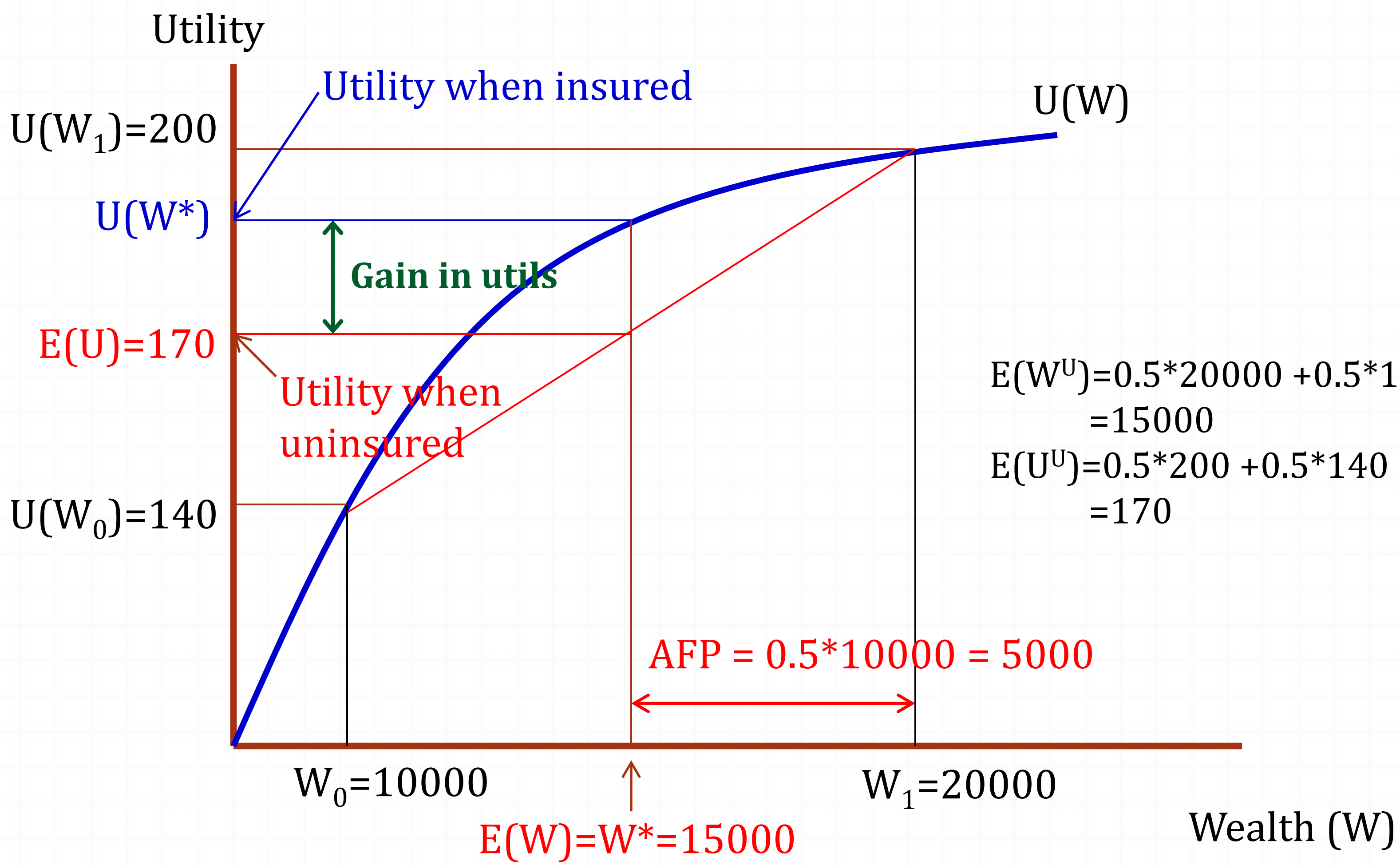
Expected Utility if Insured



Expected Utility if Insured and Uninsured



Expected Utility if Insured and Uninsured (when P_{ill}=0.5)



