

DEMAND AND SUPPLY OF HEALTH INSURANCE

EE 474 Health Economics

Semester 1/2014

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:

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

Expected Value (In General)

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

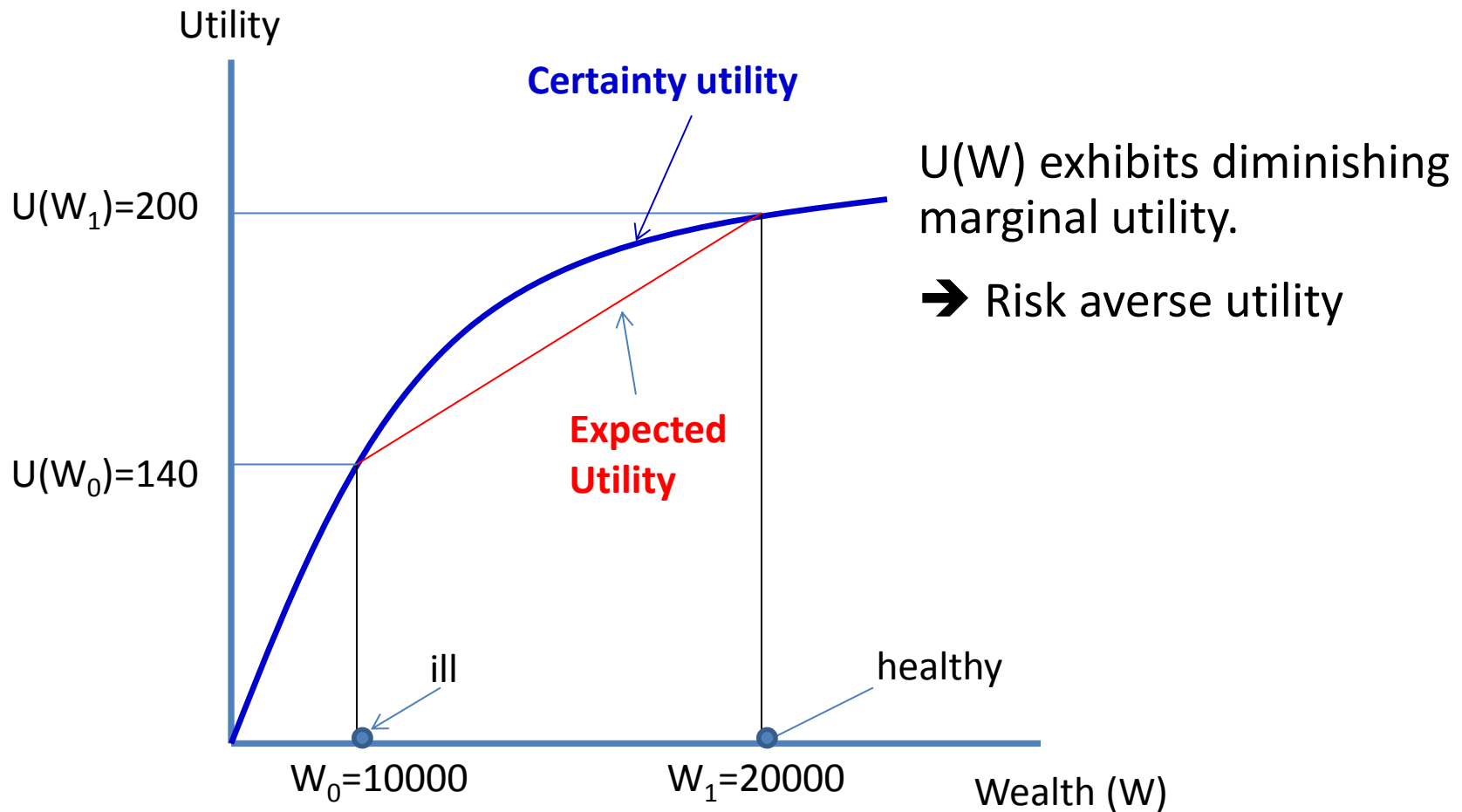
$$E = p_1 R_1 + p_2 R_2 + \dots + p_n R_n$$

- p_i is the probability of outcome i , ($i = 1, 2, \dots, n$)
 - 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. (**prize = 2^n**)?
- $EV = (1/2)*\$1 + (1/4)*\$2 + (1/8)*\$4 + (1/16)*\$8 + \dots$
 $= 0.5 + 0.5 + 0.5 + 0.5 + \dots = \infty$

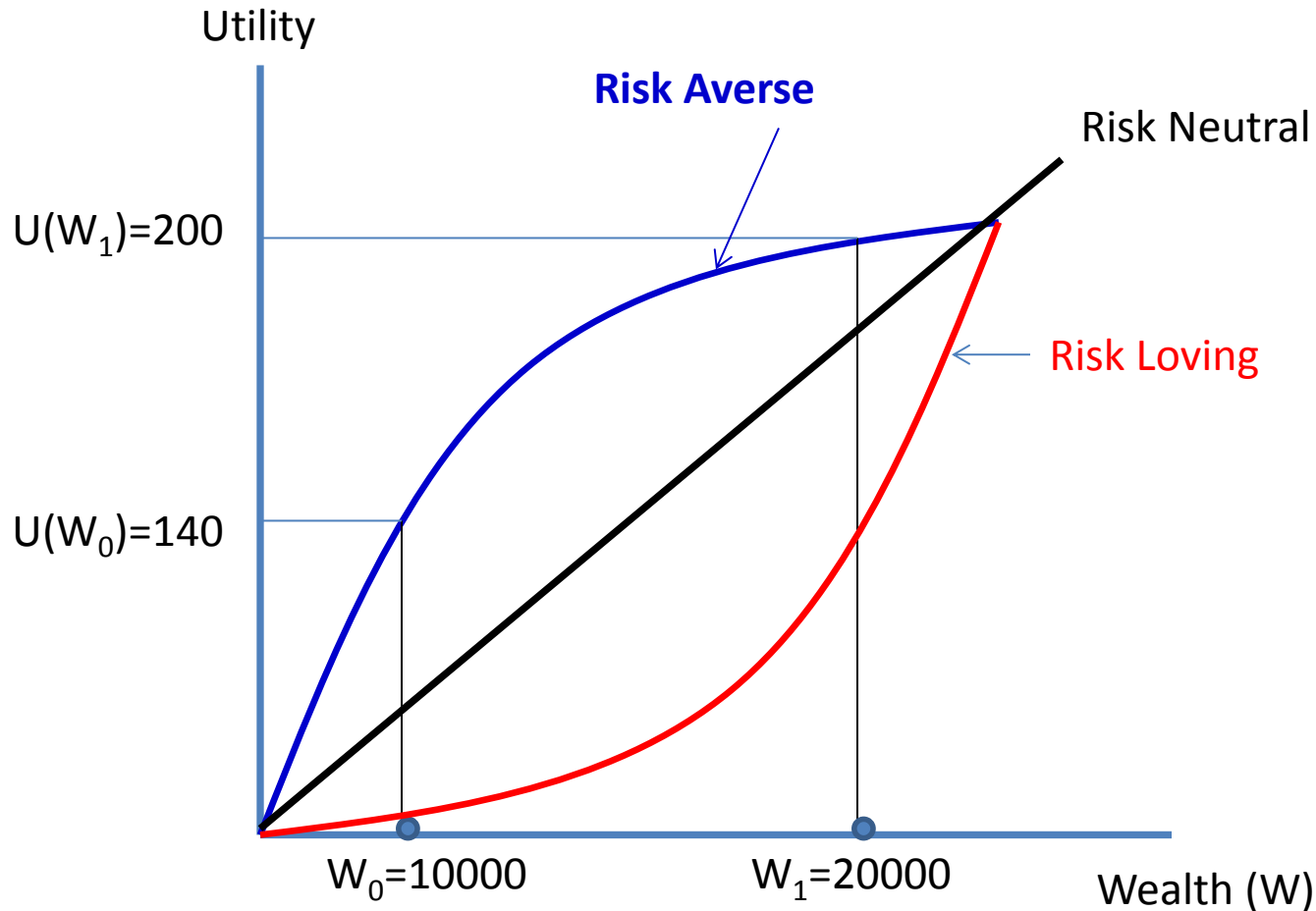
Marginal Utility of Wealth and Risk Aversion

- 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



Other Types of Utility



Expected Wealth and Expected Utility if Uninsured

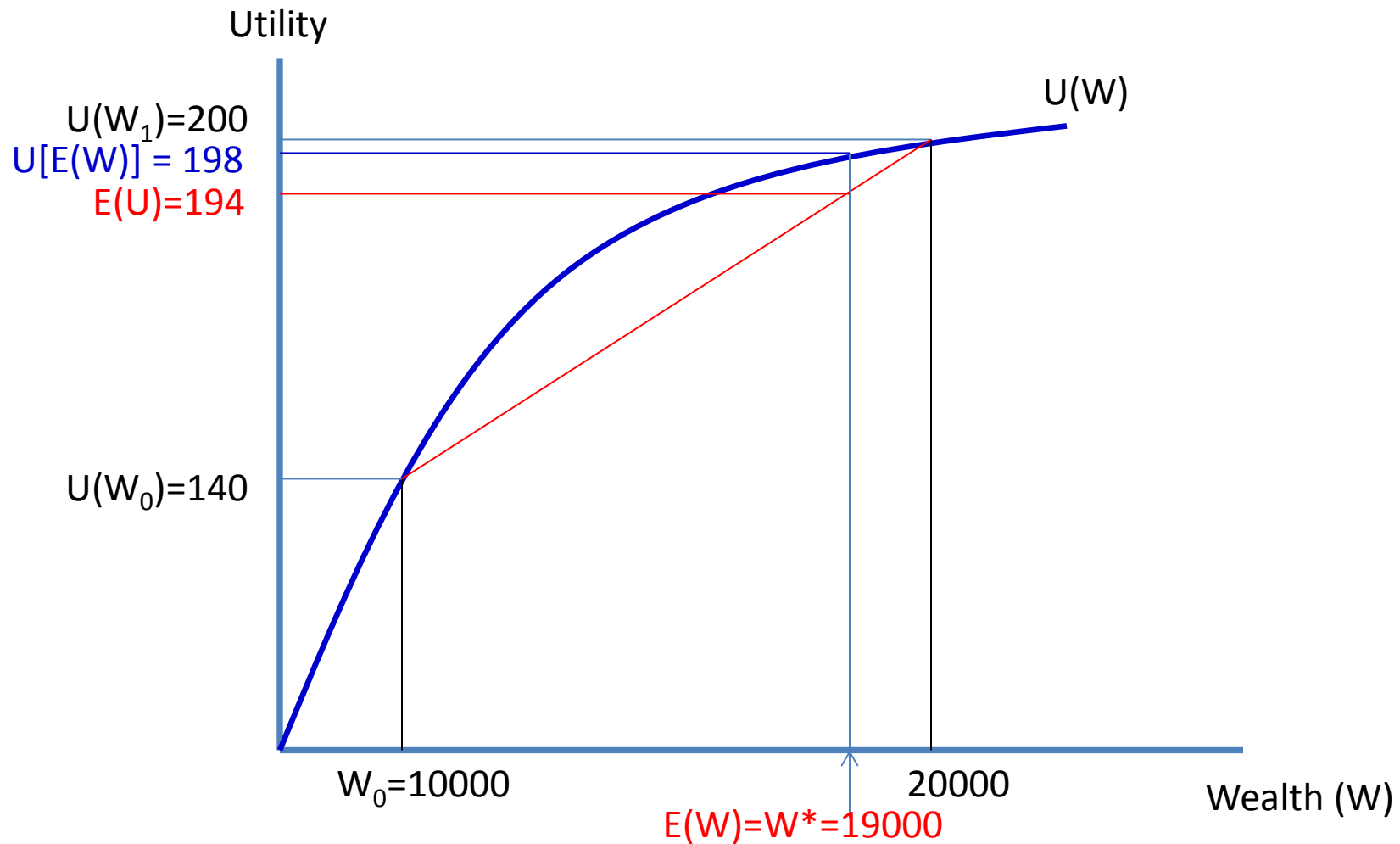
- Suppose the probability of being ill is 0.1 (probability of being healthy = 0.9), and the illness incurs a \$10,000 expense.
- **Expected value of wealth:**

$$\begin{aligned} E(W^{\text{uninsured}}) &= (\text{Prob}_{\text{healthy}} * W_{\text{healthy}}) + (\text{Prob}_{\text{ill}} * W_{\text{ill}}) \\ &= (0.9 * 20000) + (0.1 * 10000) \\ &= \$19,000 \end{aligned}$$

