Lecture - Adverse Selection, Risk Aversion and Insurance Markets

David Autor

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1 Adverse Selection, Risk Aversion and Insurance Markets

- Risk is costly to bear (in utility terms). If we can defray risk through market mechanisms, we can potentially make many people better off without making anyone worse off.
- We gave three explanations for why and how insurance markets operate:
  1. Risk pooling – Law of large numbers.
  2. Risk spreading – Social insurance for non-diversifiable risks.
  3. Risk transfer (Lloyds of London) – Trading risk between more and less risk averse entities.
- (Note: risk spreading does not generate Pareto improvements, but it may still be economically efficient.)
- There is an exceedingly strong economic case for many types of insurance. Efficient insurance markets can unequivocally improve social welfare.
- If the economic case for full insurance is so strong, why do we *not* see full insurance for:
  - Health
  - Loss of property: home, car, cash
  - Low wages
  - Bad decisions:
    - Marrying wrong guy/gal
    - Going to the wrong college
    - Eating poorly
- Instead, we see:

- Markets where not everyone is insured (health insurance, life insurance)
- Incomplete insurance in every market where insurance exists at all:
  - Deductibles
  - Caps on coverage
  - Tightly circumscribed rules (e.g., must install smoke detectors in house, must not smoke to qualify for life insurance).
  - Coverage denied
  - Insurance markets that don't exist at all, even for major life risks
    - Low earnings
    - Bad decisions

- Why are insurance markets incomplete?
- Roughly 4 explanations:

  1. Credit constraints: People cannot afford insurance and hence must bear risk. Health insurance could be an example (i.e., if you already know you have an expensive disease, it may be too late to buy insurance).
  2. Non-diversifiable risk cannot be insured, e.g., polar ice cap melts, planet explodes. No way to buy insurance because we all face identical risk simultaneously.
  3. Adverse selection–Individuals' private information about their own 'riskiness' causes insurers not to want to sell policies to people who want to buy them.
  4. Moral hazard ('hidden action')–Once insured, people take risky/costly actions that they otherwise would not. This makes policies prohibitively costly.

- The model that we'll develop in this lecture concerns adverse selection in insurance markets. This model is closely related to the Akerlof (Lemons) model that we studied in the previous lecture. By way of analogy, you can think of the buyers of insurance policies in this model as the sellers of used cars and the sellers of insurance policies as the buyers of used cars. Sellers (potential insured) know about their health (riskiness) and buyers (insurance companies) do not. Sellers attempt to sell their risk to insurance companies, which are willing to buy it if they expect to break even. What differentiates this model from Akerlof's is that sellers are risk averse. Hence, they are willing to take 'a loss' in expectation on their health insurance to defray risk. Given this, insurance companies should be able to break even (or make profits) on insurance policies. Yet, like the Akerlof model, a 'no trade' equilibrium is a possible outcome of this model.

2 The Environment

- Consider an insurance market where each potential insured faces two states of the world.

  1. No accident, in which case wealth is w.
  2. Accident, in which case wealth is $w - d$ (where $d > 0$ stands for damage).

- So, each person's wealth endowment is:

$$W_i = \begin{cases} \Pr(p_i) & w \\ \Pr(1-p_i) & w-d \end{cases}$$

- If a person is insured, her endowment is changed as follows

$$W_i = \begin{cases} \Pr(p_i) & w-\alpha_1 \\ \Pr(1-p_i) & w-\alpha_2 \end{cases}$$

- Hence, the vector $\alpha = (\alpha_1, \alpha_2)$ describes the insurance contract. You can think of the insurance premium α_1 as paid in both the accident and no-accident states. Hence, α_2 is the net payout of the policy in event of accident.