$E(W^U)$=0.5*20000 +0.5*10000
=15000
$E(U^U)$=0.5*200 +0.5*140
=170

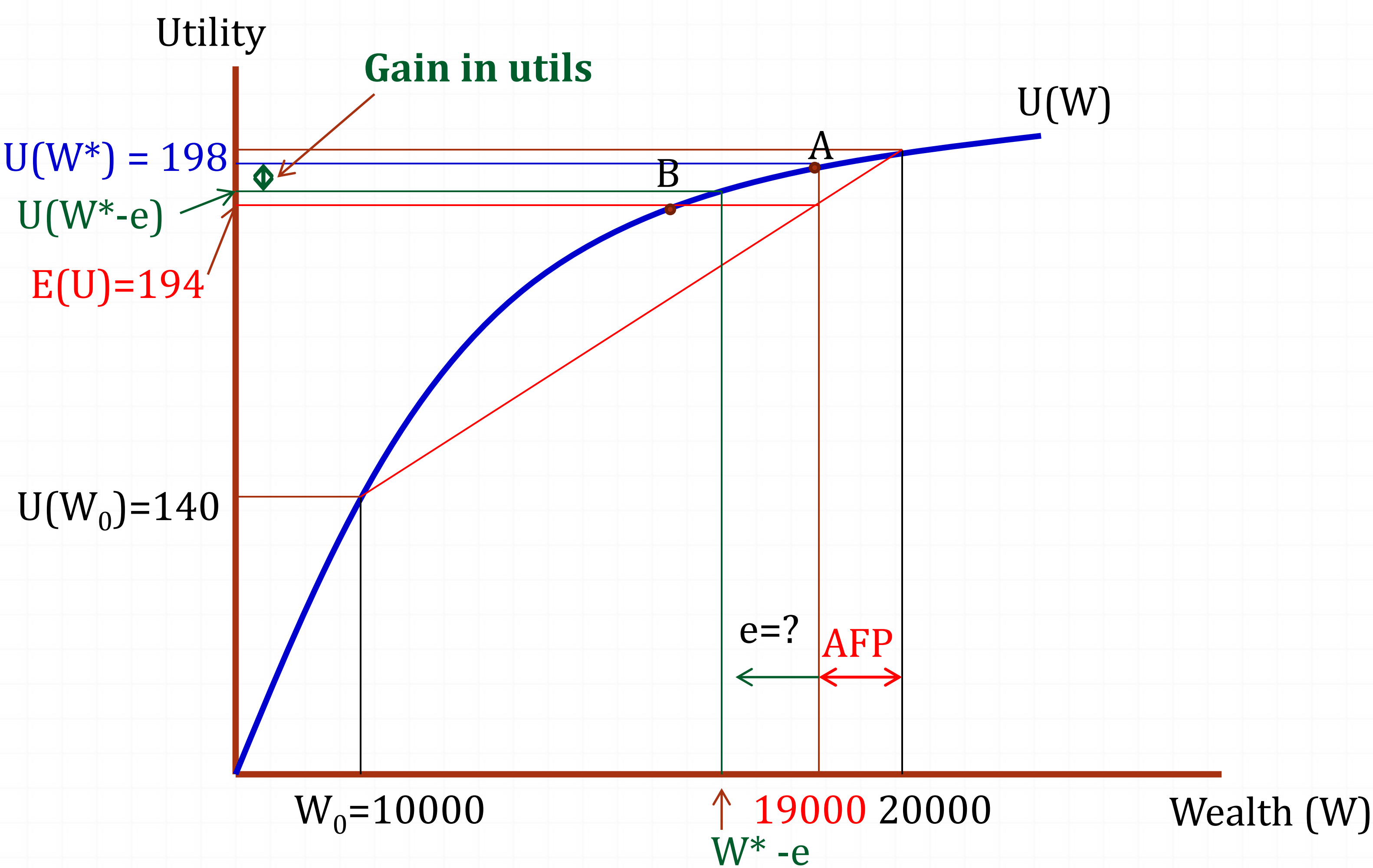
Gain from Insurance in Utility

- If insured, $EU^{ins} = U(W^*)$, and if uninsured, $EU^{unins} = E(U^{unins})$
  - Gain from insurance is $U(W^*) - E(U^{unins})$ in utility terms
  - In our example, gain from insurance = 198 – 194 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"