- **Expected utility of wealth:**

$$\begin{aligned} E(U^{\text{uninsured}}) &= (\text{Prob}_{\text{healthy}} * U_{\text{healthy}}) + (\text{Prob}_{\text{ill}} * U_{\text{ill}}) \\ &= (0.9 * 200) + (0.1 * 140) \\ &= 194 \end{aligned}$$

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)
 - $AFP = \text{Prob}_{\text{ill}} * (W_1 - W_0) = 0.1 * (20000 - 10000) = 1000$
 - 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**: $W_{\text{healthy}} = W_1 - \boxed{(W_1 - W^*)} = W^*$

➤ $W_{\text{healthy}} = 19,000$

- If **ill**: $W_{\text{ill}} = W_1 - \boxed{(W_1 - W_0)} - \boxed{(W_1 - W^*)} + \boxed{(W_1 - W_0)} = W^*$

➤ $W_{\text{ill}} = 19,000$

- Expected value of wealth** if insured:

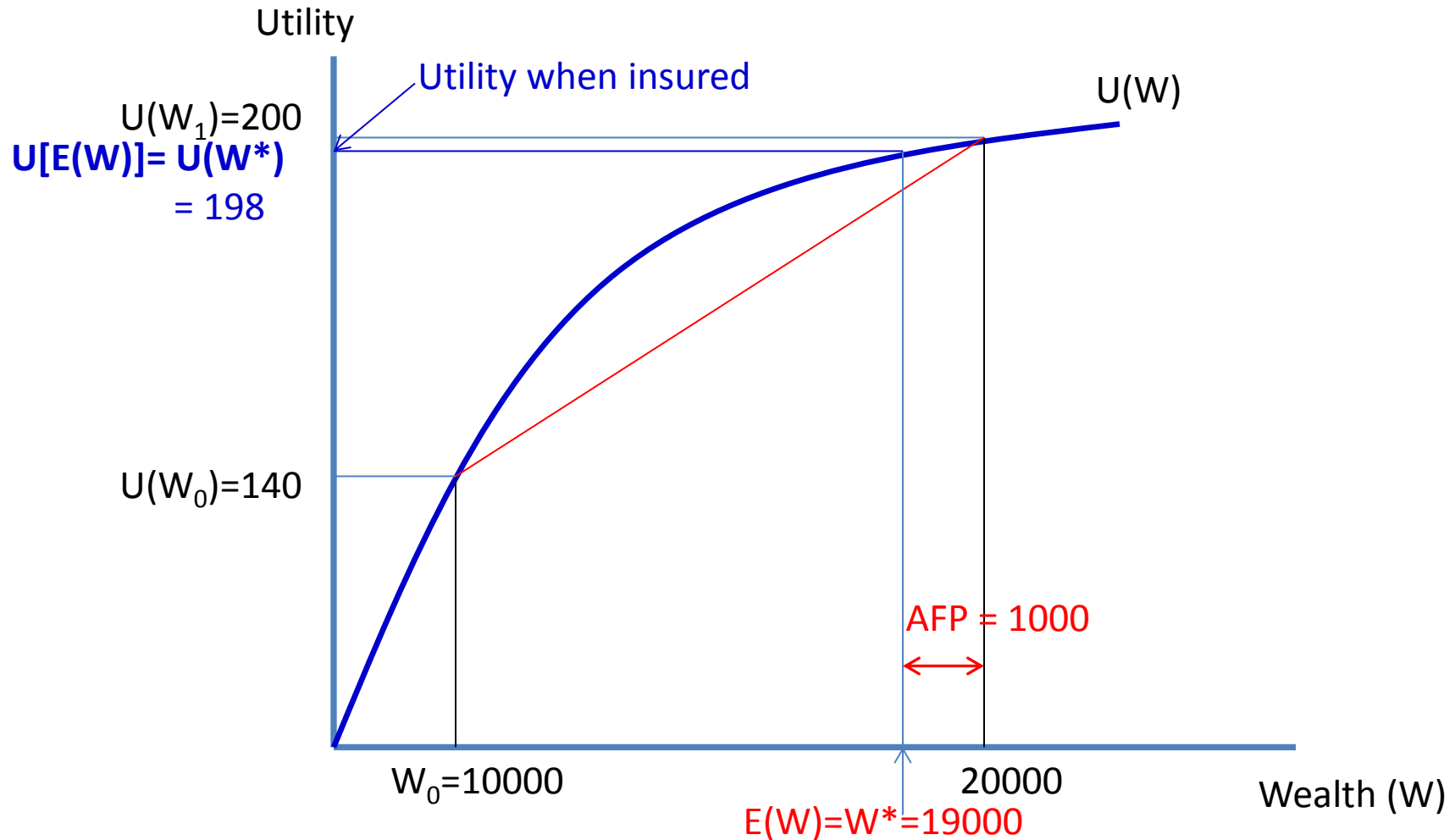
$$E(W^{\text{insured}}) = (\text{Prob}_{\text{healthy}} * W^*) + (\text{Prob}_{\text{ill}} * W^*) = W^* = 19,000$$

- Expected utility** if insured:

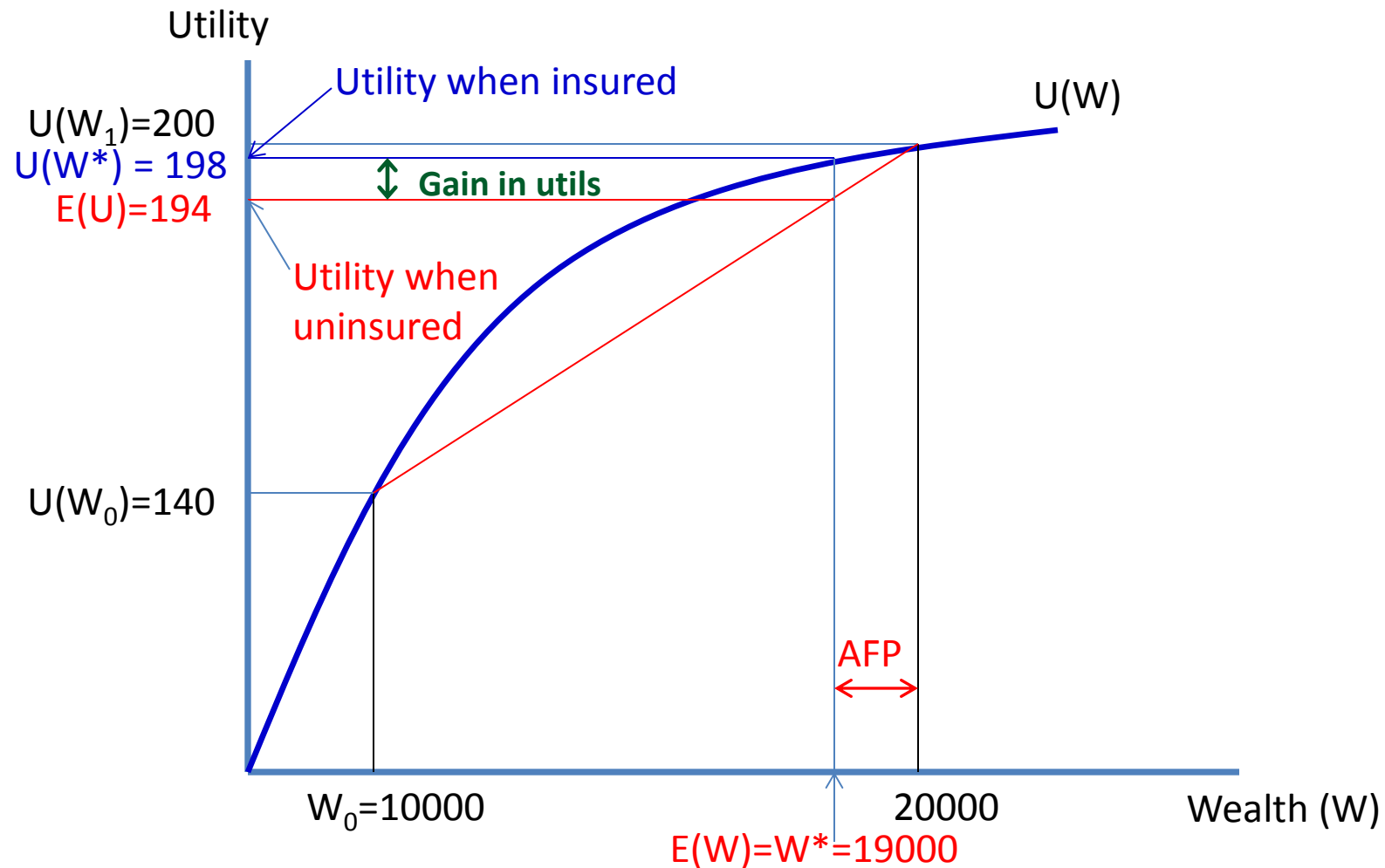
$$E(U^{\text{insured}}) = (\text{Prob}_{\text{healthy}} * U(W^*)) + (\text{Prob}_{\text{ill}} * U(W^*)) = U(W^*)$$

➤ Expected utility if insured is certain!

