INSURANCE

7MHPH010 – Health Economics and Health Policy

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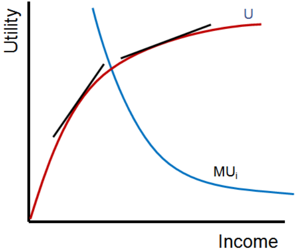
A THEORETICAL MODEL OF HEALTH INSURANCE

- Why do people buy insurance?
  - Chance/Uncertainty give rise to shocks in health
  - Restoration of health require medical care
  - This in turn produces shocks to income
  - People have a aversion to risk
  - Insurance doesn't guarantee health, but provides funds to purchase health care
- What do we pay for when buying medical insurance?
  - We pay for the expected costs, i.e., the average cost of medical care
  - Plus, a risk premium, i.e., for the insurance company to take on the risk
  - Risk itself is a the variance in the costs
  - We also pay for administrative costs
- The insurer can pool or spread risk among many insurees
  - The insurance company can lower the variance and hence the risk premium
  - It does so by enrolling a large number of people
  - The more people are enrolled, the lower the variance and hence lower the premium

- Recall that consumer maximizes utility, which is a function of health and other goods $u = U(H,X)$
- Additionally, marginal utility of health ($MU_H = \Delta U/\Delta H$) and other goods ($MU_X = \Delta U/\Delta X$) is positive but diminishing
- Because income/wealth can be used to purchase X or medical care, which can increase H, we can talk about the indirect utility of income and the marginal utility of income – which is also positive[1]

- A person derives utility from wealth/income
- In addition, we also assume diminishing marginal utility of income
- The *curvature* of the utility function measures the risk level of risk aversion of a person



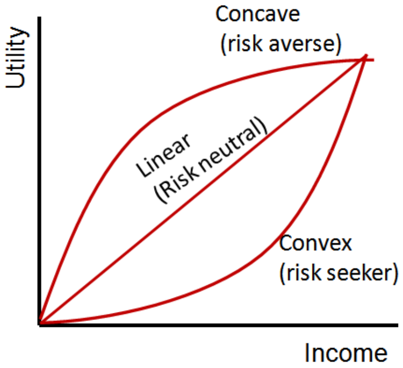
[1] The link between income and utility allows us to redefine $u = U(H,X)$ into comparable indirect utility function $v = V(I, p_m, p_x)$, which is a function of income and prices

Risk Aversion

Utility of Wealth

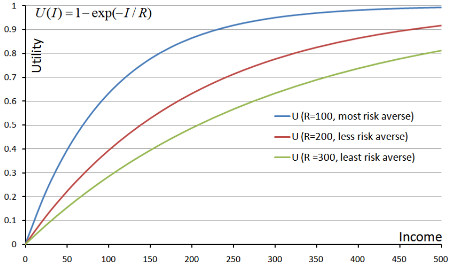
- Risk averse people will have a *concave* utility function – but the utility function is not concave if a person is risk neutral or a risk seeker

- A concave utility function means that the person is risk averse
- A linear utility function means that the person is risk neutral
- A convex utility function means that the person is a risk seeker
- Examples
  - Risk neutral, linear utility function: $U(I) = 100I$
  - Risk averse, concave utility function: $U(I) = \sqrt{I}$
  - Risk seeker, convex utility function: $U(I) = I^2$



- Risk averse people will have a *concave* utility function and the greater the curvature of the function, the greater is the risk aversion
- The curvature depends on how fast the marginal utility of income decreases with income[2]
- Example: an exponential utility function $U(I) = 1 - e^{-I/R}$ where $e = 2.7182$, I is the level of income and R is a parameter that controls the shape of the utility function according to the risk tolerance

- How to measure R: determine the maximum value of Y for which a person is willing to participate in the following gamble:
  - Win Y with probability 0.5
  - Loose $Y/2$ with probability 0.5
  - The maximum value of Y an individual is willing to take the gamble is a reasonable estimate of the risk tolerance



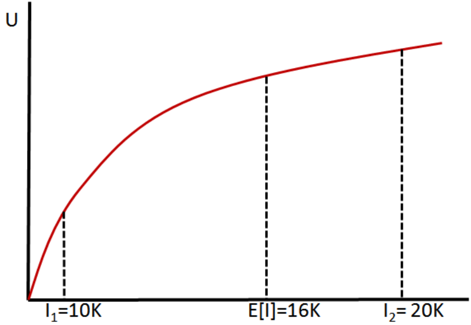
[2] Economists often use the Arrow-Pratt measure of absolute risk-aversion which is defined as $-u''/u'$ where u' is marginal utility of income and u'' is the rate at which marginal utility is changing

A Risk Averse Decision Maker

Why do we buy insurance?

- Suppose that a person has a concave utility function and faces the following risky situation
  - Their initial income is I_2 (say £20K)
  - There is some probability (say .4) with which they will loose £10K
  - Then the expected income for the person is $E[I] = .4(10K) + .6(20K) = 16K$
- How much would they be willing to pay to get rid of this risk?

- To answer this question, we need to figure out
  - what is their expected utility
  - what level of certain income would have generated the same expected utility and
  - compare this income (called **certainty equivalent** income) to their expected income
- For now we will assume that the utility function is known (i.e., the formula for $U(I)$ is known)



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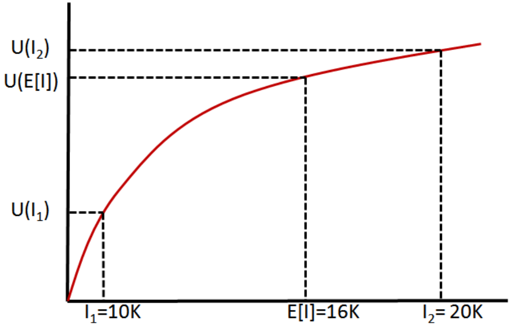
- How much would they be willing to pay to get rid of this risk?

- Suppose the utility function is such that
  - the utility of 20K is some number $U(I_2)$
  - the utility of 10K is some number $U(I_1)$ and
  - the utility of expected income, 16K, is some number $U(E[I])$
- What we need to compute next is the expected utility (which is not the same as utility of expected income)



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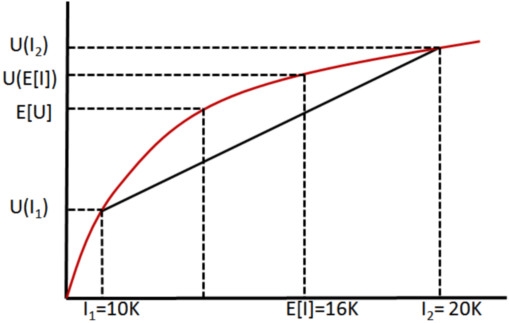
- How much would they be willing to pay to get rid of this risk?