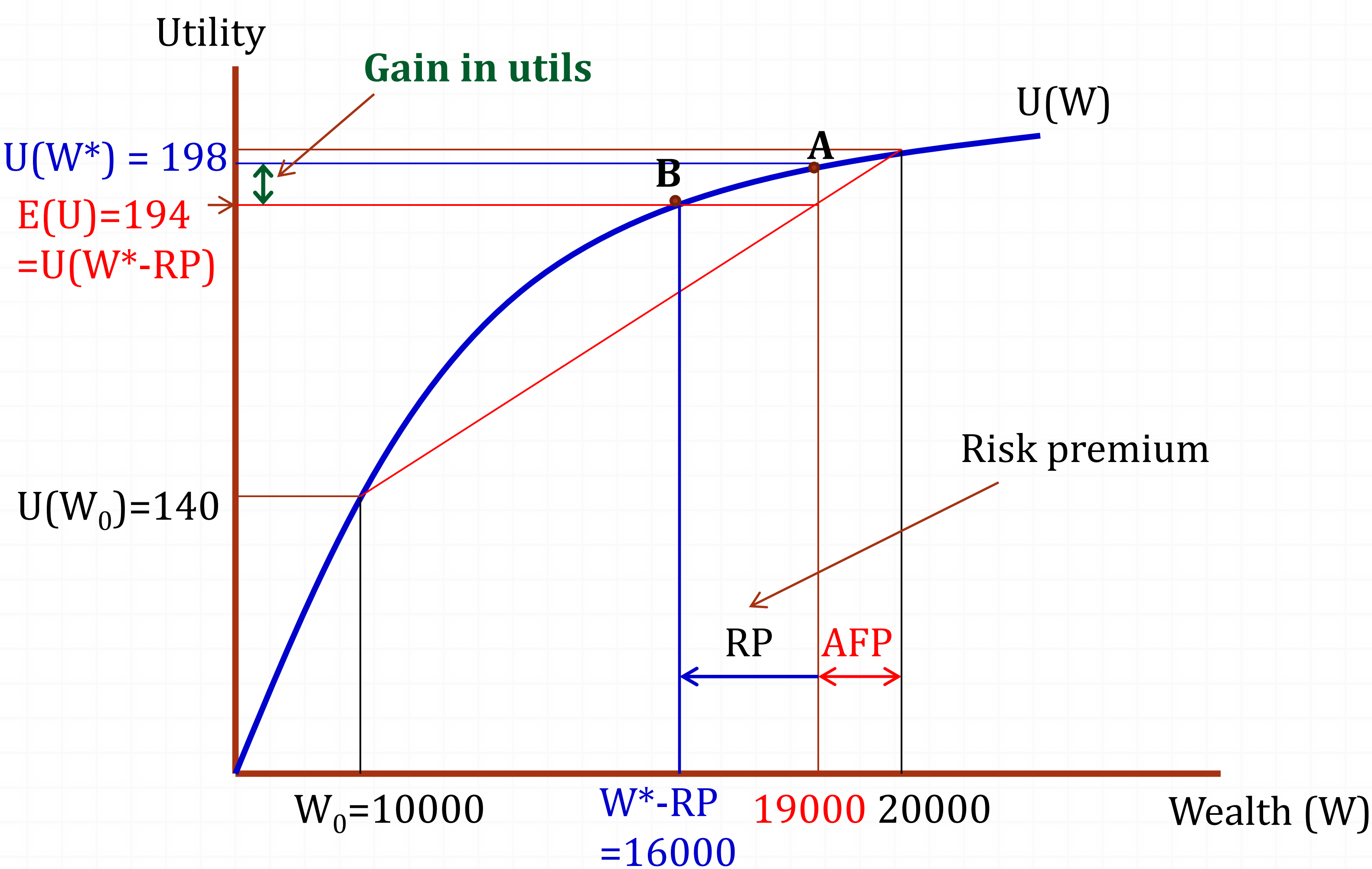
Gain from Insurance in Dollars

- 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



Gain from Insurance in Dollars



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.
- If the consumer pays AFP + RP for insurance, he would be *indifferent* to being insured or uninsured.
- 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.