- Denote the probability of an accident as p. An individual will buy insurance if the expected utility of being insured exceeds the expected utility of being uninsured, i.e.,

$$(1-p) \cdot u(w-\alpha_1) + p \cdot u(w-d+\alpha_2) > (1-p) \cdot u(w) + p \cdot u(w-d).$$

- An insurance company will sell a policy if expected profits are non-negative:

$$\alpha_1 - p(\alpha_1 + \alpha_2) \geq 0.$$

- Competition will insure that this equation holds with equality, and hence in equilibrium:

$$\alpha_1 - p(\alpha_1 + \alpha_2) = 0.$$

- We now need to define an equilibrium for this model. R-S propose the following equilibrium conditions:

  1. No insurance contract makes negative profits (break-even condition).
  2. No contract outside of the set offered exists that, if offered, would make a non-negative profit. If there were a potential contract that could be offered that would be more profitable than the contracts offered in equilibrium, then the current contracts cannot be an equilibrium.

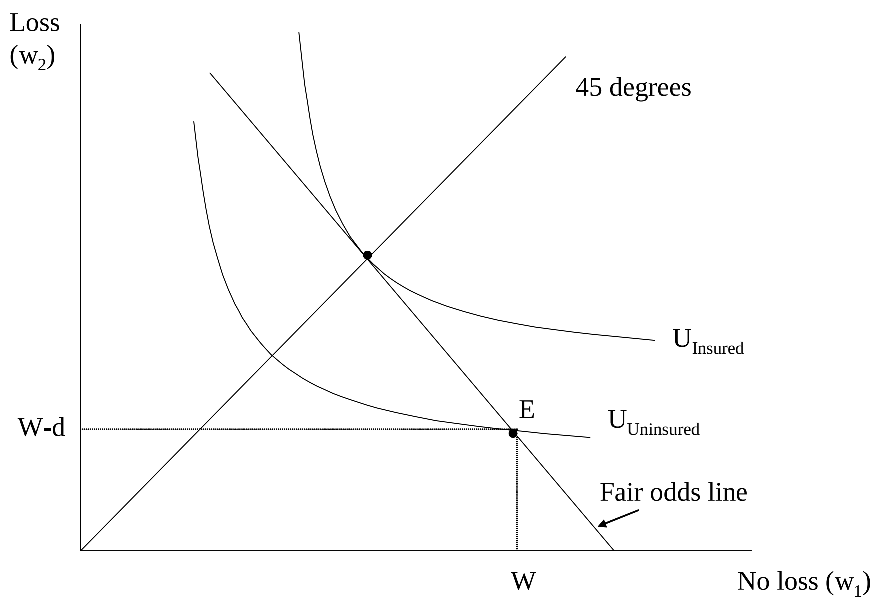

Figure 1:

3 Base case: Homogeneous risk pool

- To fix ideas, it is always useful to start with the simplest case.
- Assume for now that all potential insured have the same probability of loss, $p : p_i = p \ \forall i.$. And note that we have already assumed that all losses are equal to d.
- (Fixing d is without loss of generality. We only need one free parameter here, either p or d. We'll be using p below.)
- See the Figure 1 below, which recaps the state preference diagram from our prior lectures on risk aversion and insurance.
- Note that from the initial endowment $E = (w, w - d)$, the fair odds line extends with slope $\frac{-(1-p)}{p}$, reflecting the odds ratio between the accident and no-accident states.
- As we showed some weeks ago, a risk averse agent (everyone is assumed to be risk averse here) will optimally purchase full insurance. Following from the Von Neumann Morgenstern expected utility property, the highest indifference curve tangent to the fair odds line has slope $\frac{-(1-p)}{p}$ at

its point of tangency with the the fair odds line, which is where it intersects the 45^0 line. At this point, wealth is equalized across states. So, the tangency condition is

$$\frac{(1-p)u'(w-\alpha_1)}{pu'(w-d+\alpha_2)} = \frac{(1-p)}{p} \Rightarrow w-\alpha_1 = w-d+\alpha_2.$$

- [You can demonstrate this to yourself by solving for α_1, α_2 in the Lagrangian for wealth allocation across states where the constraint is: $(1-p)w + p(w-d) - (1-p)(w-\alpha_1) + p(w-d+\alpha_2) = 0$. You should discover that $\alpha_1 = pd$, and $\alpha_2 = (1-p)d$, so that $w - \alpha_1 = w - d + \alpha_2 = w - pd = w - d + (1-p)d = w - pd$.]