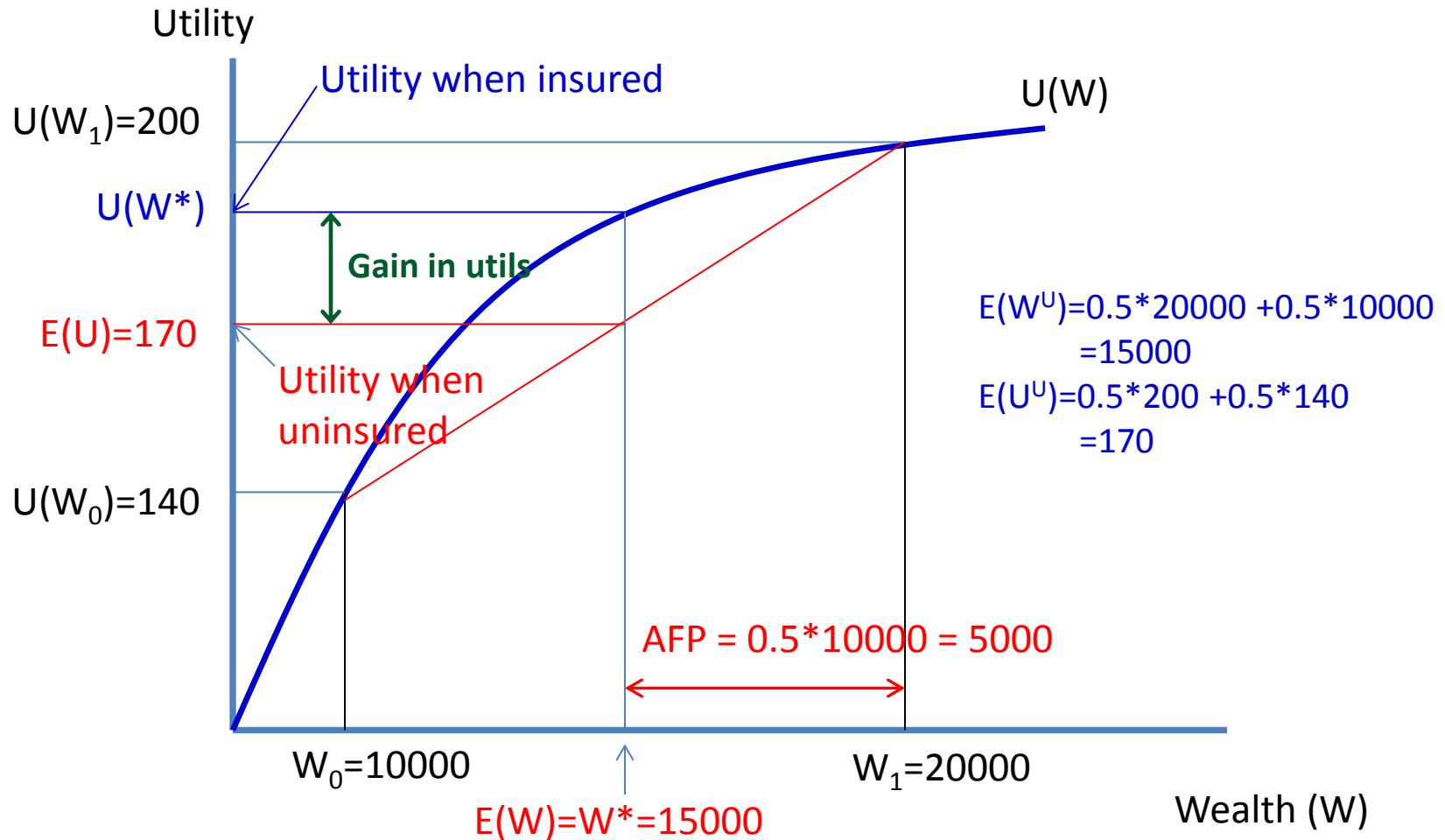
Expected Utility if Insured



Expected Utility if Insured and Uninsured



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



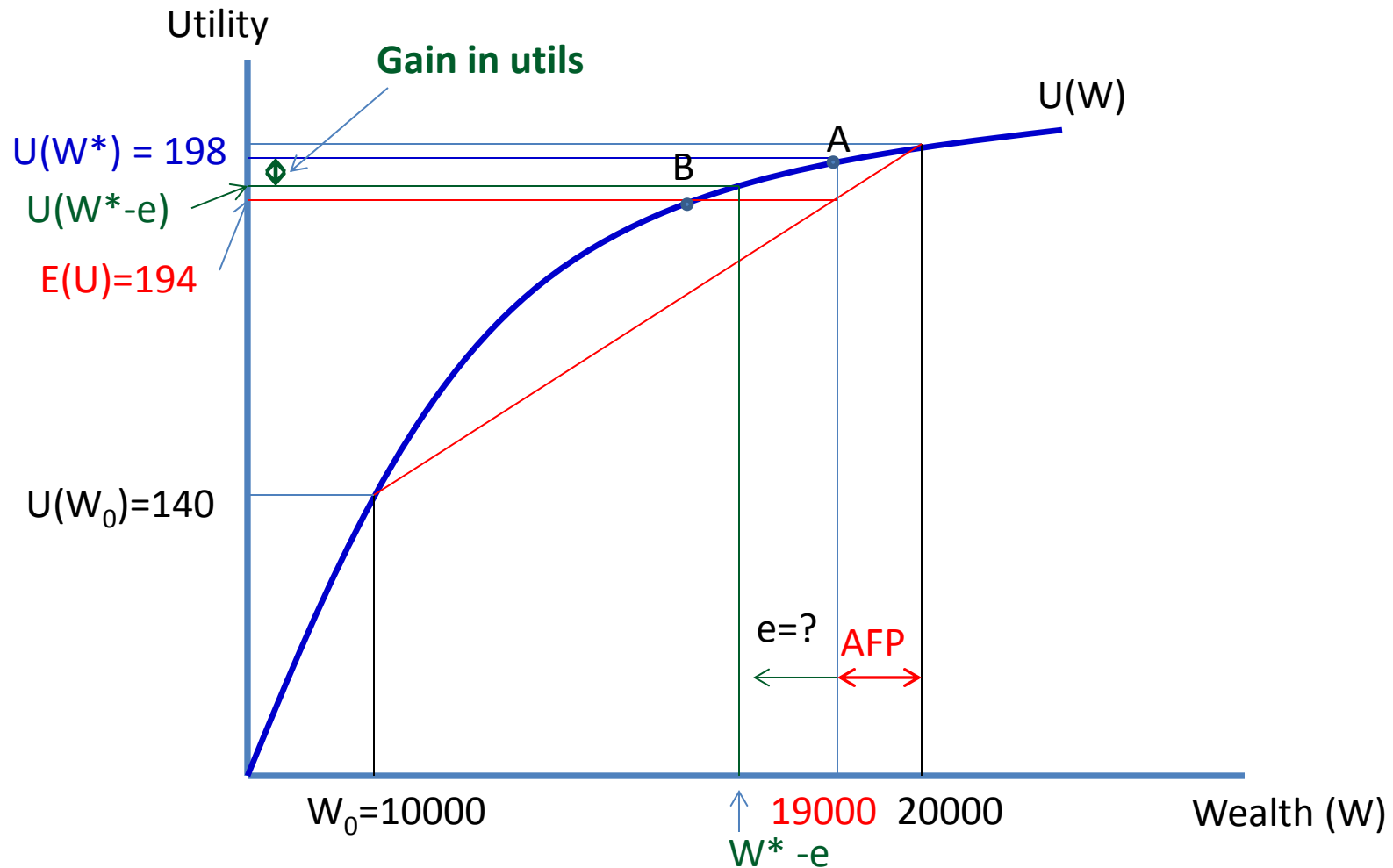
Gain from Insurance in Utility

- If **insured**, $EU^{\text{ins}} = U(W^*)$, and if **uninsured**, $EU^{\text{unins}} = E(U^{\text{unins}})$
 - Gain from insurance is $U(W^*) - E(U^{\text{unins}})$ 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”

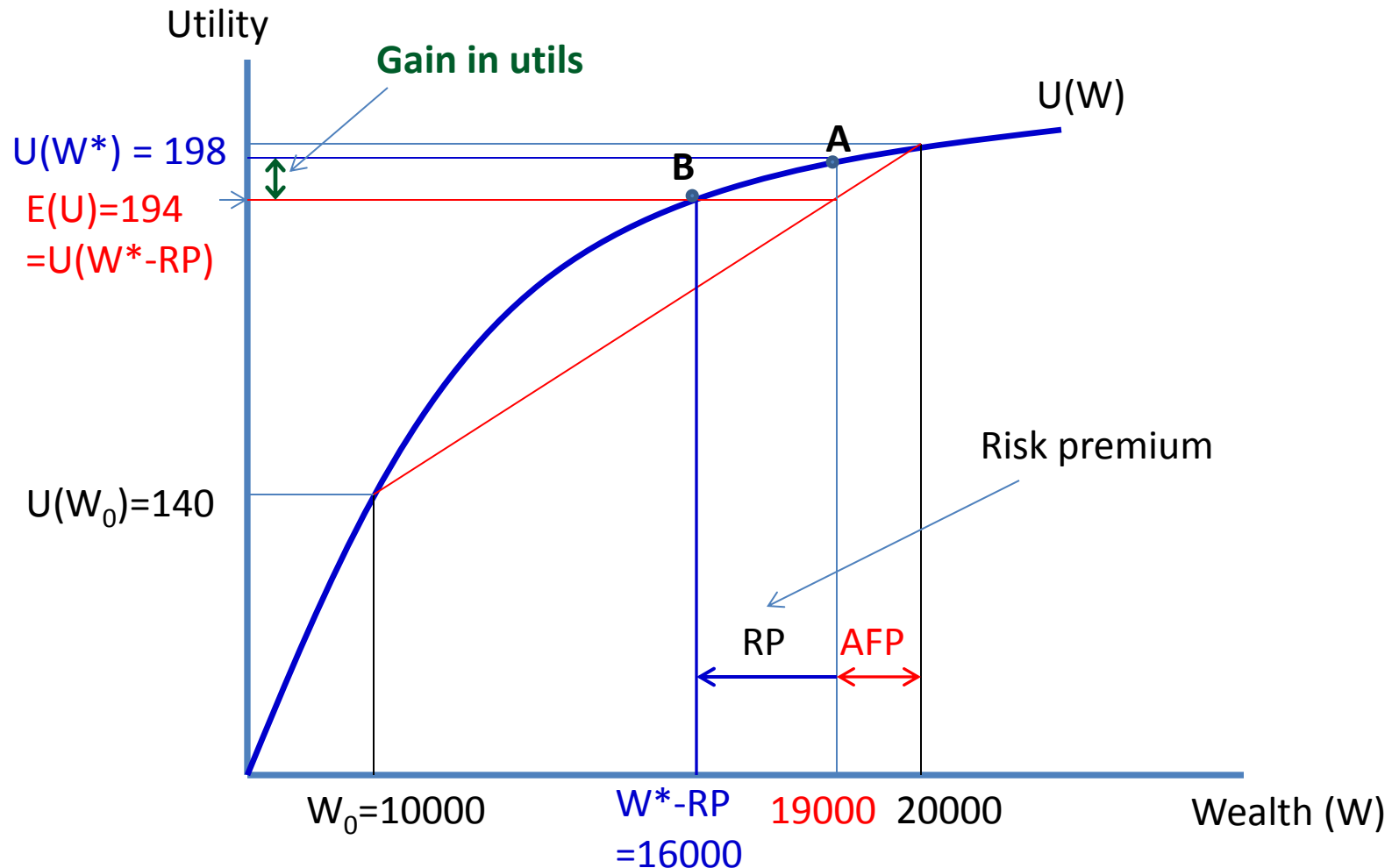
Gain from Insurance in Dollars

- 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 $U(W)=194$.