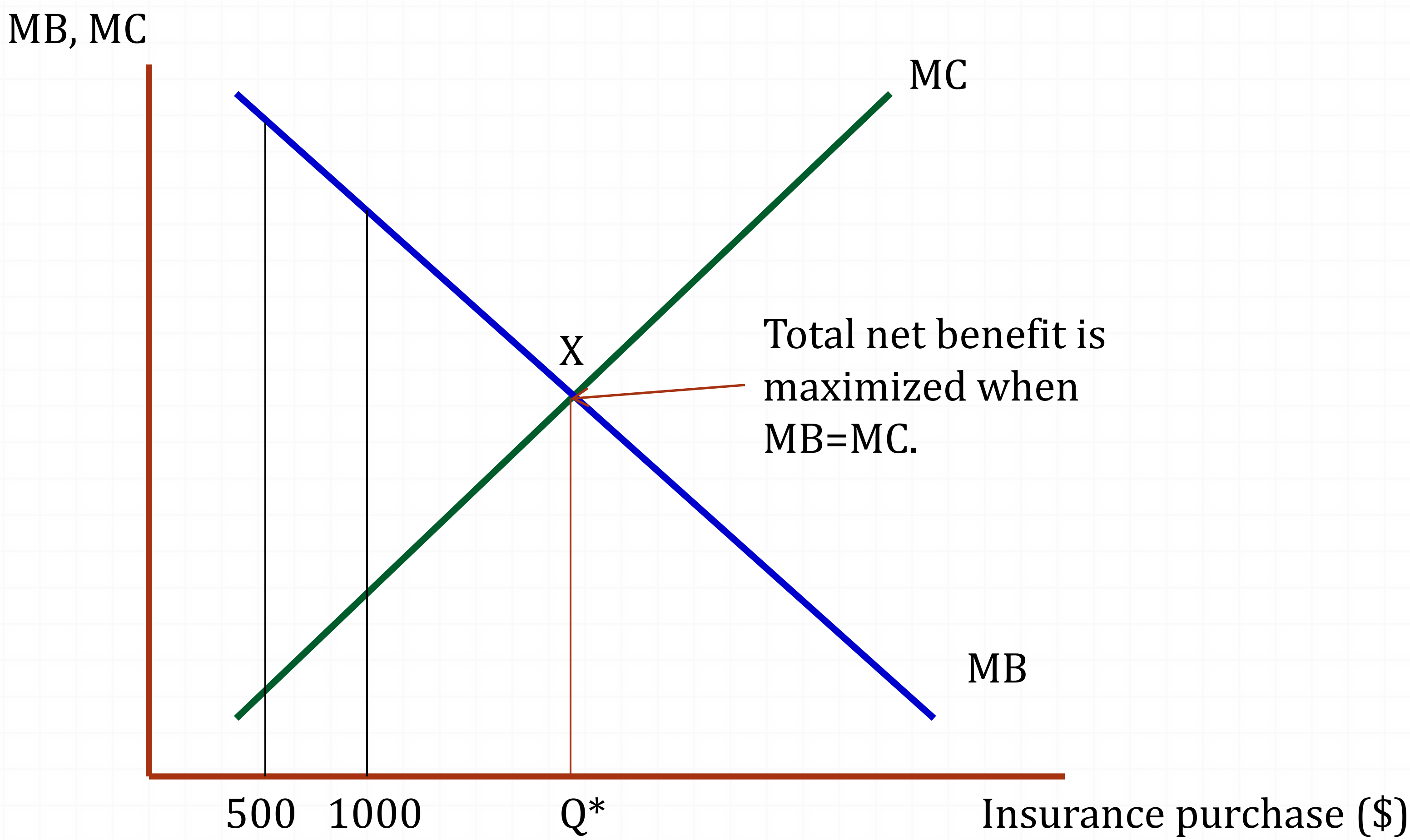
Demand for Insurance

- Apply the concepts of marginal benefits (MB) and marginal costs (MC) to determine health insurance choice.
- Suppose that the insurance coverage = \$500, and the consumer must pay a 20% premium (20%*500 = \$100).
- New wealth when ill: $W_I' = 20{,}000 - 10{,}000 - 100 + 500 = 10{,}400$
- New wealth when healthy: $W_I' = 20{,}000 - 100 = 19{,}900$
  - $MB_{500} = E[MU_{400}]$
  - $MC_{500} = E[MU_{100}]$