- In this initial case, insurance companies will be willing to sell this policy $\alpha = (pd, (1-p)d)$ since they break even.

- This will be an equilibrium since no alternative profit-making policies could potentially be offered.

4 Adding heterogenous risk and private information

- We extend the model to the case with:

  1. Heterogeneity: The loss probability p varies across individuals. Specifically, assume two types of insurance buyers:

$$\begin{aligned} H &: \text{ Probability of loss } p_h, \\ L &: \text{ Probability of loss } p_l, \\ \text{with } p_h &> p_l. \end{aligned}$$

     These buyers are otherwise identical in w and the amount of loss d in event of an accident (and their utility functions $u()$). Only their odds of loss differ.

  2. Private information: Assume that individuals' i know their risk type p_i but this information is not known to insurance companies. (Note: private information without heterogeneity is not meaningful; if everyone is identical, there is no private information.)

- How realistic is the latter assumption? The gist is clearly correct: you know more about your 'riskiness' than your insurance companies. It is this informational advantage that is at the heart of the model. Although the model presents a particularly stark case, the same general results would hold with any degree of informational asymmetry.

- Given asymmetric info, H and L, there are two possible classes of equilibria in the model:

1. 'Pooling equilibrium' – All risk types buy the same policy.
2. 'Separating equilibrium' – Each risk type (H, L) buys a different policy.

- We'll take these possibilities in order.

5 Candidate pooling equilibrium

- In a pooling equilibrium, both risk types buy the same policy.
- The equilibrium construct requires that this policy lie on the *aggregate* fair odds line (so that it earns neither negative nor positive profits).
- Define λ as the proportion of the population that is high risk.
- The expected share of the population experiencing a loss is

$$\bar{p} \equiv \lambda p_h + (1 - \lambda) p_l.$$

And the expected share not experiencing a loss is

$$1 - \bar{p} = 1 - (\lambda p_h + (1 - \lambda) p_l).$$

- The slope of the aggregate fair odds line is

$$-\frac{1 - \overline{p}}{\overline{p}}.$$

- See Figure 2:
- Notice first that the 'pooling' policy A must lie on the aggregate fair odds line. If it lay above, it would be unprofitable and so would not exist in equilibrium. If it lay below, it would it would make positive profits and so would not exist in equilibrium.
- Notice 2nd that the figure is drawn with:

$$\left|MRS^H_{w_1,w_2}\right| < \left|MRS^L_{w_1,w_2}\right|.$$

This is quite important. How do we know it's true?

- To simplify notation, define

$$\begin{aligned} w_1 &= w + \alpha, \\ w_2 &= w - d + \alpha_2. \end{aligned}$$

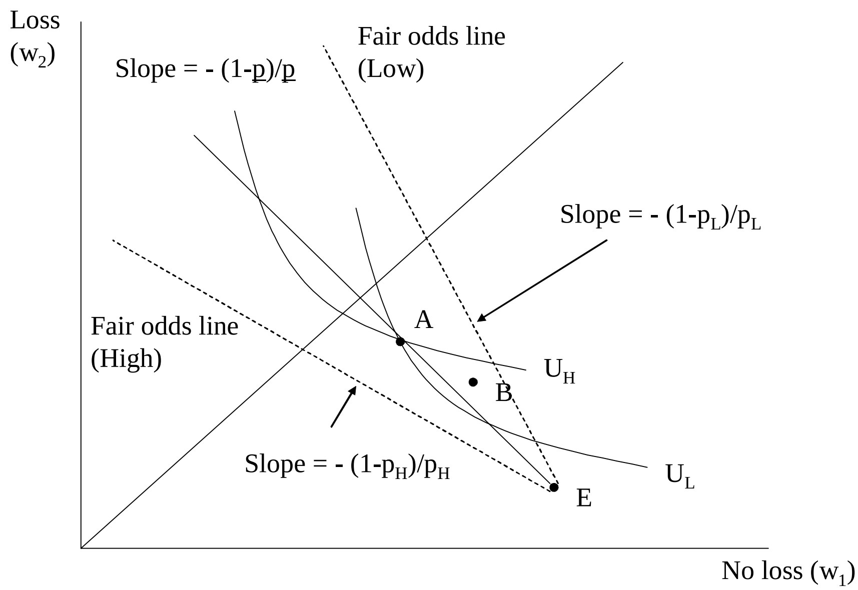

Figure 2:

- From the VNM property, we know the following

$$\begin{aligned} MRS^H_{w_1,w_2} &= -\frac{dw_2}{dw_1} = \frac{u'(w-\alpha_1)(1-p_h)}{u'(w-d+\alpha_2)p_h}, \\ MRS^L_{w_1,w_2} &= -\frac{dw_2}{dw_1} = \frac{u'(w-\alpha_1)(1-p_L)}{u'(w-d+\alpha_2)p_L}. \end{aligned}$$

  Since we've stipulated that High and Low types are otherwise identical, we know that $u_h(w) = u_l(w)$. This implies that

$$\frac{MRS_H}{MRS_L} = \frac{1-p_h}{p_h} \cdot \frac{p_l}{1-p_l} = \frac{1-p_h}{1-p_l} \cdot \frac{p_l}{p_h} < 1.$$

  This shows that the slope of the indifference curve for type H is less steep than for type L.

- This should also follow intuitively. Since the probability of loss is lower for type L, type L must get strictly more income than H in the loss state to compensate for income taken from the no loss state. This implies that the L types have steeper indifference curves for transfers of income between loss and no-loss states.

- Notice 3rd that the pooling equilibrium involves a cross-subsidy from L to H types (that is, L types pay more than their expected cost and H types pay less than their expected cost). We know there is a cross-subsidy because H, L pay the same premium but H makes more claims. Herein lies the problem...

- Is there anything special about how point A is selected?

    1. It's on the aggregate fair odds line. Otherwise, it is not a break-even policy.
    2. The L indifference curve that intersects A must lie above the L indifference curve that intersects E. If not, L types would prefer no insurance.
    3. The H indifference curve that intersects A must lie above the H indifference curve that intersects E. If not, H types would prefer no insurance. This 3rd condition is automatically met. Because the pooling policy provides a subsidy to $H's$ *and* provides some insurance, it must be preferred to E.

- There are many points on the aggregate fair odds line that will meet these criteria and so could be labeled A.

5.1 Failure of the pooling equilibrium

- Although A meets the 1st equilibrium condition (it breaks even), consider the second condition: no potentially competing contract can make a non-negative profit.
- Consider what happens if another insurance company offers a policy like point B in the figure:
- How do H types react to the introduction of B? They do not. As you can see, B lies strictly below U_H, so clearly H types are happier with the current policy.
- However, L types strictly prefer this policy, as is clear from the fact that B is above U_L. Why is this so? Point B is actuarially a better deal – it lies above the fair odds line for the pooling policy. On the other hand, it doesn't provide as much insurance – it lies closer to E than does point A. This is attractive to L types because they would rather have a little more money and a little less insurance since they are cross-subsidizing the H types. (For the opposite reasons, H types prefer the old policy.)
- So, when policy B is offered, all L types change to B, and the H types stick with A.
- B is profitable if it attracts only L types. That's because it lies below the fairs odds line for L types.
- But A cannot be offered without the L types participating – it requires the cross-subsidy.