- Expected utility
  - Expected utility: The expected utility is the weighted average of utility of 10K and utility of 20K
  - Thus, $E(U) = .4U(I_1) + .6U(I_2)$
  - The expected utility $E(U)$ lies 60% of the way between $U(10K)$ and $U(20K)$
- What we need to compute next is the level of income with certainty that would have generated the same utility as $E(U)$



A Risk Averse Decision Maker

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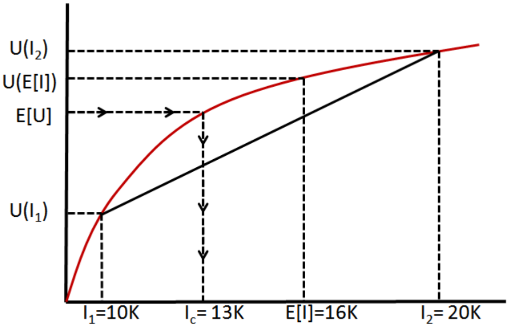
- How much would they be willing to pay to get rid of this risk?

- Certainty equivalent I_c
  - What level of income would have generated the same utility as $E(U)$?
  - Start with $E(U)$ on the y-axis and find on the x-axis the corresponding value of income that would have generated the same expected utility — call it I_c — and for concreteness let this value be £13K
- This is the same as inverting the utility function – i.e., $I_c = U^{-1}(E(U))$



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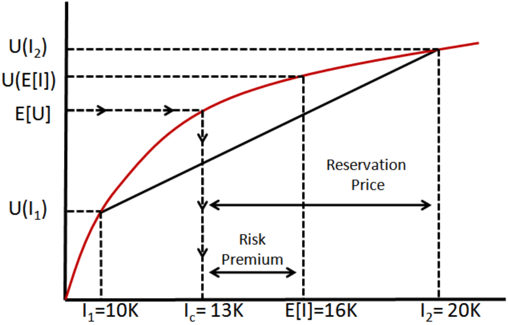
- How much would they be willing to pay to get rid of this risk?

- Risk premium
  - The difference between the certainty equivalent income and expected income is called the *risk premium*
  - It represents the maximum amount a risk-averse person is willing to pay to avoid this risk
- The reservation price is the expected loss (here £4K) plus the risk premium

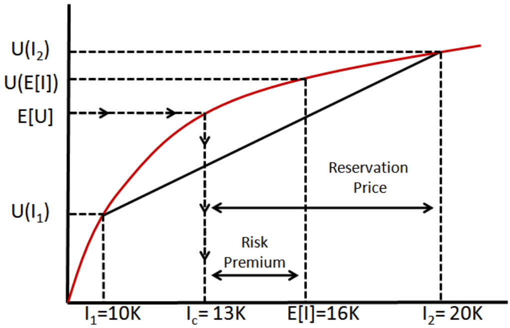


A Risk Averse Decision Maker

Why do we buy insurance?

- Put another way, suppose an insurance company were to offer the following deal to a risk-averse person
  - Each year, give me your paycheck – whether it is £10K or £20K – and in return we will give you every year certain income that is larger than I_c
  - Then the risk-averse person would accept this deal
- How far below can I_c go below $E(I)$?

- The greater the curvature, the greater the difference between $E(I)$ and I_c – i.e., larger the risk premium $(E(I) - I_c)$
- It can be shown that the risk premium a person is willing to pay to avoid risk is
  - proportional to the variability of the gamble (the variance in statistical sense of the income) and
  - how rapidly marginal utility declines with income
  - infact, it is approximately $0.5 \times r(I) \times \sigma^2$ where $r(I)$ is a specific measure of the curvature and σ^2 is the variance of the risky income



- Problem
  - Fred can incur a work related injury with probability 0.25. If he gets injured, he earns nothing and if he does not get injured, he earns £100
  - Suppose Freds utility function is given by $u(I) = 1000\sqrt{I}$
  - If an insurance company offers to complectly cover his lost income at a cost of £15 (should he get injured), should Fred buy the insurance?
  - What is the maximum amount Fred would be willing to pay for such an insurance?
- Solution
  - Yes, he should buy this insurance – lets see why
  - If he does not buy insurance, his expected utility (of self-insurance) is given by

$$E(U) = .25U(0) + .75U(100)$$
$$E(U) = .25\sqrt{(0)} + .75(1000\sqrt{(100)})$$
$$E(U) = 7500$$

  - If Fred buys insurance at £15, his utility is

$$U(100-15) = U(85) = 9291.54$$

  - Since $9219.54 > 7500$, buy the insurance (its a steal)

A Risk Averse Decision Maker

A Specific Example – Fred

- What is the maximum Fred would be willing to pay for such a policy?
  - Fred's expected utility (without insurance) is $E(U) = .25U(0) + .75U(100) = 7500$
  - His certainty equivalent I_c is $U^{-1}(7500)$
    - To compute this amount, find the inverse of the utility function and evaluate it at $E(U) = 7500$ as follows:
    - $U^{-1}(u) = (u/1000)^2 = (7500/1000)^2 = £56.25$
  - Since an income of £56.25 gives him the same utility as the expected utility without insurance, the max he would be willing to pay is 100 - 56.25 = £43.75
  - Since Fred's expected income is £75 (because $E(I) = .25(0) + .75(100)$) his risk premium is

$$RP = E[I] - I_c = 75 - 56.25 = 18.75$$

  - Note that the difference between the maximum he is willing to pay (£43.75) and his risk premium (£18.75) is exactly £25 – this is the expected loss in Fred's income and the expected cost of to the insurance company (assuming no administrative costs)
  - Put another way, Fred would be willing to pay up to £25 + risk premium for this policy (i.e., 25 + 18.75 = 43.75)

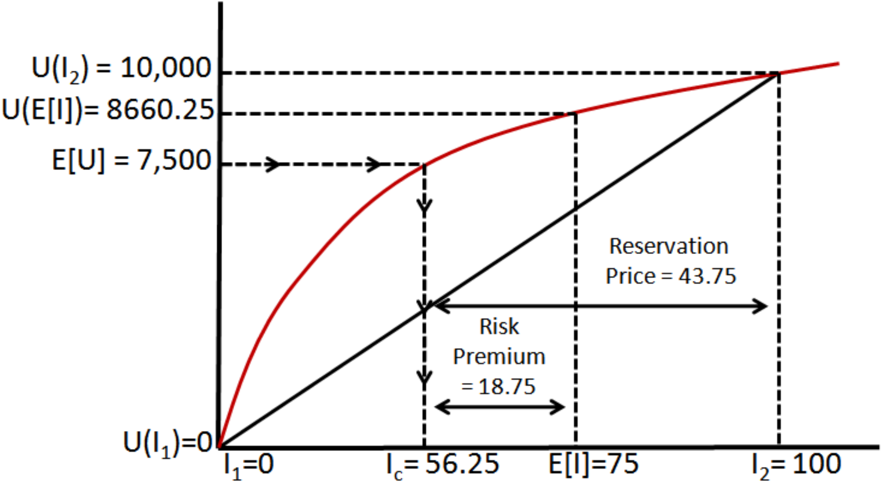
- Note that such a policy of £15 would never be offered – to see the forgoing analysis in another way consider the following
    - Fred's expected income is $E(I) = .25(0) + .75(100) = £75$ and his expected loss is £25
    - Since the expected cost to the insurance company is £25, a fair insurance policy would charge £25, i.e. where the insurance company only collects expected expenditure and charges nothing for administrative costs or for taking on the risk (often called the loading fees)
    - If the insurance company were to also collect loading fee, what would be the maximum that Fred would be willing to pay?
        - Recall that Fred's expected utility is $E(U) = .25U(0) + .75U(100) = 7500$
        - The maximum that Fred would be willing to pay (call it x) for a policy that completely covers him incase of injury should give him at least as much as utility as his expected utility without insurance (i.e., $E(U) = 7500$), thus