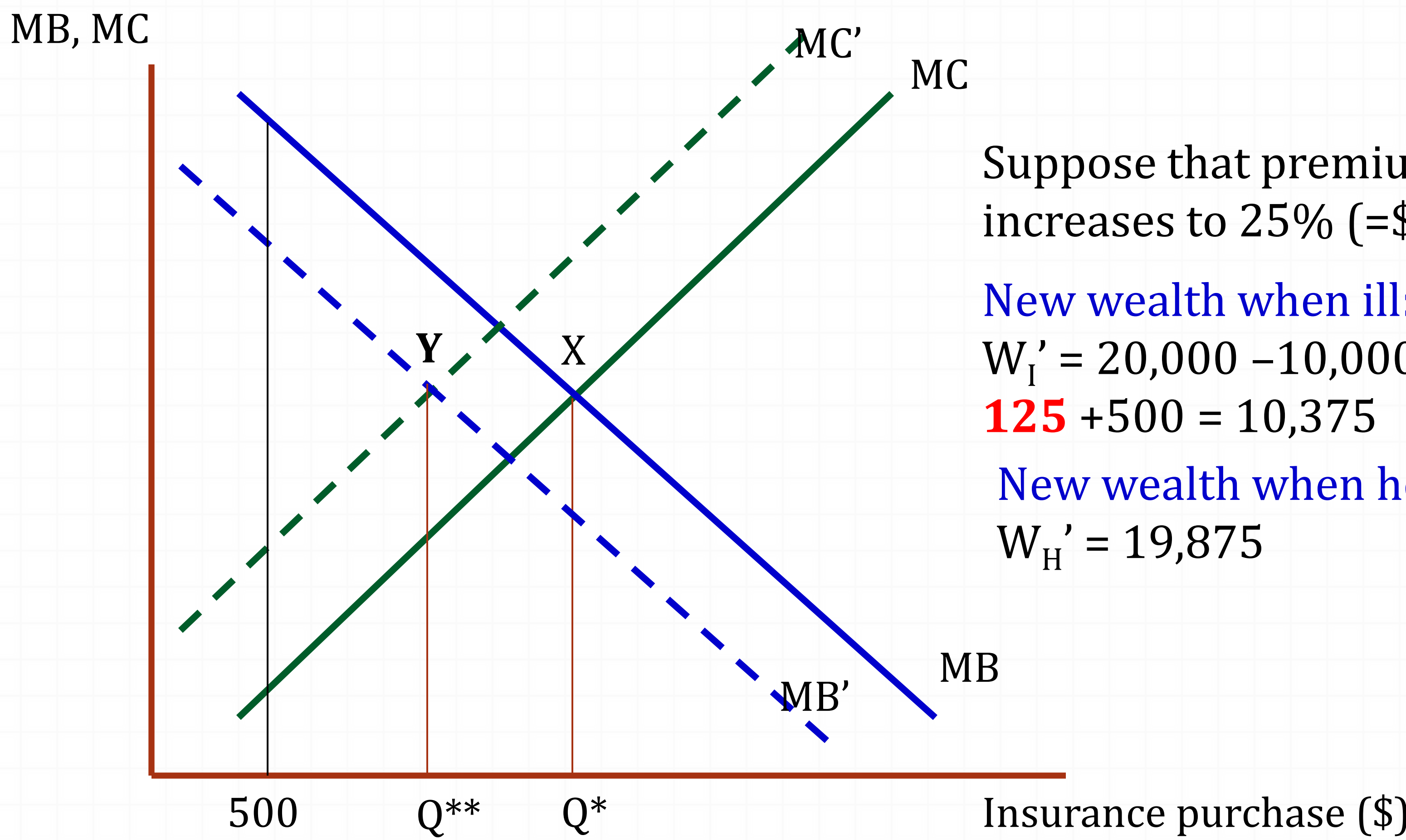
  $MB_{500} > MC_{500}$
- If purchase an additional \$500 insurance, then:
  - $MB_{1000} < MB_{500}$
  - $MC_{1000} > MC_{500}$

  b/c of diminishing marginal utility of wealth

Optimal Amount of Insurance



Optimal Amount of Insurance: Premium Increases



Suppose that premium increases to 25% (=$125)