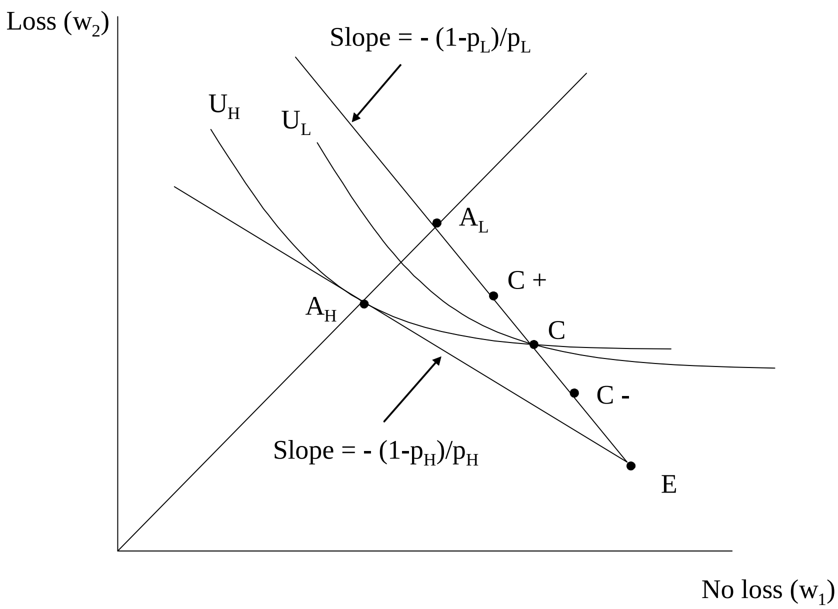

Figure 3:

- Consequently, the pooling equilibrium *does not* exist. It is always undermined by a 'separating' policy that skims off the L types from the pool.
  - Free entry leads to 'cream skimming' of low-risk from the pool.
  - This causes pooling policy to lose money b/c only high risk remain.
  - Pooling policy disappears.
- An intuitive explanation is that cross-subsidies are not likely to exist in equilibrium. If a company loses money on one group but makes it back on another, there is a strong incentive to separate the profitable from the unprofitable group and charge them different prices (or just drop the unprofitable group), thereby undermining the cross-subsidy.

6 Candidate separating equilibrium

- Since the pooling equilibrium is infeasible, let's consider instead a 'separating equilibrium.'
- See Figure 3.

- Notice again the two fair odds line corresponding to the two different risk groups.
- Points A_L and A_H are the full-insurance points for the two risk groups. Group L has higher wealth because its odds of experiencing a loss are lower.
- Note the point labeled C on the fair odds line for the L group. This is where the indifference curve from the full-insurance point for the H group crosses the fair odds line for the L group.
- Notice that the indifference curve U_L that intersects point C is steeper than the corresponding curve for the H group. In other words $\left|MRS^H_{w_1,w_2}\right| < \left|MRS^L_{w_1,w_2}\right|$, as we showed earlier.
- What is special about point C?
  - Observe that it is the best policy you could offer to the L types that would not also attract H types.
  - If a firm offered the policy C^+ on the figure, L types would strictly prefer it – but so would H types, which would put us back in the pooling equilibrium.
  - If a firm offered the policy C^-, H types would not select it, but L types would strictly prefer C, the original policy. So, any policy like $C-$ is dominated by C.
- So, C is the point that defines the 'separating constraint' for types H, L. Any policy that is more attractive to H types would result in pooling.
- Notice by the way that any point like C^+ also involves cross-subsidy (if H types take it). We can see this because U_H is the indifference curve for the fully-insured type H. If there is a point that H types prefer to full-insurance (that is actuarially fair of course), it can only mean that the policy is subsidized.
- So we have a candidate equilibrium:
  - Policies A_H and C are offered.
  - Type H chooses A_H and type L chooses C.
  - Both policies break even since each lies on the fair odds line for the insured group.
- Before we ask whether this candidate pair of policies is in fact an equilibrium (according to the criteria above), let's look at its properties:
  1. High risk types are fully insured.