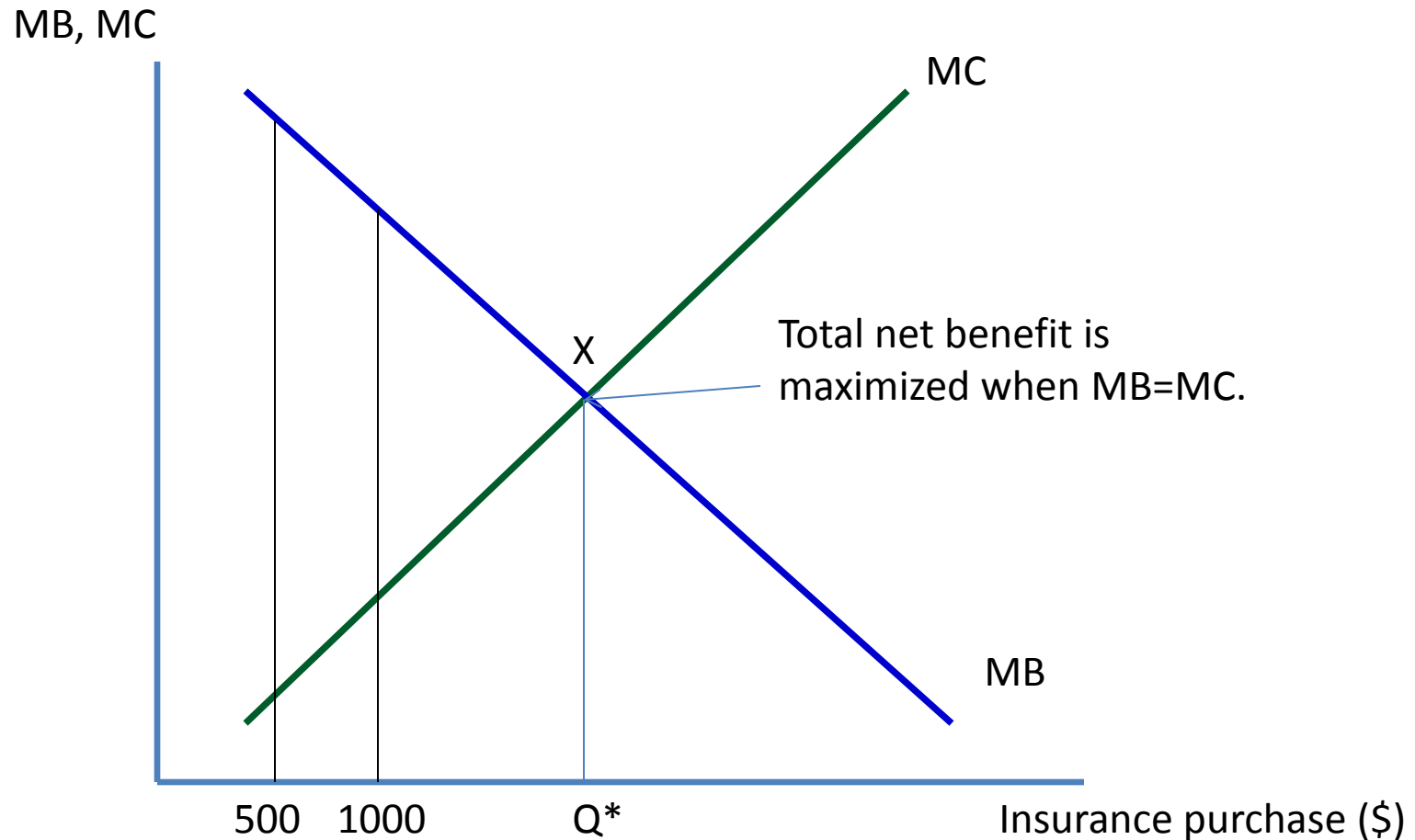
Demand for Insurance

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

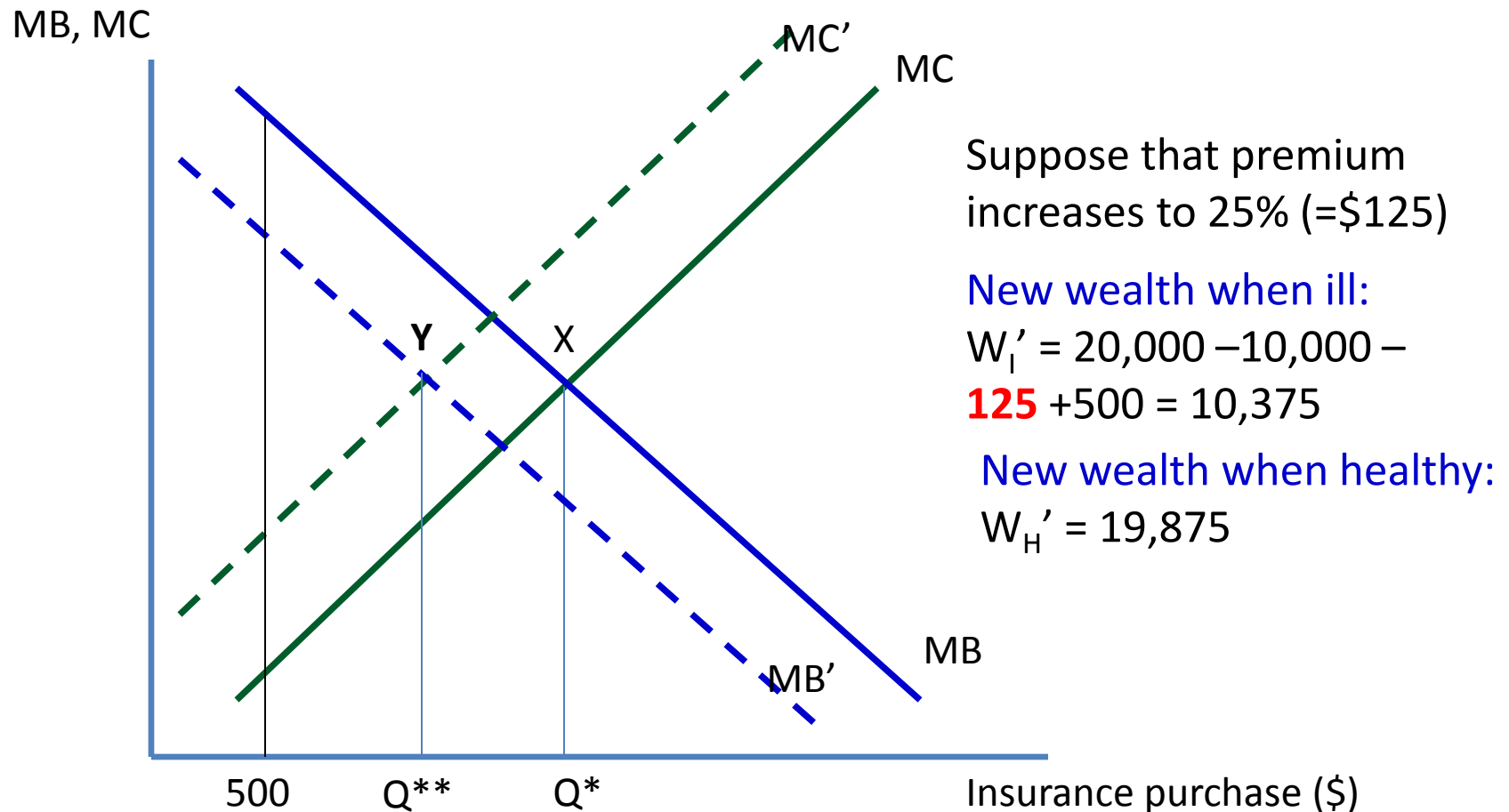
} $MB_{500} > MC_{500}$
- If purchase an additional \$500 insurance, then:
 - $MB_{1000} < MB_{500}$
 - $MC_{1000} > MC_{500}$

} b/c of diminishing marginal utility of wealth

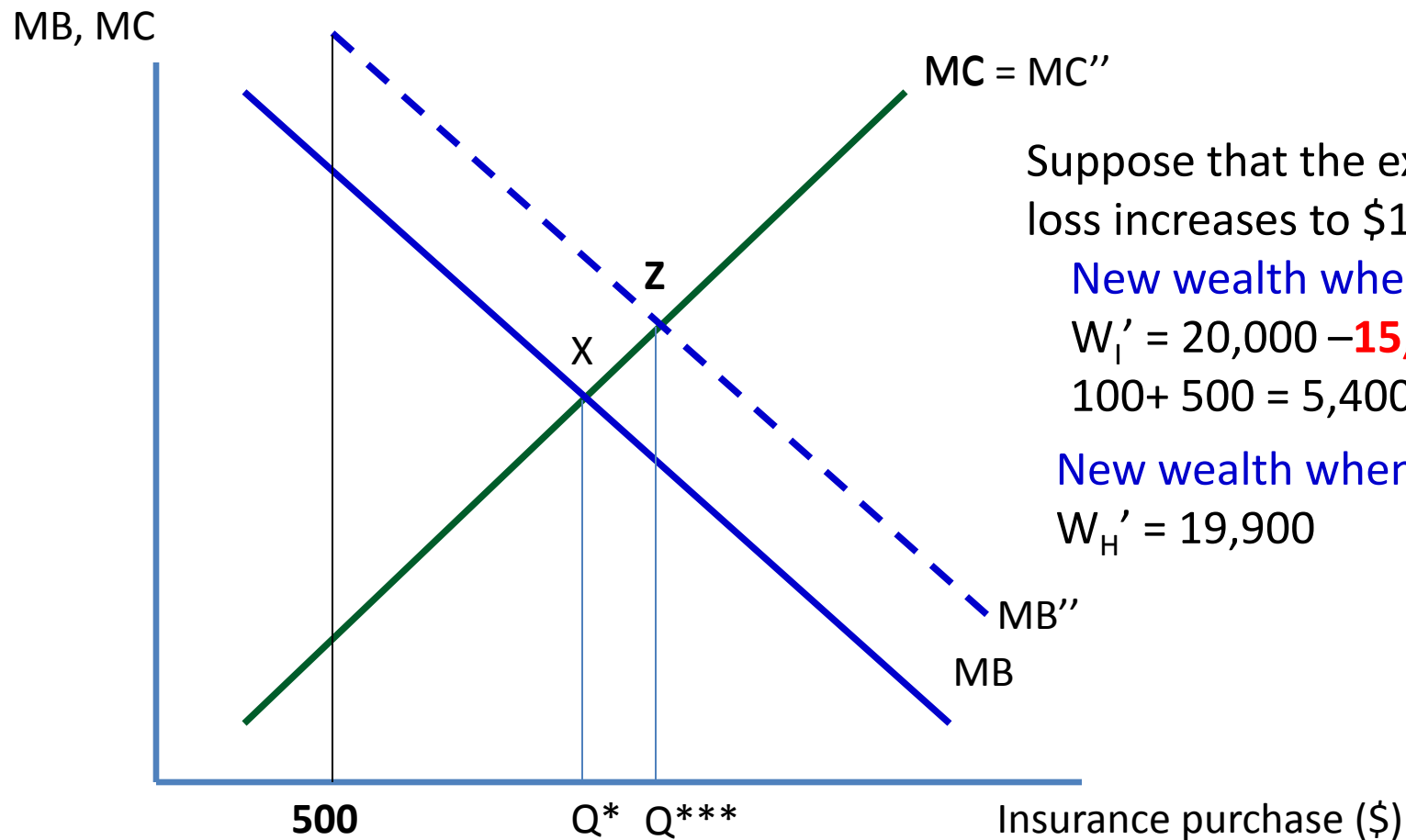
Optimal Amount of Insurance



Optimal Amount of Insurance: Premium Increases



Optimal Amount of Insurance: Expected Loss Increases



Supply of Insurance

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

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 = $75 - [(0.9 \cdot 8) + (0.1 \cdot 508)] = \$17 > 0$
- 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: $Profit = aq - pq - t = 0$

$$a = p + (t/q)$$



“Competitive premium rate”