$$7500 = U(100 - x) = 1000\sqrt{(100 - x)}$$
$$\Rightarrow x = £43.75$$

    - The max Fred would be willing to pay is £43.75
        - of this £25 is the expected cost
        - the risk premium is 43.75 - 25 = £18.75
        - Fred would be willing to pay upto £18.75 in admin costs plus £25 to cover expected loss

A Risk Averse Decision Maker

A Specific Example – Fred



- Expected benefit payment
  - In the foregoing analysis, Fred's expected loss was £25
  - This is the amount, on average, that the insurance company must pay on Fred's behalf
  - Thus the expected benefit payment of the policy is 25
- Risk premium
  - In addition to this amount, Fred was willing to pay upto £18.75 as the risk premium
  - This means that the insurance company can charge upto this amount to cover charges for risk bearing, administrative costs and profits
  - The risk premium a person would be willing to pay for a reduction in risk is $E[I] - I_c$ – It is approximately equal to $.5 \times r \times \textit{change}$ in variance of income (where r is a measure of risk aversion) and the larger this change in variance brought about due to insurance policy, the the more the consumer benefits from purchasing insurance
- Loading Fee
  - The additional amount, over and above £25 that the insurance charges is called the *loading fee* and is the actual price of insurance
  - If the insurance company only charged £25, the loading fee would be zero and the insurance would be 'free' – in the sense that it is not charging for risk bearing and administrative costs and the policy would be considered "actuarially fair"

Price of Insurance

Loading Fees

- Expected benefit payment
  - Suppose a medical insurance contract specifies that the insurer will pay $(1-c)p_m m$ if the consumer buys m units of medical care at price of p_m each and c is the co-insurance rate
  - Suppose further that the consumer might buy N different amounts of medical care during the year (corresponding to N different illnesses) and the probability of each of these illnesses is $f_i (i = 1, \ldots, N)$
  - Then the expected benefit payment to the consumer is

$$E(B) = \sum_{i}^{N} f_i (1-c) p_m m_i$$

  or more simply, $(1-c)p_m m^*$, where m^* is the expected quantity of care
- Insurance premium
  - The insurance premium (the amount actually paid by the consumer) can be defined as

$$R = (1+L)(1-c)p_m m^*$$

  where L is the loading fee above the expected benefits and is the actual price of insurance

Insurance Terminology

Summary

- *Premium, Coverage* – When people buy insurance policies, they typically pay a given premium for a given amount of coverage should the event occur
- *Pure Premium* – The actuarial losses associated with the events being insured
- *Loading Fees* General costs associated with the insurance company doing business, such as sales, advertising, or profit
- *Coinsurance/Copayment* – Many insurance policies require that when events occur, the insured person share the loss through coinsurance/copayments – the percentage paid by the insured person is the coinsurance rate e.g. 10% of hospital bill while a copayment typically refers to a flat monetary amount the insured pays per usage, e.g. £6 per filled prescription)
- *Deductible* Some amount of the health care cost is paid by the insured person in the form of a deductible, irrespective of coinsurance – in a sense, the insurance does not apply until the consumer pays the deductible
- *Exclusions* – Services or conditions not covered by the insurance policy, such as cosmetic or experimental treatments
- *Limitations* – Maximum coverages provided by insurance policies, for example, 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 – for example, pregnancy, cancer, HIV/AIDS

Demand for Insurance

Factors effecting demand

- Price of insurance
  - The true price of insurance is the loading fee – the greater the loading fee, the less the demand for insurance
  - In the earlier example of Fred's problem, he is willing to pay upto £18.75 (as *risk premium*) over and above the expected benefit of £25.
  - If the loading fee exceed £18.75 (so the the *insurance premium* is above £43.75) Fred would forge insurance
- Degree of risk aversion
  - Greater the risk aversion, the more a consumer is willing to pay for insurance
  - Risk aversion increases the demand for health insurance
  - If Fred's utility function was linear, he would be willing to pay £0 for risk bearing
- Variance
  - Income – larger income losses due to illness will increase the demand for health insurance
  - Probability of Illness – consumers demand less insurance for events most likely to occur or least likely to occur and more likely to insure against random events
  - In general, the larger the financial risk (variance) facing an individual, the more more they are willing to pay as risk premium and greater will be the demand for insurance

- Two states: healthy(h) and sick(s)
  - Initial wealth of an individual is Y_0
  - Probability of sick state π (say .2)
  - Probability of healthy state $1-\pi$ (say .8)
  - If the healthy state occurs, his income will be Y_0
  - If the sick state occurs, his wealth will be $Y_0 - m$ where m represents income lost due to loss of work and/or costs of medical care
- Expected utility

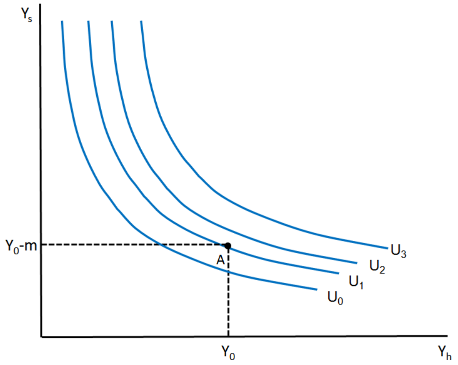
$$E(U) = (1-\pi)U(Y_h) + \pi U(Y_s)$$

- Contingent commodities
  - An insurance company promises to give him £1 in healthy state if he pays now p_h – and they will give him a total of Y_h if he pays now $p_h Y_h$
  - The insurance company also promises to give him £1 in sick state if he pays now p_s – and they will give him a total of Y_s if he pays now $p_s Y_s$
- Budget constraint

$$p_h Y_0 + p_s(Y_0 - m) = p_h Y_h + p_s Y_s$$

- Consumer's problem is to maximize expected utility subject to the budget constraint
  - Graphical analysis – draw indifference curves and budget constraint to find the tangency point

- Indifference curves
  - Assuming that marginal utility of income is positive (and concave) the indifference curve shows the trade off between income in healthy and sick state
  - The indifference curves are steeply sloped – meaning that sick state not very likely to occur and so the individual not willing to give up much income/consumption when healthy to get income/consumption when sick
  - Marginal rate of substitution (MRS) is negative of the slope of the indifference curve