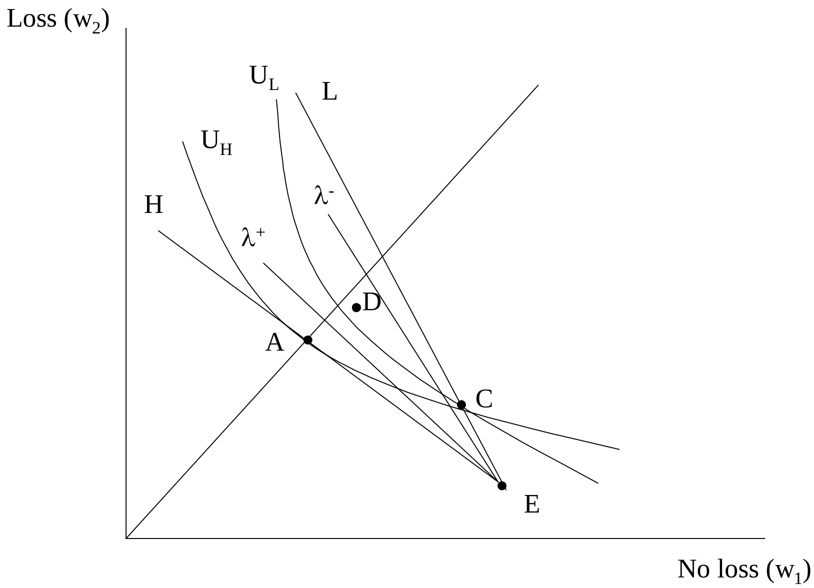

Figure 4:

2. Low risk only partly insured! (Esp. ironic since they should be 'easier' to insure.) But if a company offered a policy that fully insured the L risk, it would also attract the high risk.

- Preferences of H risk buyers act as a constraint on the market. Firms must maximize the well-being of L risk buyers subject to the constraint that they don't attract H risk buyers.
- Notice also that H risk are no better off for the harm they do to L risk. The externality is entirely *dissipative*, meaning that one group loses but no group gains. This is the opposite of Pareto improvement – and potentially a large social cost.

6.1 Possible failure of the separating equilibrium

- Do the proposed policies constitutes a separating equilibrium?
- See Figure 4.
- Consider policy D in the figure. Who would buy this policy if offered? *Both* types H and L would buy policy D because it lies above each of their indifference curves when purchasing policies A_L and C.

- What's the potential problem with D? D is a pooling policy, which we know cannot exist in equilibrium.

- What determines whether D is offered? This depends on whether D is more profitable than the pair A_L, C, both of which offer zero profits. What determines the profitability of D is λ, the share of high risk claimants in the population. To see this, observed that the slope of the fair odds line for pooling policies depends on λ: the larger is λ, the closer the pooling odds line lies to the H fair odds line; the smaller is λ, the closer the pooling odds line lies to the L fair odds line.

- In the above, figure the pooling odds lines corresponding to λ^+ and λ^- (λ^+, λ^- correspond to two different cases):

  - If the population is mostly high risk (λ^+), the pooling policy D that would break the separating equilibrium is unprofitable (lies above the fair odds line) and so will not be offered.
  - By contrast, if the population is mostly low risk (λ^-), the pooling policy D that would break the separating equilibrium is *profitable* (lies below the fair odds line) and so *will be offered.*

- In the latter case, *the model has no equilibrium.*

- Why does a low value of λ cause the separating equilibrium to fail?

  - At the separating equilibrium, the L risk types are not fully insured, and they are unhappy about this.
  - A pooling policy like D that requires just a little cross-subsidy to H types but offers more insurance is preferred by type $L's$ to policy C.
  - Hence, if there are sufficiently few H types in the market, a firm could profitably offer this policy and it will dominate the two separating policies.
  - What's ironic here is that it is the L types' risk aversion that makes them willing to tolerate some cross-subsidy to obtain insurance (i.e., they prefer more insurance at an actuarially *unfair* price to less insurance at an actuarially fair price). But the market cannot tolerate cross-subsidy – as we've shown.
  - So, if a policy involving cross-subsidy dominates a set of policies that induces separation, no equilibrium exists.