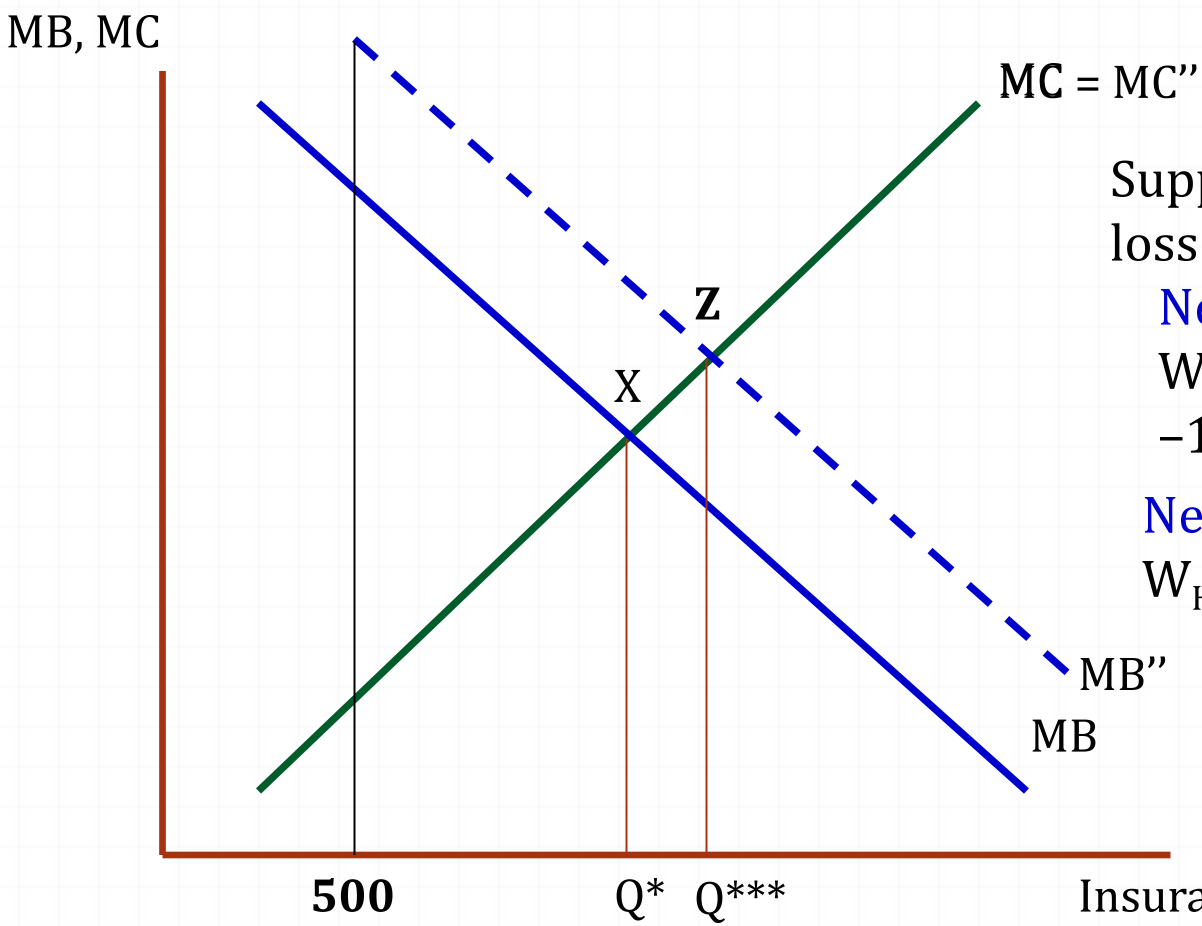
New wealth when ill:

$W_I' = 20{,}000 - 10{,}000 - \mathbf{125} + 500 = 10{,}375$

New wealth when healthy:

$W_H' = 19{,}875$

Optimal Amount of Insurance: Expected Loss Increases



Suppose that the expected loss increases to $15000.