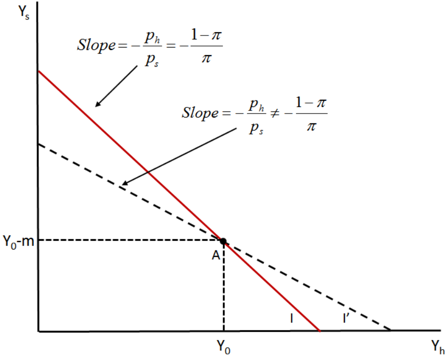
$$\text{MRS} = -\frac{(1-\pi)MU(Y_h)}{\pi MU(Y_s)}$$

  - Note that MRS depends on the probability of healthy/sick states

- Budget constraint $p_h Y_0 + p_s(Y_0 - m) = p_h Y_h + p_s Y_s$

  - Note that p_h is the price of receiving one pound if the healthy state occurs and p_s is the price of receiving a pound if the sick state occurs
  - For actuarially fair premium, i.e., one where the insurance company just recovers its expected costs and does not charge any loading fees, these prices will equal the probabilities of respective states – thus

$$p_s = \pi$$
$$p_h = 1 - \pi$$

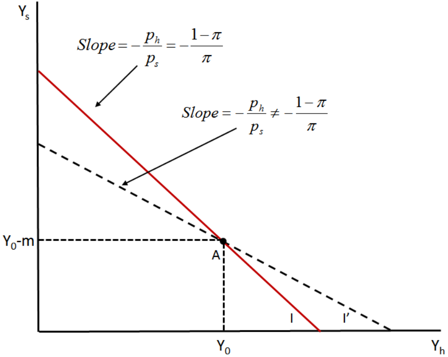


- Hence, the budget constraint can be written as

$$(1-\pi)Y_0 + \pi(Y_0 - m) = (1-\pi)Y_h + \pi Y_s$$
$$E(Y) = (1-\pi)Y_h + \pi Y_s$$

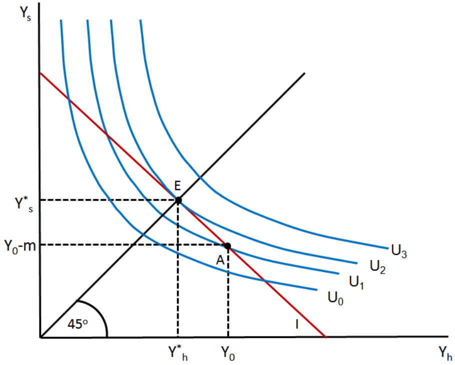
or rewritten it in terms of Y_s as $Y_s = \frac{E(Y)}{\pi} - \frac{(1-\pi)}{\pi} Y_h$

- Budget constraint $p_h Y_0 + p_s(Y_0 - m) = p_h Y_h + p_s Y_s$
  - Budget line passes through the initial endowment – i.e., the individual's wealth in health state and in sick state without insurance – the point $(Y_0, Y_0 - m)$
  - Slope of the budget line is $-\frac{p_h}{p_s}$
  - If the price is actuarially fair, then slop is $-\frac{p_h}{p_s} = -\frac{(1-\pi)}{\pi}$
  - If there is a loading fee, then slop of budget constraint does not equal to fair odds line, i.e. $-\frac{p_h}{p_s} \neq -\frac{(1-\pi)}{\pi}$



- Maximize expected utility subject to the budget constraint

  - Given the actuarially fair premium ($\frac{p_h}{p_s} = \frac{(1-\pi)}{\pi}$), consumer will move from point A to Point E
  - **Point E lies on the 45º line**
  - Solution: $Y_h^* = Y_s^*$ (Providing utility in state independent and marginal utility is positive)
  - **Thus, consumer will buy full insurance (i.e. c=0) so that his wealth in healthy or sick state is equal**
  - **Can also show that if prices are not actuarially fair, utility maximization will occur at a point where $\mathbf{Y_h > Y_s}$**



  - Tangency condition – slope of the indifference curve (-MRS) equals the slope of budget constraint
  - Slope of indifference curve: $-\text{MRS} = -\frac{(1-\pi)MU(Y_h)}{\pi MU(Y_s)}$
  - Slope of budget constraint: $-\frac{p_h}{p_s} = -\frac{(1-\pi)}{\pi}$

Problems in insurance

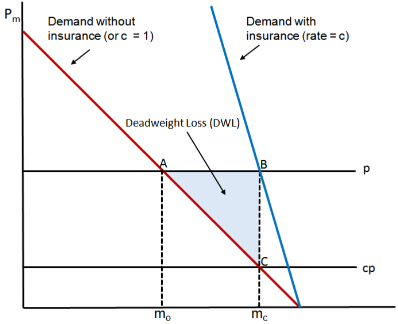
Moral Hazard & Adverse Selection

- Adverse selection and moral hazard are problems that prevent efficient use of health care
- Moral Hazard
  - If being insured affects behavior in such a way that the expected payout from the insurance company is increased, this is called moral hazard
- Adverse Selection
  - Adverse selection exists when people who are more likely to buy insurance or policies with more extensive coverage are also more likely to use more insured medical services

- Moral Hazard
    - In general, moral hazard relates to any change in behavior that occurs in response to a contractual arrangement (here the decision to insure)
    - If being insured affects behavior in such a way that the expected payout from the insurance company is increased, this is called moral hazard
        - Health insurance reduces the cost of the expenditure (medical care) associated with adverse outcome, e.g. illness
        - If the demand for medical care is the usual downward sloping function, and if health insurance reduces the price of medical care, being insured would tend to lead to the use of more medical care, everything else being held constant
        - If the insurance company pays half the bill and the insured pays the other half (e.g. has a 50% coinsurance), then the demand curve *rotates* on the x-axis
        - Main form of moral hazard associated with having health insurance is increased use of medical care by an individual or family
        - How much moral hazard is induced depends on the coinsurance rate and the elasticity of demand for the medical service

- Moral hazard relates to any change in behavior that occurs in response to a contractual arrangement (here the decision to insure)

  - Without insurance, the consumer would pay the full price p and purchase m_0 units of medical care
  - With coinsurance rate of c, the consumer pays cp per unit and purchases m_c units of medical care
  - Consuming additional units $m_c - m_0$ has an incremental cost equal to area of rectangle m_0ABm_c and an incremental benefit given by area m_0ACm_c

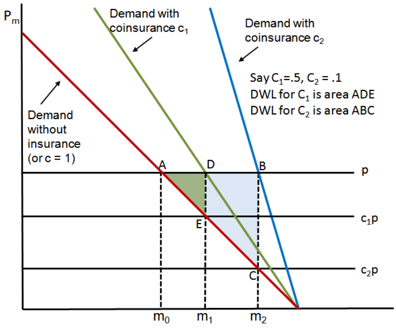


- The difference between these areas, given by the triangle ABC is a loss in well being (called a deadweight loss), because the incremental resource cost exceeds the incremental benefit