- When $t=0$, the premium is the actuarially fair rate

➔ $a = p.$

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

➔ $a^* = 0.116$

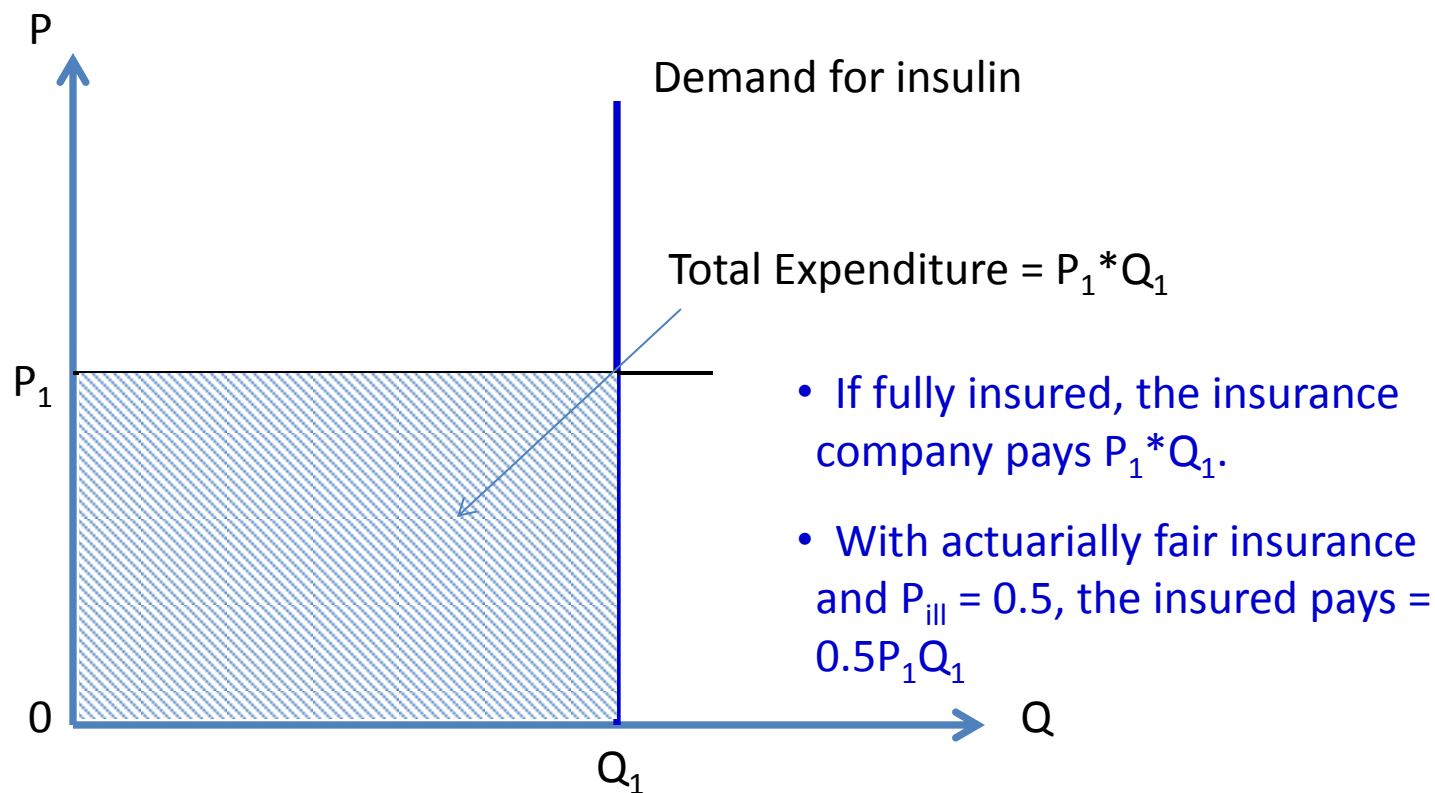
Optimal Level of Coverage

- 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):
 - $W_{healthy} = \$20,000 - (a * q)$
 - $W_{ill} = \$20,000 - \$10,000 - (a * q) + q$
 - $W_{healthy} = W_{ill} \Rightarrow q^* = 10,000$
- ➔ Optimal coverage is equal to the health care cost (in the absence of loading fees).
- ➔ Not necessarily the case!

What is Moral Hazard?

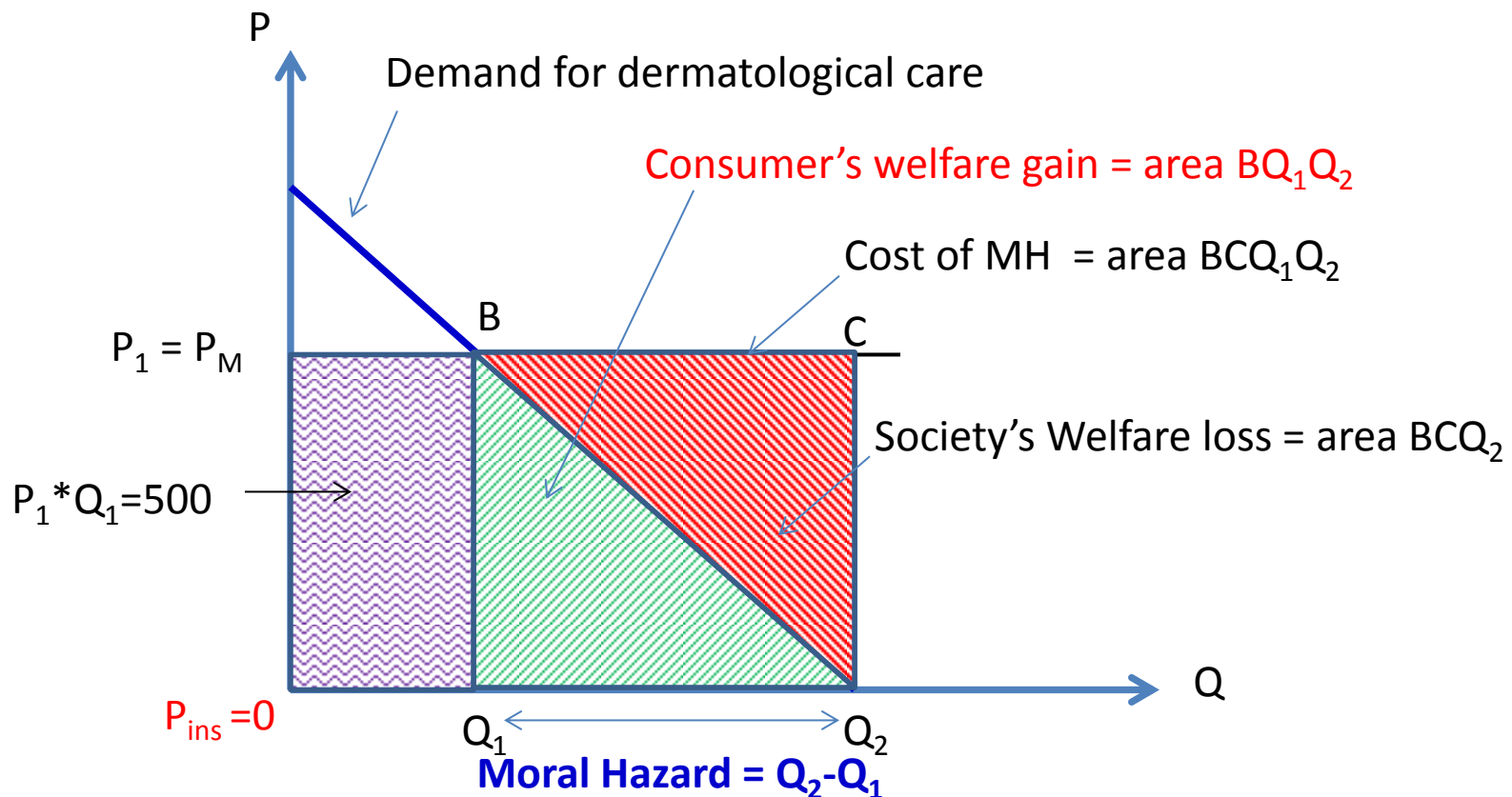
- **Moral hazard** is the change in behavior that is associated with becoming insured
- **Ex post moral hazard** refers to the change in behavior *after* you become ill
 - An increase in health care consumption by the insured consumers
- **Ex ante moral hazard** refers to the change in behavior *before* you become ill
 - 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)



➔ No welfare loss!