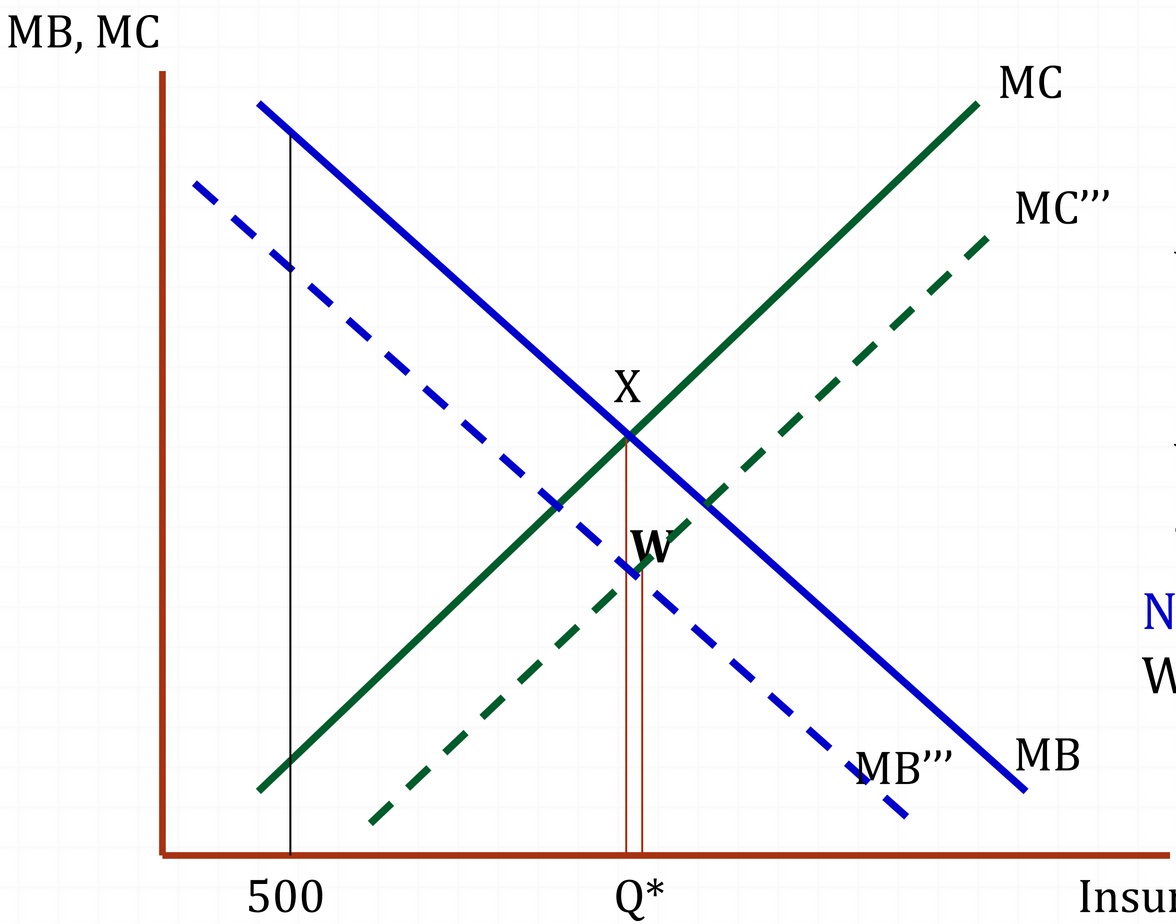
New wealth when ill:

$W_I' = 20{,}000 - \mathbf{15{,}000} - 100 + 500 = 5{,}400$

New wealth when healthy:

$W_H' = 19{,}900$

Optimal Amount of Insurance: Initial Wealth Increases



Suppose that the initial wealth increases to $25000.

New wealth when ill:

W_I' = **25,000** – 10,000 –100+ 500 = 15,400

New wealth when healthy:

W_H' = 25,990

Supply of Insurance

- Insurer's profit: Profit = Total Revenue – Total Cost
- Previous example:
  - Revenues = \$100 per policy (20%)
  - 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 – [(0.9*8) + (0.1*508)] = \$42 >0

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).
  - Profit = 75 – [(0.9*8) + (0.1*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: $Profit = aq - pq - t = 0$

  $\boxed{a = p + (t/q)}$ ⟸ "Competitive premium rate"
- When t=0, the premium is the actuarially fair rate

  → $a = p$.
- Example: p = 0.1, t= 8, q=500

  → $a^* = 0.116$

Optimal Level of Coverage

- 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):
  - $W_{healthy} = \$20{,}000 - (a*q)$
  - $W_{ill} = \$20{,}000 - \$10{,}000 - (a*q) + q$

➔ $q^* = 10{,}000$

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

➔ Not necessarily the case!