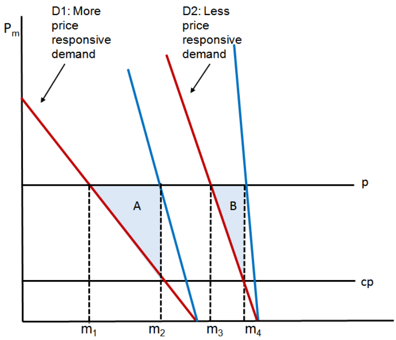
Moral Hazard

Coinsurance

- Deadweight loss increases with deeper coverage (lower value of coinsurance)
  - For coinsurance rate c_1 (say 50%), deadweight loss is area given by triangle ADE
  - For coinsurance rate c_2 (say 10%), deadweight loss is area given by triangle ABC
  - Deadweight loss associated with c_2 is grater than that associated with c_1



- Deadweight loss is larger for medical services with more elastic demand
  - Let $D1$ be the demand for a medical service that is more price responsive – the associated deadweight loss is given by area marked A
  - Let $D2$ be the demand for a medical service that is less price responsive – the associated deadweight loss is given by area marked B
  - Deadweight loss associated with $D1$ (more elastic demand) is greater than that associated with $D2$ (less elastic demand)



Moral Hazard

Elasticity of demand and coinsurance

- We can combine link between coinsurance, elasticity of demand and welfare loss due to moral hazard into one statement
  - It can be shown that for linear demand curves, the deadweight loss due to a coinsurance rate of c is will equal

$$\text{DWL} = \frac{\eta(1-c)^2 pm}{2}$$

  - where η is the elasticity of demand for medical care, c is the coinsurance rate, p is the price of medical care and m is the level of medical that the insured patient will consume
  - Deadweight loss will be larger for medical services with more elastic demand but this can be offset with less complete coverage (i.e. larger values of co-insurance rate)

Patterns of Insurance coverage

- Based on the forgoing analysis, we can make the following predictions
  - Demand for insurance should be higher for medical services where financial risk (variance) is larger
  - Demand for insurance should be less the more price elastic the demand for specific medical services
  - Any evidence??

Type of Health Care	Variance of Risk	Demand Elasticity (RAND HIS)	Percent of People Under 65 Insured
Hospital	Highest	−0.15	80
Surgical and in-hospital medical	High	−0.15	78
Outpatient doctor	Medium	−0.3	40–50
Dental	Low	−0.4	40

- Martin Feldstein (1973) – showed that the demand for insurance and the moral hazard brought on by insurance may interact to increase health care prices even more than either one alone
    - More generous insurance and the induced demand in the market due to moral hazard lead consumers to purchase more health care
    - Insurance policies impose increased costs on society because they lead to increased health services expenditures in several ways
        - increased quantity of services purchased due to decreases in out-of-pocket costs for services that are already being purchased
        - increased prices for services that are already being purchased
        - increased quantities and prices for services that would not be purchased unless they were covered by insurance
        - or increased quality in the services purchased, including expensive, technology-intensive services that might not be purchased unless covered by insurance
    - Feldstein found that the welfare gains from raising coinsurance rates from .33 to .50 would be $27.8 billion per year in 1984 dollars
    - Feldman and Dowd (1991) estimate a lower bound for losses of approximately $33 billion per year (in 1984 dollars) and an upper bound as high as $109 billion

Benefit of Insurance

A Tradeoff

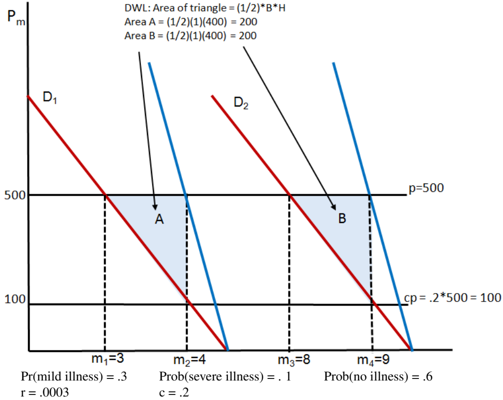
- Observe that there is a implied trade-off in setting a value of coinsurance
    - Consider an risk averse individual facing the possibility of medical service (with some given elasticity of demand)
    - The greater the insurance coverage (lower value of c), the greater is the welfare loss due to moral hazard
    - The greater the insurance coverage (lower value of c), the greater is the benefit to consumer from purchasing insurance
        - Low value of c imply that there will be a large *change* in variance of risky income — in the extreme case of $c = 0$, the consumer is fully insured and there is a maximum change in the variance of income
        - High value of c imply that there will be small *change* in the variance of risky income – in the extreme case of $c = 1$, the consumer is not at all insured and hence the change in the variance of risky income will be zero
        - The larger the *change* in variance due to insurance, the more the consumer benefits from purchasing insurance (and is willing to pay approximately $.5 \times r \times$ change in variance)
- How much is the net gain from insurance?
    - An example with a specific value of c follows

Net Gain from Insurance

A Simplified Example

- **Consider a risk averse individual risk aversion parameter r = .0003 facing the following situation**[3]

  - The person can get mildly sick with probability $\pi_1 = .3$ in which case they will face the demand curve given by D_1
  - The person can get very sick with probability $\pi_2 = .1$ in which case they will face the demand curve given by D_2
  - The person will not get sick with probability $\pi_3 = 1 - (\pi_1 + \pi_2) = .6$
  - Further, assume that the price of medical care is $p = 500$, the co-insurance rate is $c = .2$
  - Finally assume that the demand curves D_1 and D_2 are such that the quantities consumed with or without insurance are given by $m_1 = 3, m_2 = 4, m_3 = 8$ and $m_4 = 9$



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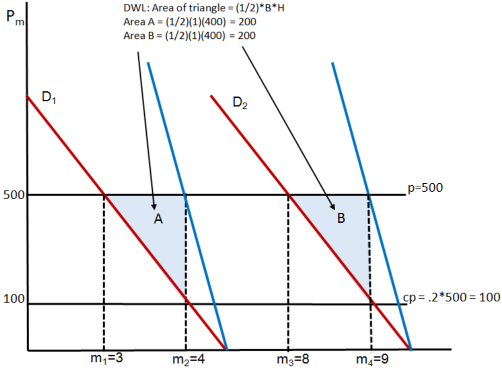
3 We are making the simplifying assumption that r is known so that calculations are easier, i.e., so that we do not have to compute risk premium using $RP = E[I] - I_C$ but can simply use $RP = .5 \times r \times$ change in variance

Net Gain from Insurance

A Simplified Example

- **What is the net gain from this insurance policy? To answer, we will make the following computations**

