

# Lecture Note 23—Adverse Selection, Risk Aversion and Insurance Markets

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## 1 Insurance market unraveling: An empirical example

The 1998 paper by Cutler and Reber, “Paying for Health Insurance: The Trade-Off between Competition and Adverse Selection,” provides a nice real world illustration of the forces that can unravel markets with private information. This paper, written by a Harvard professor and a Harvard undergraduate (now a Ph.D. economist and UCLA faculty member), studies an unusual insurance policy change at Harvard to evaluate the importance of adverse selection in health insurance plans.

In 1995 Harvard moved from a system of subsidizing generous insurance to a system of paying a fixed contribution independent of plan choice (essentially a voucher system). This policy change increased the price to employees of the most generous policy by over \$500 annually. Helpfully for purposes of study, the rollout of the new pricing policy happened in two waves. Non-unionized employees faced the new prices in 1995. Unionized employees did not see the price increase until 1996. This allows for two difference-in-difference comparisons. In the first year, non-unionized workers serve as the treatment group and unionized workers as the comparison group. In the second year, the reverse is true (since the non-union workers experience no price change in the second year). The key health-plan choice that Harvard workers faced was between the more generous and more expensive Preferred Provider Organization (PPO) plan, which allowed them considerable choice of doctors, and the less generous and less expensive Health Maintenance Organization (HMO) plan. The HMO plan provided almost no choice of healthcare providers but did offer lower prices.

Why is this setting relevant for studying adverse selection? Prior to the policy change, we would expect that less healthy workers would be differentially likely to choose the PPO; that is, they would prefer more medical care at a somewhat higher price. Healthier workers by contrast would tend to choose the HMO, receiving less care at a lower annual cost. When Harvard switched from a roughly proportional employee healthcare subsidy scheme to a flat contribution plan, this would have differentially raised prices faced by PPO enrollees (and potential enrollees) relative to the price faced by HMO enrollees (and potential enrollees) given that the PPO had a higher sticker price. This differential price increase might cause the healthier enrollees of the PPO plan to switch to the HMO plan, while potentially leaving the sicker PPO enrollees behind. As these switches occurred, plan costs (and thus prices) would generally rise for the PPO, which might induce further switching.

This spiral of adverse selection may destabilize the PPO plan entirely so that it could not be offered in the future. Alternatively, the choice of health plans might reach a new equilibrium that is stable but not necessarily socially efficient. The Cutler-Reber paper studies this process theoretically, with a simple illustrative model, and empirically, using data obtained from Harvard.

It's useful to work through their simple model just a bit. Although the model is not highly general, it does offer several nice insights. Let the willingness to pay for PPO coverage instead of HMO coverage be given by  $g(h)$ , with higher values of  $h$  denoting *worse* health. We assume that  $g'(h) > 0$ , so less healthy individuals are willing to pay more. (See Figure 1 of the paper.) Denote the health of the marginal insurance buyer for the PPO plan as  $h'$ , so  $g(h') = P_{OOP}$  and  $P_{OOP}$  is the Out Of Pocket costs for the PPO. Buyers with  $h < h'$  choose the HMO and those with  $h' \geq h$  choose the PPO.

Denote mean health of HMO and PPO enrollees as  $h_L(h')$  and  $h_H(h')$ , respectively. Note that the average health of each plan's customers is a function of the health of the marginal entrant ( $h'$ ), in this model. Note that the average enrollee on the HMO will be healthier than the marginal enrollee (health  $h'$ ) and the average enrollee on the PPO plan will be less healthy than the marginal enrollee. Let the full cost for each plan be  $P_{PPO} = h_H(h')$  and  $P_{HMO} = \alpha h_L(h')$ , where  $\alpha < 1$  reflects the pure cost savings of the leaner HMO plan (holding the amount of care received constant). C&R estimate that  $\alpha \simeq 0.9$ , so the HMO reduces cost by about 10%, holding treatment constant. Assume that Harvard's rate of subsidy is given the parameter  $\beta \in [0, 1]$ , so that the difference in out of pocket costs between the PPO and HMO is  $P_{OOP} = (1 - \beta)(P_{PPO} - P_{HMO})$ . A key assumption of the model is that when enrollees move from the PPO to HMO, the price difference between the two *increases*:  $P_{PPO} - P_{HMO}$  is higher when fewer people are enrolled in the PPO. This assumption is plausible but it is not necessarily always true. Remember that when the marginal enrollee exits the PPO and joins the HMO, the average health of both populations gets worse (the people left on the PPO are less healthy on average than the enrollee who left, whereas the new enrollee on the HMO is less healthy than the average HMO enrollee). Thus, it need not be the case that  $P_{PPO} - P_{HMO}$  is rising in  $h'$ . For the purposes of the model, however, this assumption is a reasonable one.