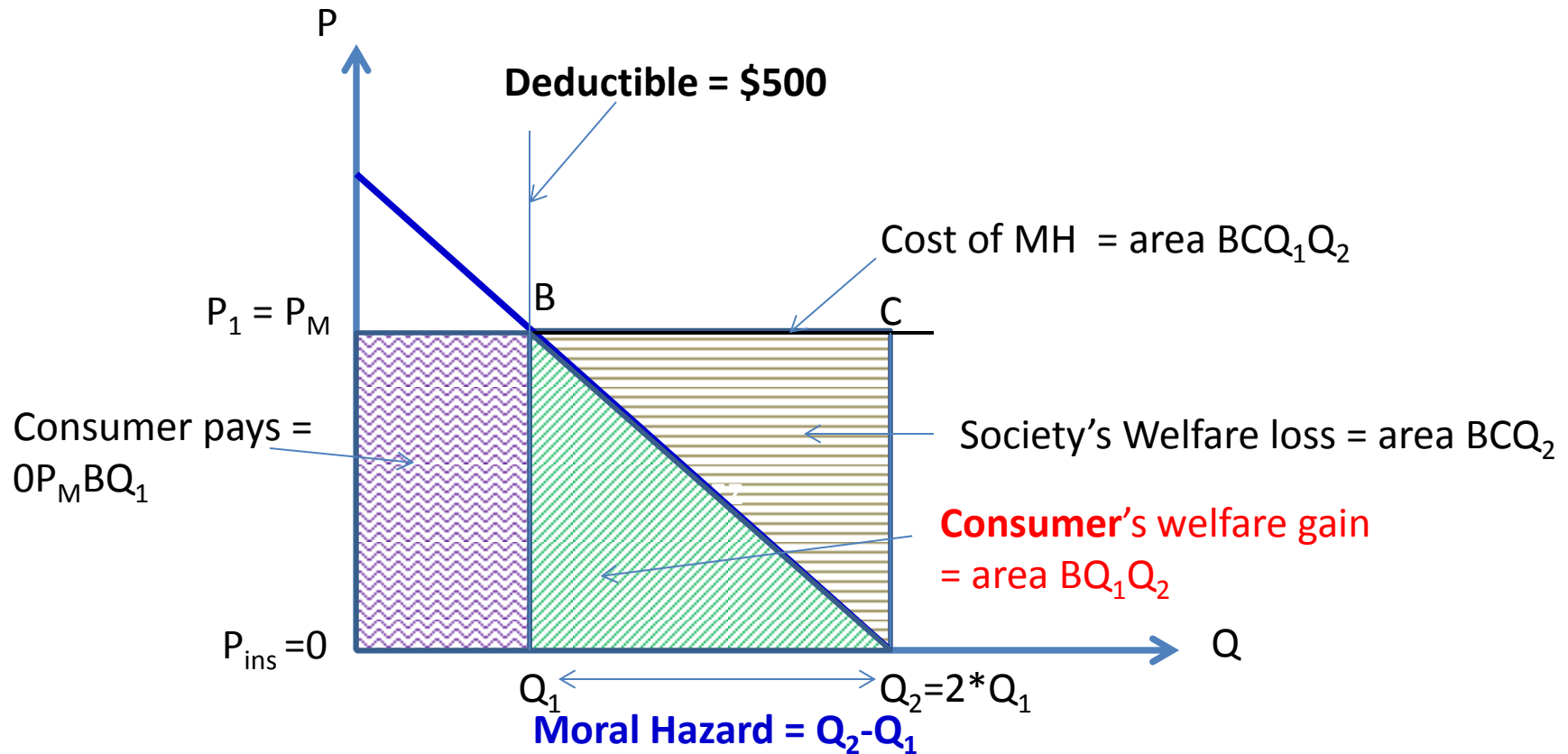
Demand for Care and Moral Hazard (Relatively Elastic Demand & Full insurance)



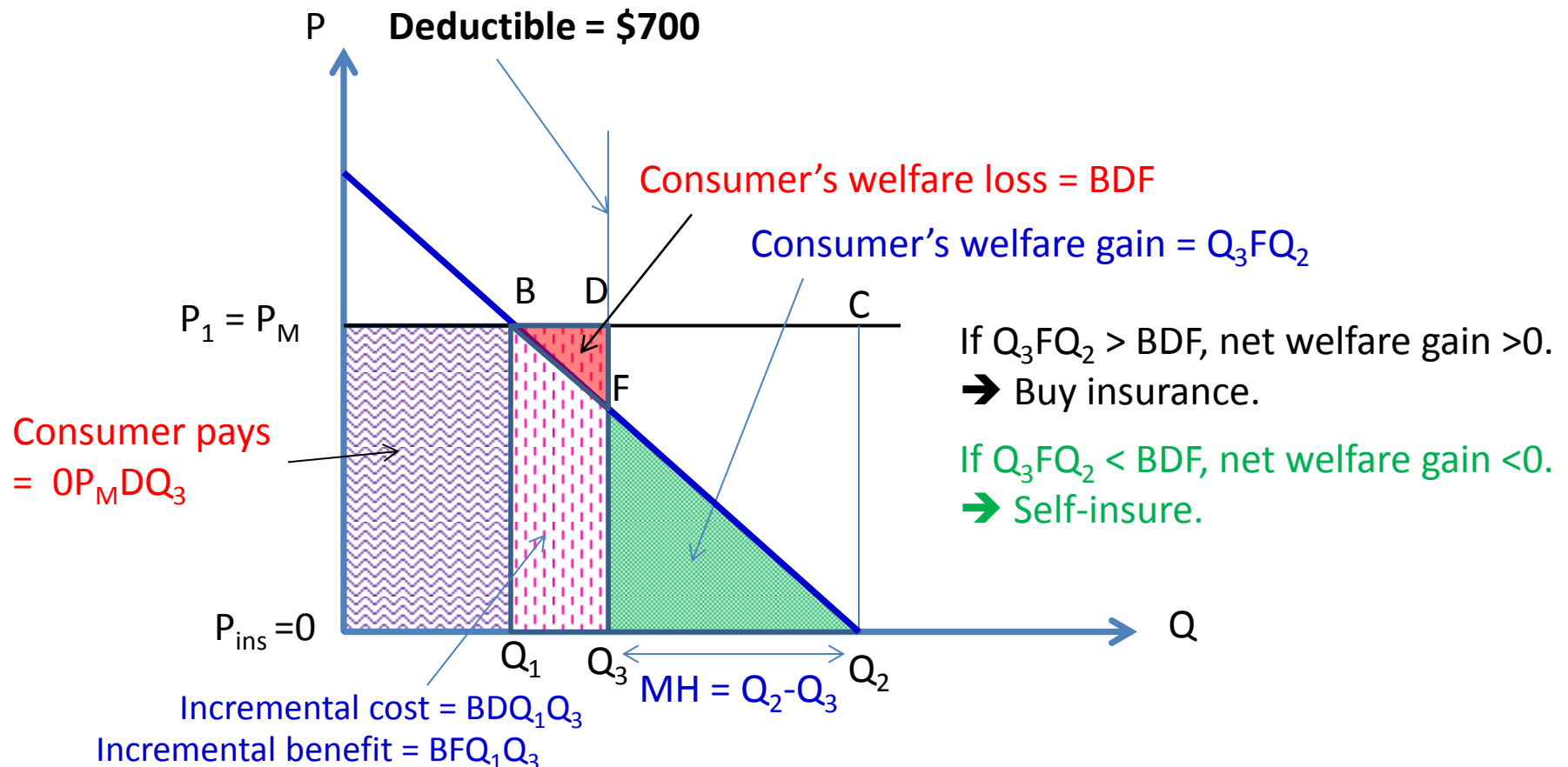
Predictions on the Types of Health Insurance

- 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

Demand for Care and Moral Hazard (Elastic Demand & Deductible)



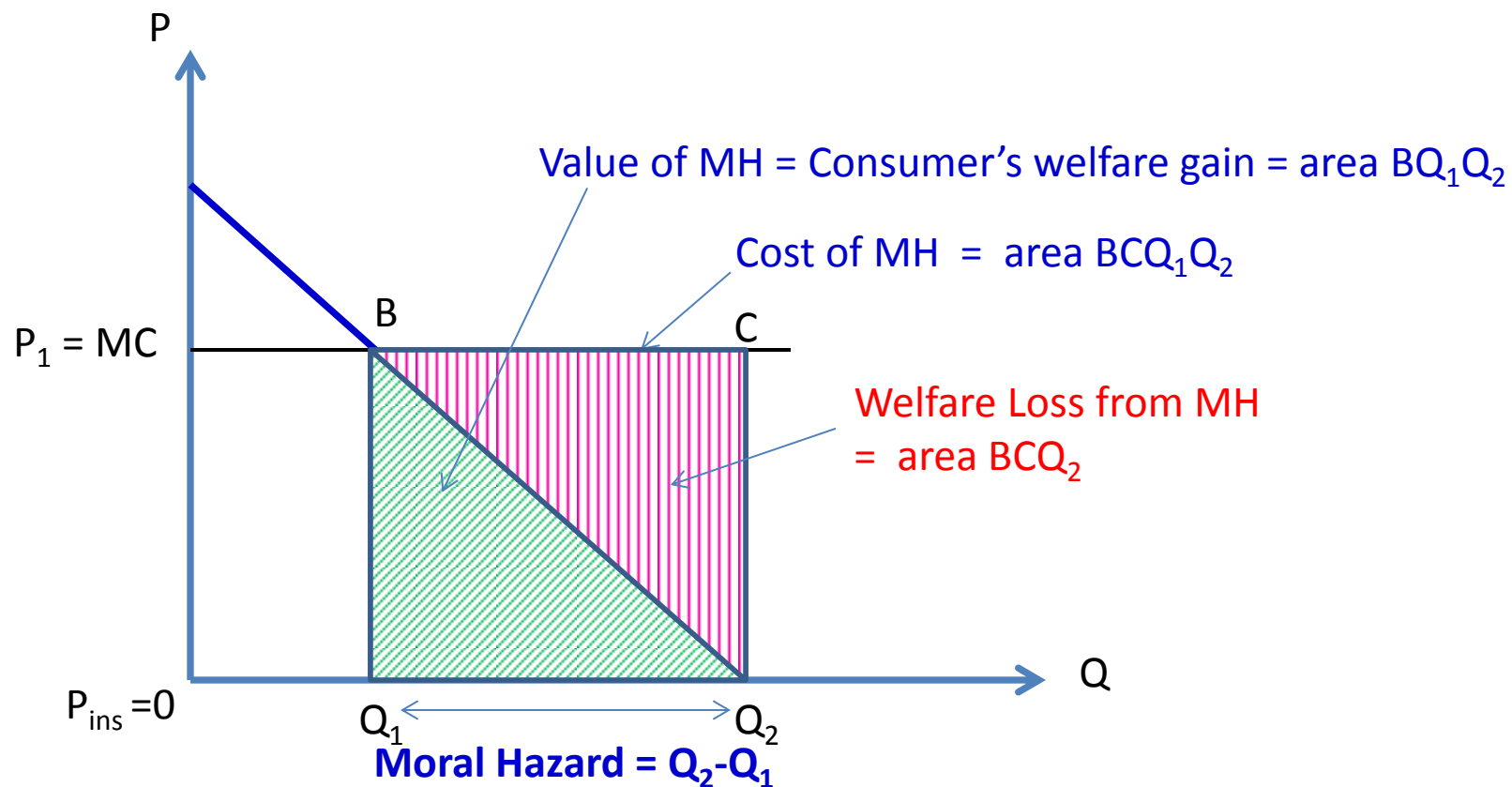
Demand for Care and Moral Hazard (Elastic Demand & Deductible)