  - 1. Compute the welfare loss due to moral hazard associated with each demand curve and then compute the expected welfare loss
  - 2. Compute the variance in costs if the person is not insured
  - 3. Compute the variance in costs if the person is insured with policy c = .2 (i.e., is responsible for paying only 20% of medical bills)
  - 4. Use the change in variance to compute the risk premium that the person is willing to pay to avoid the risk – this is a measure of benefit to the consumer from purchasing insurance
  - 5. Look at the difference in expected welfare loss (due to moral hazard) and the benefit to consumer (also adjust further if the insurance company charges any additional loading fees)



Pr(mild illness) = .3 Prob(severe illness) = . 1 Prob(no illness) = .6

r = .0003 c = .2

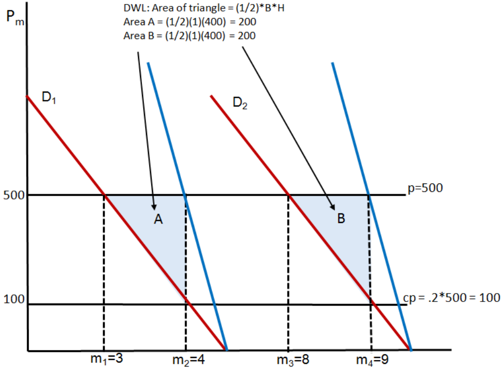
Net Gain from Insurance

A Simplified Example

- **1. Compute the welfare loss due to moral hazard associated with each demand curve and then compute the expected welfare loss**

  - Deadweight loss can be computed as area of triangle
  - Area of triangle is computed as $(1/2) \times \text{Base} \times \text{Height}$
  - Base for each triangle is 1, height for each triangle is 400
  - For a coinsurance of .2, the out of pocket price to the consumer is $.2 \times 500 = 100$ and given the values of m_1, m_2, m_3, m_4, areas of triangles A and B are $.5 \times 1 \times 400 = 200$ each
  - Expected welfare loss is the weighted average of each of the two values computed above
  - Expected welfare loss

$$
\begin{aligned}
EWL &= .3 * 200 + .1 * 200 + .6 * 0 \\
&= £80
\end{aligned}
$$



Pr(mild illness) = .3 Prob(severe illness) = . 1 Prob(no illness) = .6
r = .0003 c = .2

Net Gain from Insurance

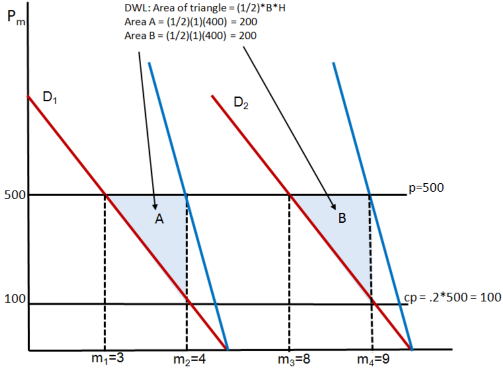
A Simplified Example

- **2. Compute the variance in costs if the person is not insured**

  - Without insurance, the person will use either 3 units or 8 units of medical service (at a cost of £500 per unit) depending on if they get mildly sick or very sick
  - Hence expected cost is $.3(3 \times 500) + .1(8 \times 500) = £850$
  - Variance can be computed as (weighed sum of square of values) minus (the square of the expected value)
  - Hence, variance (when not insured) is

$$Var = .3(1500)^2 + .1(4000)^2 - 850^2$$
$$Var = 1,552,550$$

  - Variance in income <u>without insurance</u> is 1,552,550



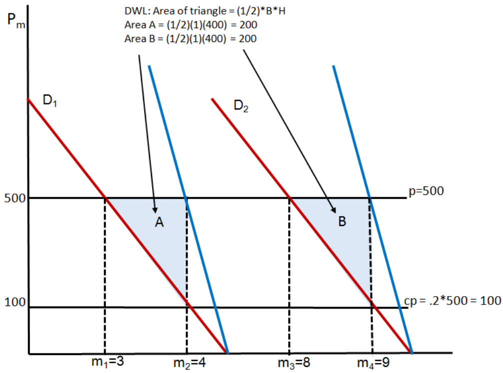
Pr(mild illness) = .3
r = .0003
Prob(severe illness) = . 1
c = .2
Prob(no illness) = .6

- **3. Compute the variance in costs if the person is insured with policy c = .2 (i.e., is responsible for paying only 20% of medical bills)**

  - With insurance, the person will use either 4 units or 9 units of medical service (at a cost of £100 per unit) depending on if they get mildly sick or very sick
  - Hence expected cost is $.3(4 \times 100) + .1(9 \times 100) = £210$
  - Variance can be computed as (weighed sum of square of values) minus (the square of the expected value)
  - Hence, variance (when insured) is

$$Var = .3(400)^2 + .1(900)^2 - 210^2$$
$$Var = 84,900$$

  - Variance in income with insurance is 84,900



Pr(mild illness) = .3 Prob(severe illness) = . 1 Prob(no illness) = .6
r = .0003 c = .2

Net Gain from Insurance

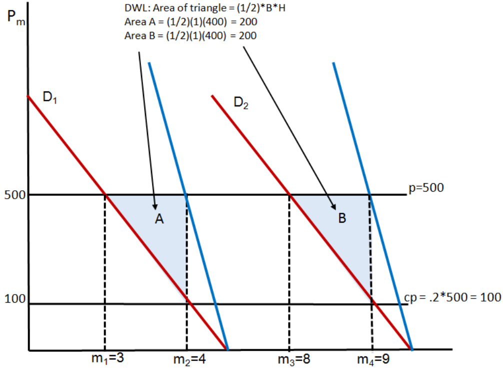
A Simplified Example

- **4. Use the change in variance to compute the risk premium that the person is willing to pay to avoid the risk – this is a measure of benefit to the consumer from purchasing insurance**

  - Without insurance, variance is 1,552,550
  - With insurance, variance is 84,900
  - Insurance changes the variance by 1,467,600
  - Maximum person willing to pay (risk premium) for risk reduction is approximately $.5 \times r \times$ change in variance

    $$RP = .5(.0003)(1467600) = £220$$

  - The value of insurance (benefit) to the consumer is £220



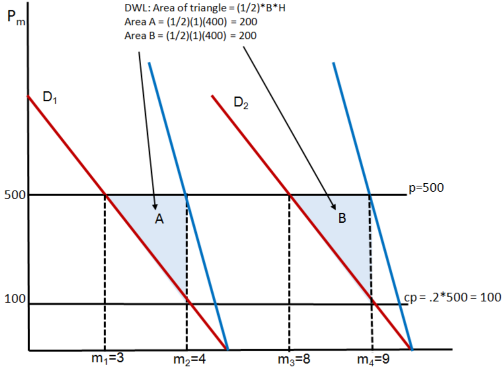
Pr(mild illness) = .3
r = .0003
Prob(severe illness) = . 1
c = .2
Prob(no illness) = .6

Net Gain from Insurance

A Simplified Example

- **5. Look at the difference in expected welfare loss (due to moral hazard) and the benefit to consumer (also adjust further if the insurance company charges any additional loading fees)**