Imagine a line  $PP$  that captures the relationship between  $P_{OOP}$  and  $h'$ . The higher is  $h'$ , the higher is  $P_{OOP}$  under our assumptions. Equilibrium in this market is given by the point where  $g(h)$  crosses  $PP$ . At this point, the marginal enrollee is indifferent between the higher cost PPO plan and the lower cost HMO plan. The paper denotes this equilibrium point by  $E$ . As drawn, the locus  $g(h)$  is steeper than  $EE$ , so this equilibrium is stable, meaning that small perturbations around  $E$  wouldn't cause the market to shift violently towards 100% HMO enrollment for example. The stability of the equilibrium comes from the fact that  $g(h)$  is steeper than  $EE$ , meaning that willingness to pay for the PPO rises faster than  $P_{OOP}$  when  $h'$  rises (i.e., which would occur if the marginal enrollee became less healthy). Because WTP lies above  $EE$  to the right of  $h'$  and below it to the left of  $h'$ , a small shift in enrollment that temporarily raised or lowered  $P_{PPO}$  would be self-correcting.

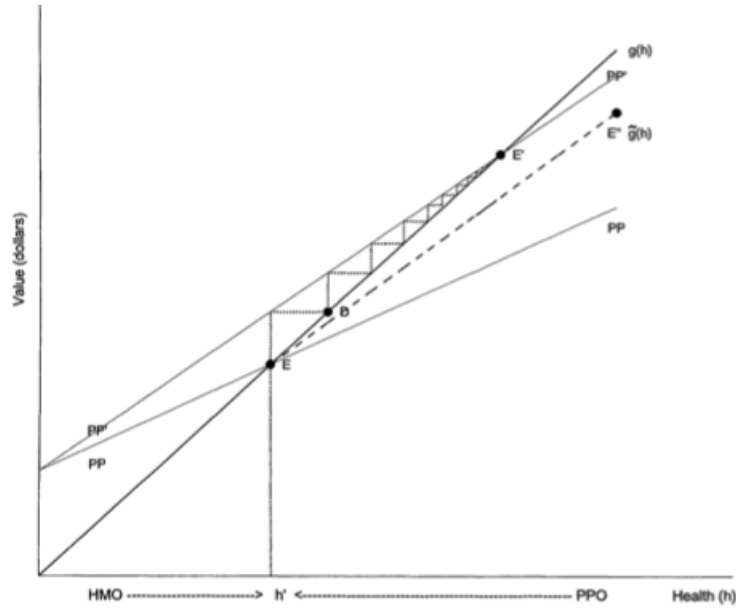


FIGURE I  
Insurance Market Equilibrium

Figure 1: Death Spiral in Insurance Markets [Cutler and Reber, 1998]

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Now suppose that the firm (Harvard) reduces  $\beta$ , so  $P_{PPO}$  rises. Note that this causes the locus  $EE$  to rotate, rather than rise uniformly, because the value of the subsidy is proportional to total expenditure (it's not a flat amount). This price increase has two effects. Initially, the rise in price causes some marginal enrollees to switch from the PPO to the HMO. But this increases the cost differential,  $P_{OOP}$ , since the PPO population's health cost rises more than the HMO's cost. This is depicted as the movement from point  $E$  to point  $D$  in the figure. But as the healthiest enrollees leave the PPO for the HMO, the price differential between the two ( $P_{OOP}$ ) rises further, leading more workers to switch from the PPO to the HMO. This adverse selection spiral may lead to complete unraveling where no one purchases the PPO plan (or only the least healthy worker). Or, as depicted in Figure 1, it may lead to a less extreme outcome, with fewer (but not no) PPO enrollees, and a much higher  $P_{OOP}$ .