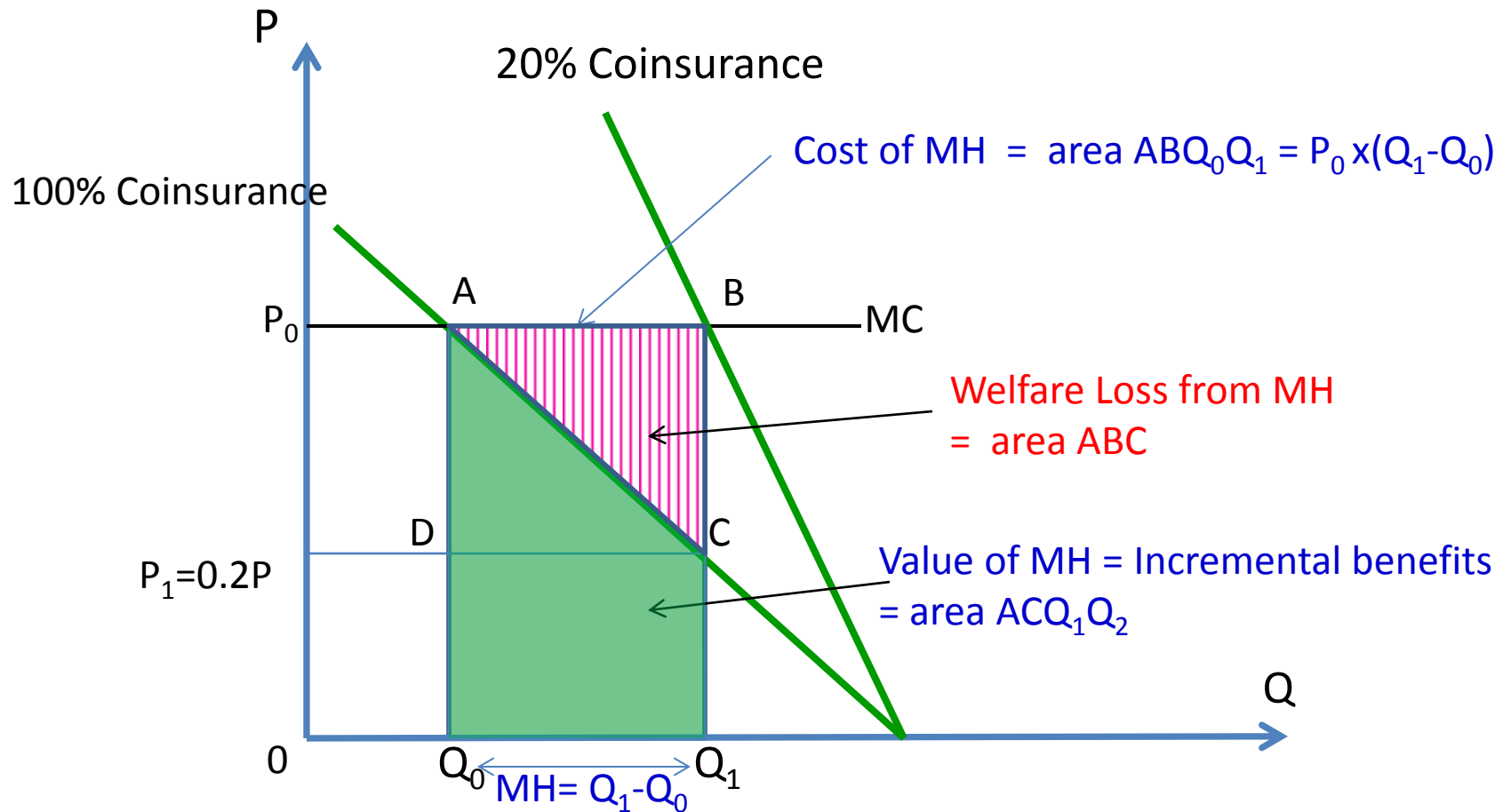
Efficient Allocation of Resources

- The **efficient allocation** of society's scarce resources occurs when **marginal cost (MC) equals marginal benefits (MB)**.
 - MC = The incremental cost of bringing the resources to market
 - MB = The valuation to those who buy the resources
- If $MB \neq MC$, 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.
 - $MC > MB \rightarrow$ **Welfare loss to society**

Moral Hazard and Welfare Loss (Full Insurance)

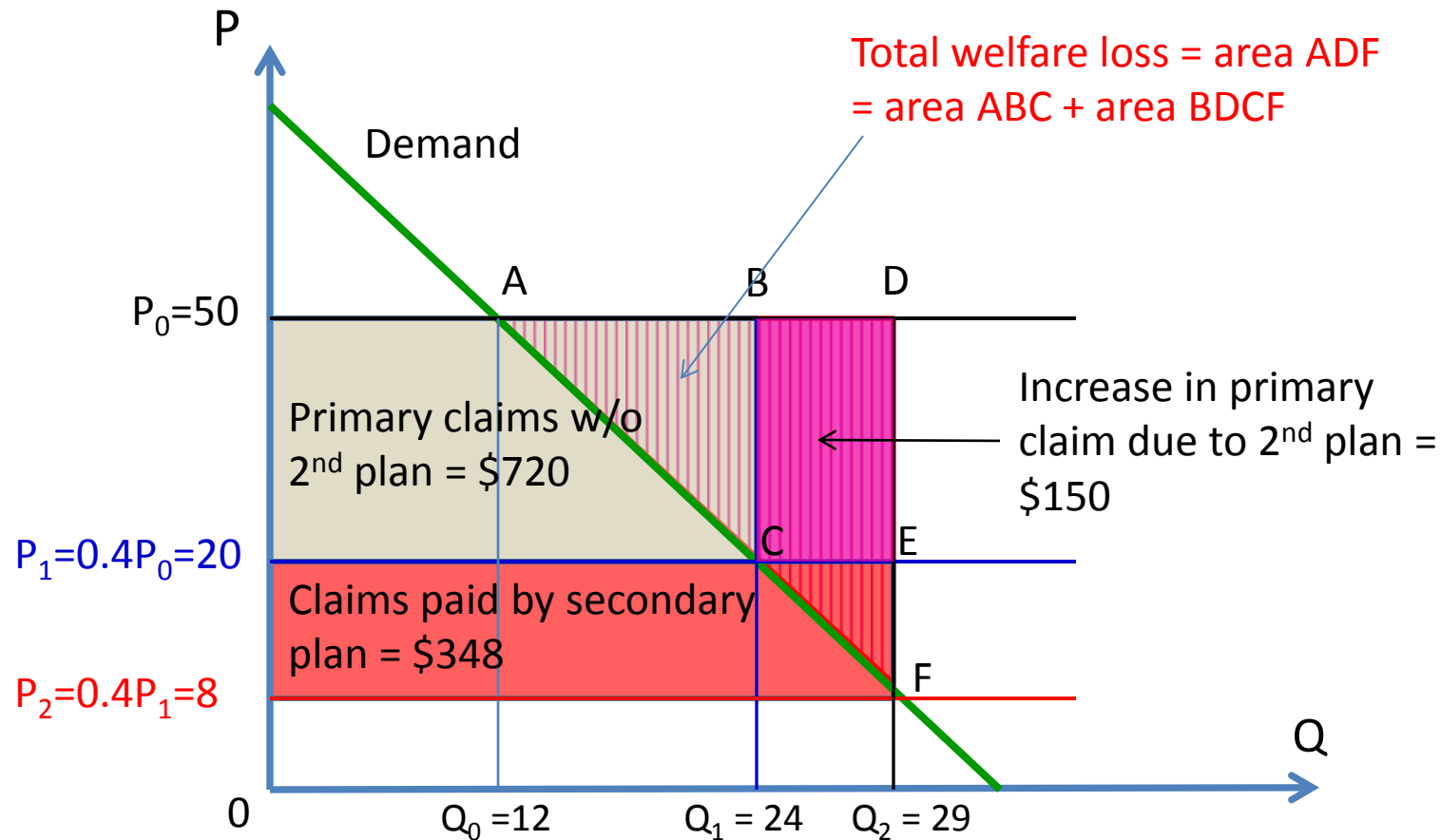


Moral Hazard and Welfare Loss (20% Co-insurance)

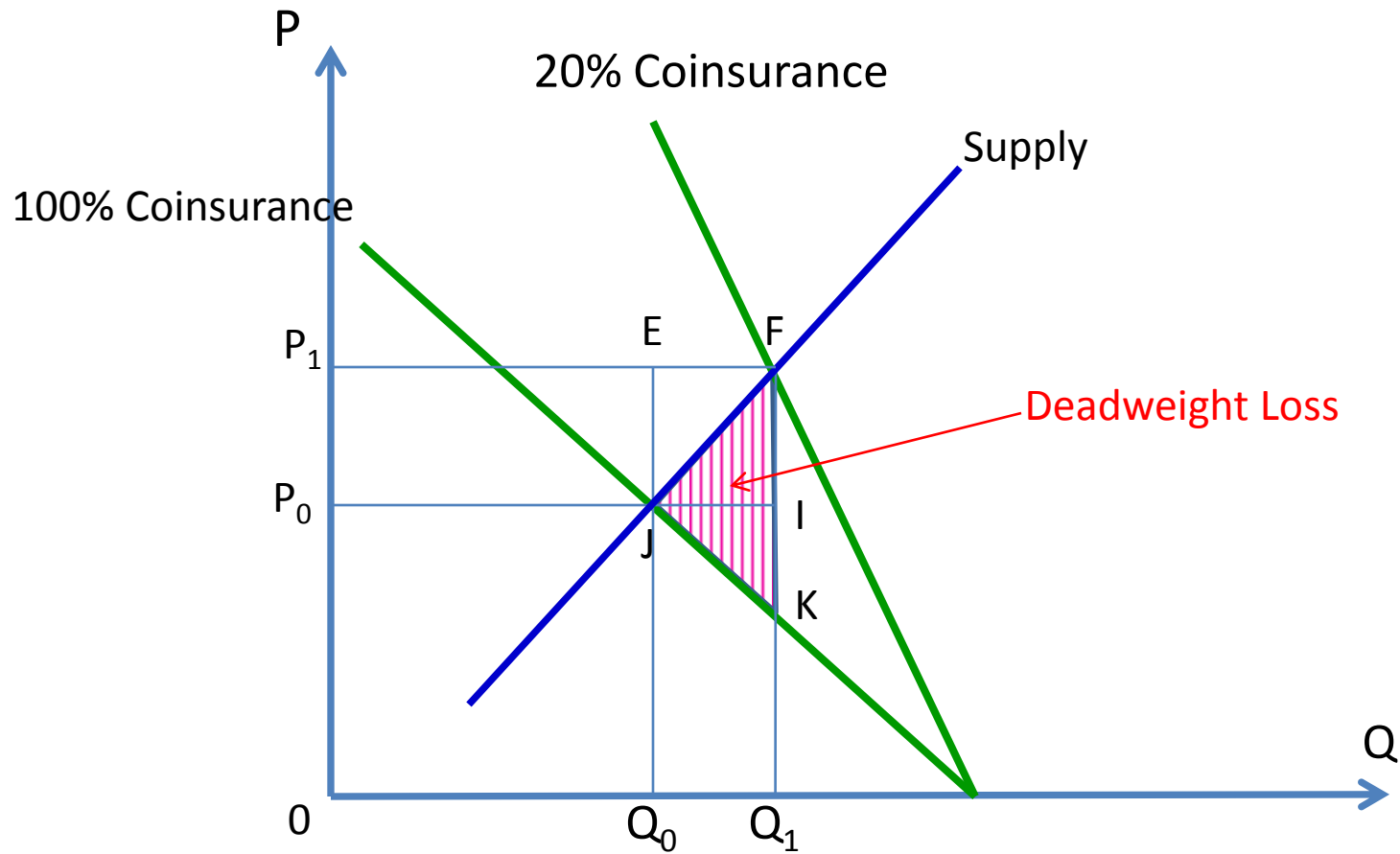


Two-tiers Insurance

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



Deadweight Welfare Loss



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 **a 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