  - Say loading fees are zero
    - Expected welfare loss £80
    - Gain to consumer £220
    - Net gain = 220 - 80 = £140
  - In general, loading fees are some percentage of the expected cost – say loading fee was 10% of expected costs for the insurer
    - For a $c = .2$ policy, insurer pays 500*.8 = £400 per unit of medical care
    - Insurers expected cost = .3(400*4) + .1(400*9) = £840
    - Loading fee at 10% is £84
    - Net gain = 220 - 80 - 84 = £56



Pr(mild illness) = .3
r = .0003

Prob(severe illness) = . 1
c = .2

Prob(no illness) = .6

Net Gain from Insurance

Optimal coinsurance

- In the previous example, if coinsurance was lower, say c = 0 (complete coverage)
  - Welfare loss would be larger but also the benefit from insurance would increase
  - Whether the net gain increases or decreases depends on which of the above two quantities increase by a larger amount
- In the previous example, if coinsurance was higher, say c = .5 (less coverage)
  - Welfare loss would be loss but also the benefit from insurance would be less
  - Whether the net gain increases or decreases depends on which of the above two quantities decreases by a larger amount
- Is there an optimal level of coinsurance – one that maximizes the net welfare gain?

- Phelps (2002) shows that the optimal coinsurance is

$$c^* = -E(pm_i\eta_i)/[r\sigma^2 - E(pm_i\eta_i)]$$
$$= \frac{(\text{Moral Hazard Loss})}{(\text{Moral Hazard Loss} + \text{Risk Premium})}$$

- Note that the optimal level depends on elasticity of demand η

- Using estimates from the RAND HI experiment finds the following optimal coinsurance rates

Type of Care	μ	η	σ^2	C*
Well Care	120	.4	150^2	.96
Dental	300	.4	300^2	.65
Physician	500	.3	1250^2	.49
Hospital	500	.15	3150^2	.07

Note: r = .0001 in all base case calculations

Problems in insurance

Offsetting Moral Hazard

- Insurance companies can structure insurance policies so as to offset moral hazard via increased cost sharing
  - Deductibles
  - Copayments (higher copayments for services with more elastic demand)
  - Life-time limits on payouts
  - Reimbursing in accordance with "usual or customary fees"
  - Increased cost-sharing has the following effects
    - Reduces the quantity demanded by increasing price consumer faces
    - Increases preventive behavior/reduces unhealthy behavior since consumer faces part of "costs" from these behaviors
    - Increases the likelihood of consumer choosing less expensive types of medical care
    - Raises the likelihood that consumer better monitors provider behavior
    - Increases likelihood that consumer "shops around" for less expensive sources of care
- Managed Care
  - Utilization Review
  - Gatekeepers
  - Provider guidelines
  - Provider networks

- Adverse selection and moral hazard are problems that prevent efficient use of health care
- Moral Hazard
  - If being insured affects behavior in such a way that the expected payout from the insurance company is increased, this is called moral hazard
- Adverse Selection
  - Adverse selection exists when people who are more likely to buy insurance or policies with more extensive coverage are also more likely to use more insured medical services

- Adverse Selection
  - Adverse selection exists when people who are more likely to buy insurance or policies with more extensive coverage are also more likely to use more insured medical services
  - Adverse selection in an insurance pool will
    - Drive up the price of insurance premiums, causing those who expect to purchase fewer insured services (the younger and healthier) to drop out of the pool
    - May lead to a "Death Spiral" – the pool of insured will become smaller and smaller, with only the high risk members of the pool remaining, in which case, the insurer may discontinue marketing the product, since the market has shrunk

Problems in insurance

Adverse Selection

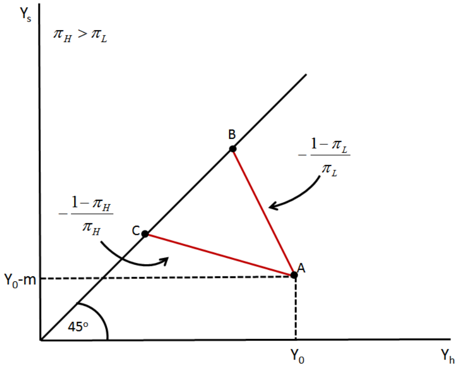
- Adverse Selection
  - If premiums based on average population risk ("**community rated**"), then
  - Healthier persons less likely to buy insurance
    - Welfare loss from inability to buy insurance at price that appropriately reflects risk
  - Higher risk persons more likely to buy insurance
    - Likely to over-insure given low price relative to risk
  - Revenues generated by premiums fall short of realized costs
    - Complicated by excess utilization/higher costs among insured resulting from moral hazard
    - Spiraling effect if next periods premiums based on this periods realized costs
    - Potential instability in insurance market

- Consider two individuals with initial income Y_0 and each facing the possibility of a loss of m when sick

  - Mr. High Risk has a probability of being sick π_H (say 0.5)
  - Mr. Low Risk has a probability of being sick π_L (say 0.1)
  - From earlier analysis, with actuarially fair insurance (and state independence), both would prefer to fully insure so that their wealth is the same in healthy state or sick state
  - Thus, each would move from 'A' to the certainty line (the 45^o) line along their respective fair odds line
  - Fair odds lines

    Mr High Risk: Slope $= -(1-\pi_H)/\pi_H$

    Mr Low Risk: Slope $= -(1-\pi_L)/\pi_L$

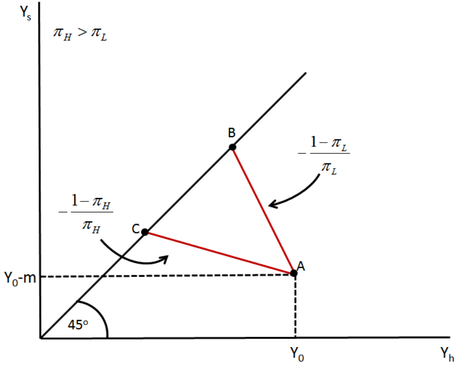


  - Thus, Mr. Low Risk maximize his utility at point B and Mr High Risk maximizes his utility at point C
  - However, situation may be unstable if insurers do not have full information

Adverse Selection

Differential Risks and Asymmetric Information

- With full information, Mr. Low Risk maximize his utility at point B and Mr High Risk maximizes his utility at point C
  - However, situation may be unstable if insurer does not have the same information about risk categories as Mr. HR and Mr. LR
  - Point B provides more wealth in both states than does point C
  - Mr High Risk would also prefer point B to point C
  - Mr High risk has incentive to purchase insurance intended for Mr. Low Risk
  - In the absence of information about risk categories, the insurer cannot deny policy B (along line AB) to Mr. High Risk