Would this new equilibrium (or the old equilibrium) be efficient? What would efficiency mean in this market? A useful benchmark is that everyone who values the additional services provided by the PPO at their *marginal* cost or above is on the PPO plan whereas the rest are on the HMO plan. By emphasizing the word *marginal* here, you can see why this condition is unlikely to be satisfied. The insurer has to charge consumers roughly the *average* cost of enrollees on the plan. Given adverse selection, the average cost exceeds the marginal cost for the PPO and vice versa for the HMO. This makes it unlikely that we'll have an efficient equilibrium. What would efficient pricing be? Under the assumptions of the model, a sufficient condition for efficient self-selection is that the marginal enrollee to the PPO is just willing to pay for the additional cost of services on the PPO relative to the HMO (reflected in foregoing the cost savings in the HOM stemming from  $\alpha$ ). This can be

expressed as  $(1 - \alpha)h^* = g(h^*)$ , where  $h^*$  is the health of the marginal enrollee. This express says that the marginal PPO enrollee values the PPO more than the HMO by exactly the amount of the cost differential. Thus,  $P_{PPOP}^* = (1 - \alpha)h^*$ .

We will discuss the results of the paper in class.

## 2 [For self-study if desired.] Why do insurance markets work *at all*? Finkelstein and McGary (2006), “Multiple Dimensions of Private Information: Evidence from the Long-Term Care Insurance Market.”

- Based on the RS paper, you might be left with the thought, “It’s a wonder that insurance markets work at all! If even a small degree of adverse selection is enough to destabilize the market (e.g., there is no equilibrium in RS when almost everybody is a high-risk type save for a few low-risk types), then shouldn’t be things much worse in the real world where, presumably, there are many, many dimensions of heterogeneity and private information?”
- The Finkelstein-McGary (FM) paper from 2006 provides a highly original set of insights into why insurance markets may function *better* than the RS model would suggest, despite the presence of adverse selection.
- FM does not in any sense overturn RS. It does offer an important insight into the nature of insurance markets, specifically: that *both adverse and advantageous selection* may be present.
  - Adverse selection: Consumers with private information that they are riskier than other observably similar consumers are more likely to buy insurance.
  - Advantageous selection: Consumers who are *less risky* than other observably are more likely to buy insurance (that is, all equal, they are willing to pay more for insurance or are more likely to buy it at a given price).
- Adverse selection tends to arise because ‘risky’ people can benefit from paying an insurance premium that is lower than their expected cost. This would be true even if these consumers are risk neutral (e.g., if I can buy an auto policy for \$100 a year and my expected accident costs are \$300 per year, that’s a policy I’d like to have).
- Advantageous selection may occur if consumers who are more cautious also have greater demand for insurance. This would occur, for example, if cautiousness and risk aversion (the concavity of the utility function over wealth) are positively correlated. This does not seem implausible. People who don’t start their cars until they’ve secured their seat belts and would never drive above the speed limit may also not sleep easily unless they are abundantly insured. People who like to drive with one hand on the wheel and the other on a cold can of beer

may not be the worrying type. Thus, it could be the case that ‘taste for risk’ and ‘taste for insurance’ are inversely correlated.

- FM explores this idea in the Long Term Care insurance market. (Long Term Care is an extremely expensive proposition. Individuals who require *LTC* can easily use up their entire life savings in a few years time. *LTC* insurance is expensive and not widely purchased in the U.S..)
- The FM analysis proceeds in three interesting and readily interpretable steps:
  1. FM first establish that individuals *do* have informative beliefs about their odds of requiring *LTC*, *and* moreover that these beliefs are *not* captured by the insurance industry’s risk assessment model. Thus, consumers have private information about their riskiness. And moreover, these beliefs predict the purchase of *LTC* insurance; consumers who believe that they are more likely to require *LTC* are more likely to buy a policy. This is direct evidence of adverse selection on private information about risk.
  2. FM next show that, contrary to intuition, consumers’ private information about their *LTC* needs is *unrelated* to the joint probability that they both buy *LTC* insurance and receive *LTC*. That is, consumers who buy *LTC* insurance are not differentially likely to receive *LTC* (*conditional* on the insurance company’s information set — so, private information does not appear important.)
  3. FM resolve this paradox by showing that there is also *advantageous* selection into *LTC* coverage. Individuals who (1) take better care of their health, (2) are wealthier, and/or (3) use their seat belts more often are *less likely* to require *LTC* and *more likely* to buy *LTC* insurance ( $I = 1$ ).
- This paper is easy to understand if we break up the problem into discrete categories. Imagine that there are two types of *LTC* risk populations, *H* and *L*, and two types of risk preference populations, *C* and *R*, for Cautious and Reckless.
- Imagine that a person will buy *LTC* Insurance if she is either *H* or *C*—that is, she is high-risk or cautious.
- The population parameters (describing the fraction of *H* v. *L* and *C* v. *R*) are:

$$\begin{aligned}\Pr(H) &= \lambda_H, \Pr(L) = 1 - \lambda_H \\ \Pr(C) &= \delta_c, \Pr(R) = 1 - \delta_c\end{aligned}$$

- The probability that a person requires *LTC* are:

$$\begin{aligned}\Pr(LTC|H) &= p_H, \\ \Pr(LTC|L) &= p_L,\end{aligned}$$

with  $p_H > p_L$ .