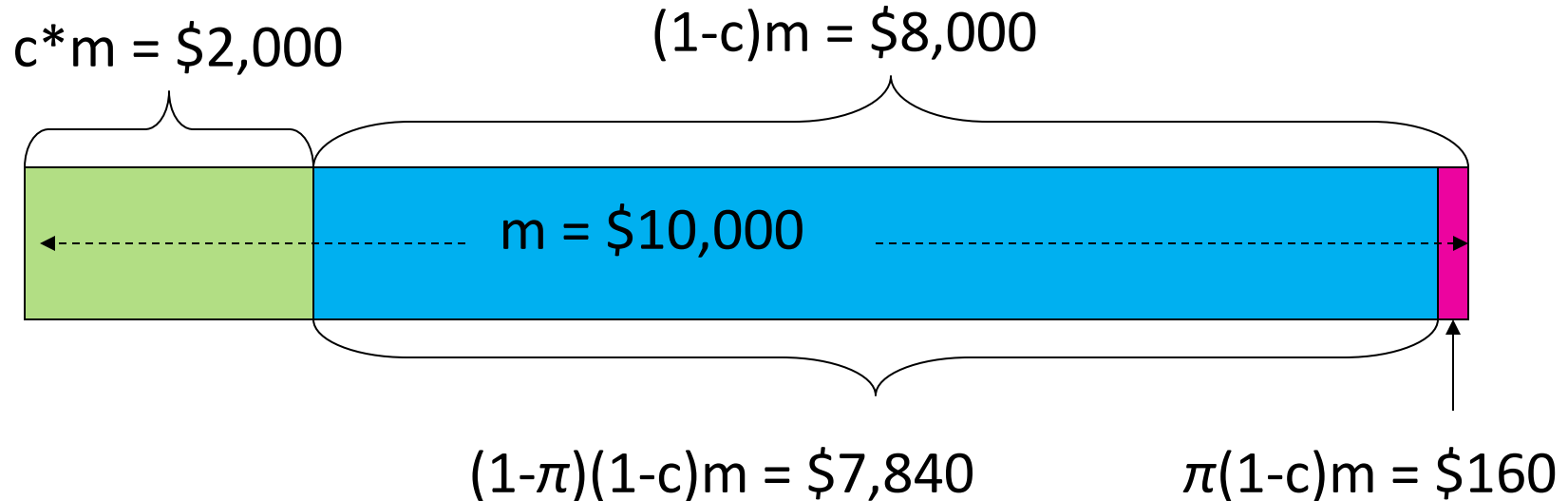
- Some notations:
 - m_i is total medical care cost when illness occurs
 - r is the premium
 - π is the probability of illness.
 - c = coinsurance rate (Note: we've assumed $c=0$ previously.)
- Insurer sets a premium, r , at the actuarially fair level:
$$r = \pi(1-c)m_i$$
- The payoff that the insurer pays to the beneficiary who becomes ill is equal to $(1-c)m_i$.

Nyman's Model

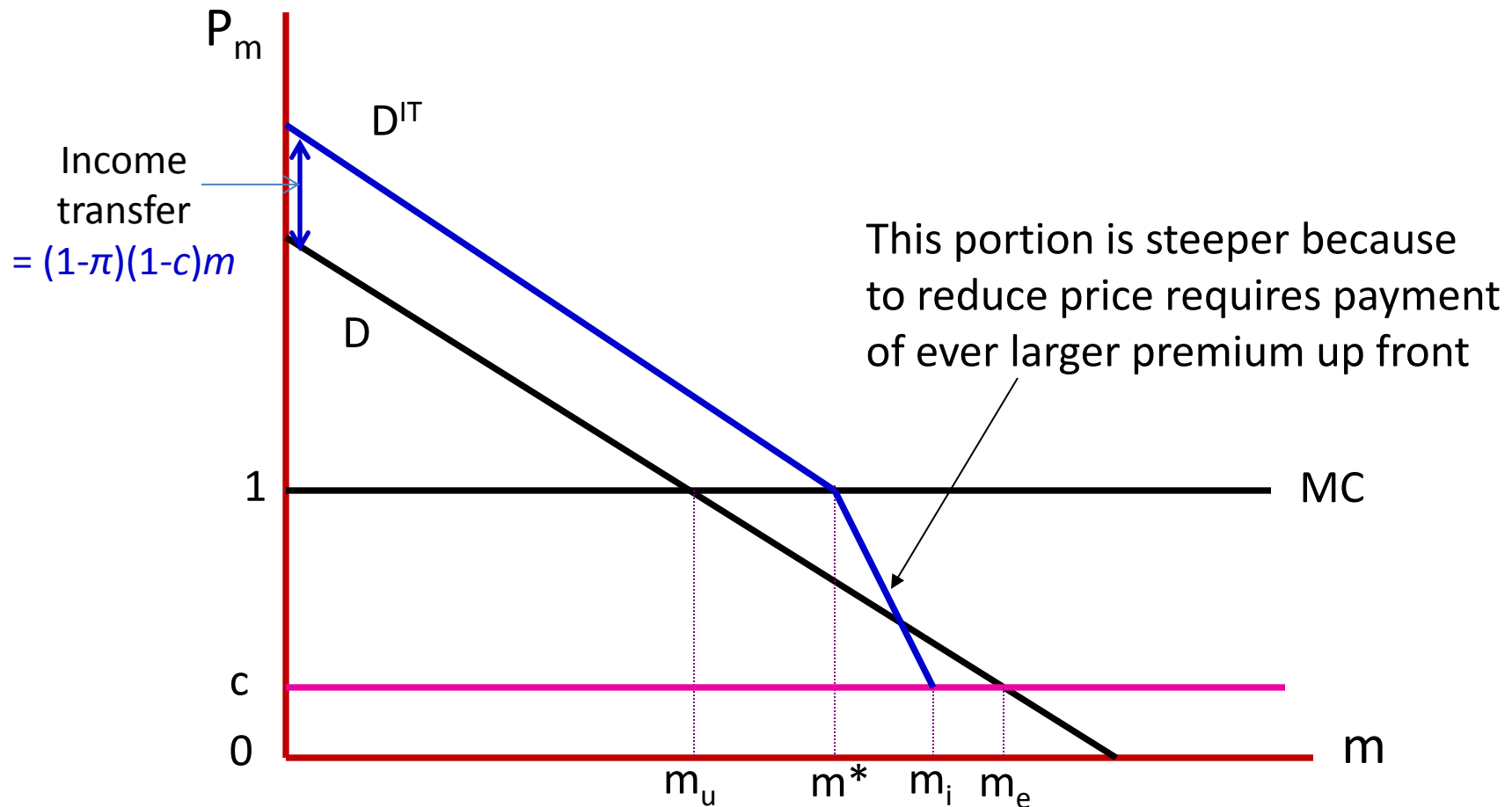
- **Income transfers** are the portion of the payoff to the ill that is paid for by those who purchase insurance and remain healthy:
 - *Payoff* to ill: $(1-c)m_i$
 - *Premium* paid by each insured: $\pi(1-c)m_i$
 - *Income transfers to ill*: $(1-\pi)(1-c)m_i$
- Example: Medical spending with insurance 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 (*i.e. coinsurance*)
 - Insurer pays: $(1-c)m_i = \$8,000$
 - AFP: $r = \pi(1-c)m_i = 0.02(\$8,000) = \160
 - **Income transfers** are: $(1-\pi)(1-c)m_i = 0.98(\$8,000) = \$7,840$

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

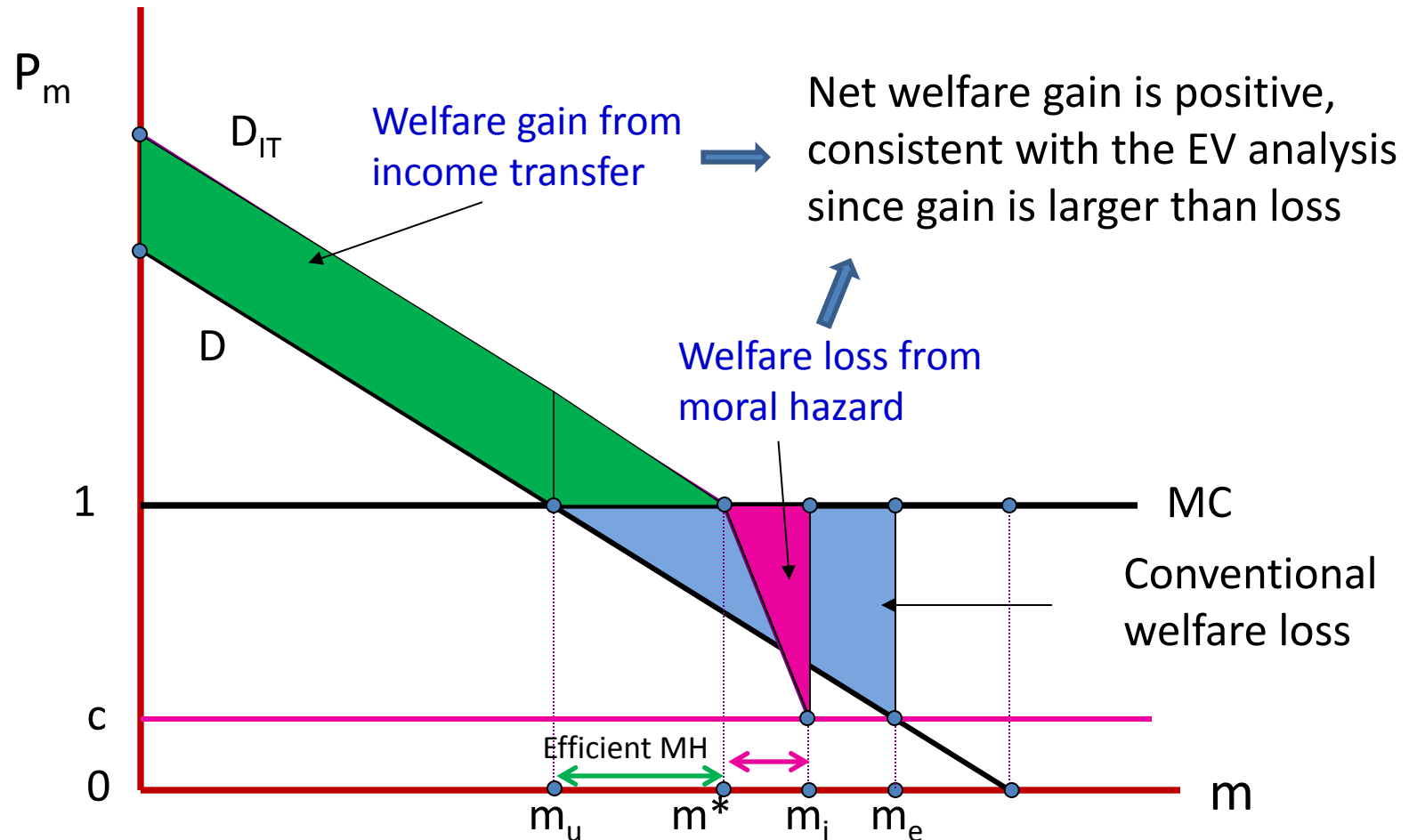
- Example
 - $m = \$10,000$
 - $c = 20\%$
 - $\pi = 2\%$



Nyman's Decomposition of Moral Hazard using Demand Curve



Nyman's Model: Welfare Gain



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

} 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**.
- 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