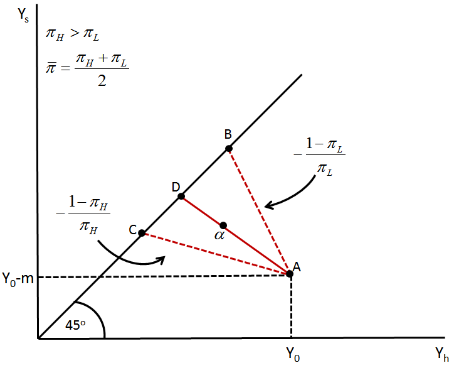


  - But with mixed group, the insurer will face a higher average probability of medical expenses than π_L and will on average loose money on each policy sold
  - Thus point B is not a viable equilibrium for mixed risk categories

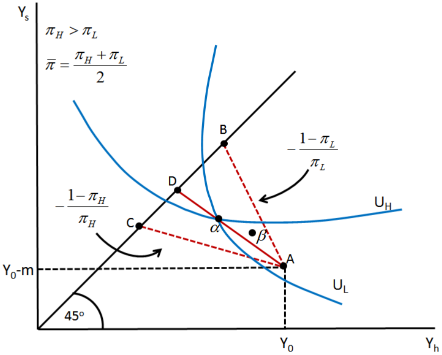
Adverse Selection

Pooled Equilibrium

- Suppose the insurer offers a policy whose premium is based on the average probability of loss in the group $\bar{\pi} = (\pi_H + \pi_L)/2$
  - With premium set at $\bar{\pi}$, both Mr. HR and Mr. may not opt for complete coverage (such as point) – since it does not represent the true probability of loss for either
  - Instead, they may go for a partial coverage policy, such as point α along the line AD
  - However, even a point such as α is not an equilibrium point since at α further trading opportunities exist for Mr. LR



- Suppose the insurer offers a policy whose premium is based on the average probability of loss in the group $\bar{\pi} = (\pi_H + \pi_L)/2$
    - However, even a point such as α is not an equilibrium point since at α further trading opportunities exist for Mr. LR
    - At α the indifference curve for Mr. LR is steeper than that for Mr. HR (why?)
    - The insurance policies such as β exist that are attractive to Mr. LR and profitable to insurers (since the price line passing through β is less steep than the line AB)
    - If there are no barriers to entry, points such as β will be offered (say by another company) and Mr. LR will move to that point/company
    - But that implies that α is not an equilibrium because pooled probability will rise $\bar{\pi}$

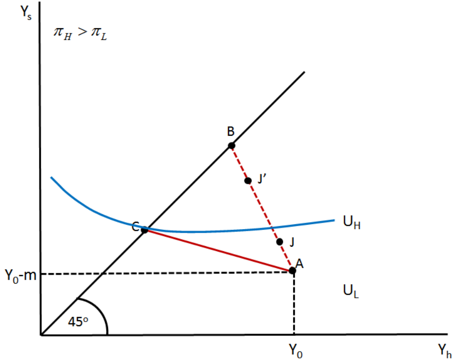


Adverse Selection

Separating Equilibrium

- Given asymmetric information, if the market is to have an equilibrium, then there has to be some way of separating high risk and low risk individuals such that they have incentives to purchase different insurance policies

  - If insurers offer premium based on line AC, then Mr. HR will opt for full insurance at point C
  - Let U_H be the indifference curve for Mr. HR passing through the point C
  - If a policy such as AJ' is also offered, it will be less than full coverage, but Mr. LR will opt for it (at point J'), as it is on a higher indifference curve for him and it is also economically viable since it lies on the fair odds line AB
  - However, Mr. HR will also opt for it since it places him on a higher indifference curve (relative to U_H)

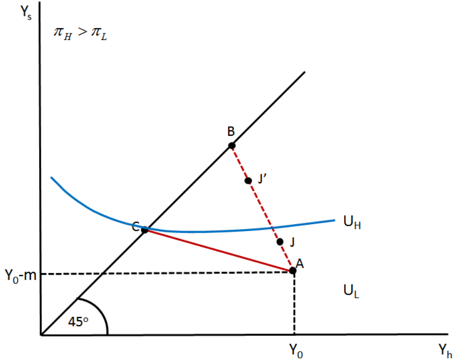


Adverse Selection

Separating Equilibrium

- Given asymmetric information, if the market is to have an equilibrium, then there has to be some way of separating high risk and low risk individuals such that they have incentives to purchase different insurance policies

  - On the other hand if a policy such as J is offered (on the line AB), Mr. LR will opt for it (since he will be on a higher indifference curve) and is economically viable (since on line AB)
  - HOWEVER, Mr. HR will not buy it since it puts him on a *lower* indifference curve
  - Thus C and J are possible solutions – with full coverage for Mr. HR and partial/incomplete coverage for Mr. LR
  - The separating equilibrium at C and J is inferior to equilibrium under the full information
    - If insurers could determine true risk for different individuals, then high risk individuals would be no worse (than separating equilibrium or full information equilibrium) and low risk would be better off (since they would be at B rather than J)



- Experience rating or risk adjusted premiums
  - If insurance companies can distinguish individuals who are higher and lower risk and can set prices in accordance with this, adverse selection can be offset
  - Differential premiums charged to different populations based on observable characteristics, health examinations and/or previous experience with given population
  - Exclusions based on past medical records and to price in accordance with apparent health status, in some cases providing insurance that excludes coverage of "*pre-existing conditions*"
  - Waiting periods for some benefits
  - Limited ability to switch plans – e.g. short, infrequent open enrollment period
  - Differences in benefit packages
- Group health insurance (employment based):
  - Partially offsets the problem of adverse selection
  - Within groups there is **community rating**, e.g. no price discrimination based on medical histories or personal characteristics of individual members of the group
- Potential for "cream skimming" or "cherry picking"
  - Policy debate over experience vs. community rating

Adverse Selection

Empirical Evidence

- Cutler and Reber (1998) – Use a natural experiment due to a change in insurance policy
  - Mid-1990s health insurance changes at Harvard
    - Multiple insurance options offered
    - University made same contribution to each
  - Exclusions for pre-existing conditions
  - Limited ability to switch plans
    - Short, infrequent open enrollment period
  - Differences in benefit packages, type of plan
    - Ranged from comprehensive/few restrictions to more limited and/or more restrictive
    - Employees pay remainder of premium above university contribution
    - About 4 fold difference between most generous and most restrictive benefits
  - Control group
    - Employees in unions that did not agree to new policy for first two years

Adverse Selection

Empirical Evidence

- Cutler and Reber (1998) – Use a natural experiment due to a change in insurance policy
  - Find evidence of adverse selection
    - Younger employees more likely to switch to lower cost plans
    - Those switching into lower cost plans spent significantly less
    - Healthier more likely to switch to lower cost plans
  - Insurer providing more generous benefits (BCBS/PPO) lost money in first year
    - Significantly increased premium next year
    - Higher premium led to additional movement out of generous benefit plan
    - Additional losses incurred by insurer in second year
    - Generous plan option discontinued "death spiral"
  - Estimate welfare loss from adverse selection of 2-4% of baseline spending
    - Significant reduction in Harvards premiums
    - Suggest risk-adjusted voucher system to minimize welfare loss from adverse selection