- To sum up:

  1. Welfare (efficiency) losses from adverse selection can be high.
  2. The costs appear to be born entirely by the low risk claimants (b/c of the need to get the H risk to select out of the pool). [This is a general result: the sellers of high quality goods will need to 'pay' to distinguish themselves from the low-quality sellers. This is seen, for example, in the art auction problem in the prior lecture note.]
  3. Pooling equilibria are unstable/non-existent
  4. Separating equilibrium may also not exist.

7 Implications of Rothschild-Stiglitz

- When information is private, the usual efficiency results for market outcomes can be rapidly undermined. Case in point: the only imperfection in this market is that one set of parties is better informed than another. (Clarify for yourself that there would be no inefficiency if the insurance company could tell who is type L, H). The equilibrium of the R-S model violates the first welfare theorem: the free market equilibrium is not Pareto efficient.

- How relevant is this model to real insurance markets? In my view, it is highly relevant. The insights of the model are fundamentally correct, though the results are probably too stark (usually the case).

- Health insurance:

  – Health club benefits, maternity benefits – Why are these offered?

  – Why do individual policies cost so much more than group policies?

- Auto insurance: can choose your deductible, but your premium rises nonlinearly as you chooser lower and lower deductibles. Why?

- What if MIT allowed new Economics professors to choose between two salary packages: low salary plus guaranteed tenure or high salary but no tenure guarantee. Assume there is no moral hazard problem (i.e., professors don't slack-off if tenured). Will this personnel policy yield a good faculty?

8 An example

8.1 Example: Altman, Cutler, Zeckhauser (1998)

- Group Insurance Commission of Massachusetts: Data visible to individuals *but not known to their insurance plans at the time of enrollment.*

- Three policies offered:

  1. Traditional indemnity: Most generous. You pay for whatever services you want, the insurance company pays you back.
  2. PPO (Preferred Provider Organization): Less generous, but few restrictions on utilization.
  3. HMO (Health Maintenance Organization): Most restrictive. They limit who you can see and what care is administered.

- Question 1: Why is indemnity plan so much more expensive than HMO plan?

  Table I

	Premium	Unadjusted Benefit Cost	Age/Sex Adjusted Benefit Cost
Indemnity	\$2,670	\$2,176	\$1,908
HMO	\$1,631	\$1,115	\$1,320
Difference	\$984	\$943	\$588

- It appears that about $2/3^{rds}$ of the difference in the premium of the indemnity versus HMO plan is *not* explained by the age and sex composition of the plan clientele. Why?

  – One explanation is moral hazard: people spend more when they get on this plan.

  – Another is adverse selection: people with greater taste for spending on health care choose the Indemnity plan.

  – Most likely explanation is a combination of the two.

- Table II:

  – People leaving indemnity plan for the HMO have average cost of $\$1,444$.

  – People staying in indemnity have average cost of $\$2,252$.

  – This is a 37% difference!

- Similarly:

  – People leaving HMO for indemnity have cost of $\$1,615$.

- People staying in HMO have cost of $1,125.
- This is a 47% difference.

- However, notice that plan 'immigrants' spent about average for the new plan they enter once they are in it.

	Indemnity	HMO
Stayers in 2nd year	$1,960	$1,344
Immigrants in 2nd year	$2,095	$1,181

- Table III
  - Accounting for adverse selection:
    - If no switching were allowed: Indemnity cost would be $16 lower per person.
    - If no switching were allowed: HMO costs would be $9 higher per person.
  - New enrollees:
    - By contrast, new enrollees *reduce* average costs by about $20 per person per plan per year ($20 in indemnity plan, $19 in HMO). Why?
  - Adverse retention:
    - If costs are convex in age (that is, rise nonlinearly as people age)
    - And if stayers are older at indemnity plans than HMOs
    - Then plan premium will rise faster at indemnity than HMO plan.
    - Over time, this will cause more young people to depart HMOs, bringing premiums up further.
    - The effect of "adverse retention" is $23 at indemnity plan versus $9 at HMO.

- So, program costs rise about $40 faster at indemnity than HMO. This may not be stable: adverse selection spiral of death is conceivable...