- Imagine finally that  $H$  and  $L$  know their types but insurance companies cannot tell them apart. (All that matters here is that applicants have a better guess about  $H$  and  $L$  than do insurance companies; thus, there is ‘residual’ private information.)
- Now, let’s do the FM analysis in three steps...

### 2.1 Will $H$ types be more likely to require $LTC$ than $L$ types?

- Yes, this is true by assumption:  $p_H > p_L$ .

### 2.2 Will $H$ types be more likely to buy insurance than $L$ types?

- You might be tempted to say yes, but this is not necessarily true. We said that a person buys insurance if either  $H$  or  $C$ . So, a person buys insurance iff:

$$\begin{aligned}\Pr(I|H) &= 1 \\ \Pr(I|L) &= \Pr(C|L).\end{aligned}$$

So, as long as  $\Pr(C|L) < 1$ , that is so long as that not all  $L$  types are Cautious, then it will be true that  $H$  types are more likely than  $L$  types to buy insurance. Of course, if  $\Pr(C|L) = 1$ , then all  $H$  and all  $L$  types will buy insurance.

- Assuming that  $\Pr(C|L) < 1$  would give us a case consistent with FM’s first observation:  $H$  types are more likely than  $L$  types to buy insurance.
- Again, bear in mind that we are assuming that a consumer’s type,  $H$  or  $L$ , is known to him or her but unobservable to the insurer. Thus,  $H$  or  $L$  is residual private information. We could equally well assume that each consumer knows  $H$  or  $L$  with certainty, and that the insurance company observes  $H$ , which is a noisy signal of  $H$ , where  $\Pr(H = 1|H) = \gamma_H < 1$  and  $\Pr(H = 1|L) = \gamma_L > 0$  and  $E(H) = \lambda_H$ . Here, the consumer’s beliefs about  $H$  are still more informative than the insurance company’s assessment of  $H$ , so the consumer again has residual private information. We won’t add this extra layer of complexity because it does not add substantively to the model.
- So, we are in a setting where  $H$  types have higher probability of buying insurance than  $L$  types and are more likely than  $L$  types to require  $LTC$ .

### 2.3 Will $C$ types be more likely to buy insurance than $R$ types?

- The answer to this question is analogous to above. A person buys insurance if  $H$  or  $C$  :

$$\Pr(I|C) = 1$$

$$\Pr(I|R) = \Pr(H|R)$$

So, as long as *not* all Reckless types are High risk, it will be the case that Cautious people are more likely to buy insurance than Reckless people.

- Thus, we can have both *adverse* selection on  $H$  and *advantageous* selection on  $C$  operating simultaneously.

## 2.4 Will insured consumers be more likely than average to require $LTC$ ?

- Here's the subtlety: given both adverse and advantageous selection, it's not clear whether consumers purchasing  $LTC$  insurance will be more or less likely than average consumers to require  $LTC$ .
- The *baseline* probability that the average consumer requires  $LTC$  is equal to  $\Pr(LTC) = p_H \lambda_H + p_L (1 - \lambda_H)$ .
- The insured are more likely than average to require  $LTC$  iff:  $\Pr(H|I) > \lambda_H$ , in which case  $\Pr(LTC|I) > p_H \lambda_H + p_L (1 - \lambda_H)$
- What is  $\Pr(H|I)$ ? This probability is a function of both  $\lambda_H$  and  $\delta_c$  and their correlation (or, in this discrete case, the probability of their joint occurrence).

### 2.4.1 Case 1: Adverse and advantageous selection cancel:

- Consider a case where  $\frac{1}{2}$  the population is high risk ( $\lambda_H = 0.5$ ) and  $\frac{1}{2}$  the population is cautious ( $\delta_c = 0.5$ ). Moreover, assume that 100% of  $H$  people are reckless and 100% of  $L$  people are cautious. This can be written in the following contingency table:

	Cautious	Reckless	
High Risk	0%	50%	<b>50%</b> = $\lambda_H$
Low Risk	50%	0%	<b>50%</b> = $\mathbf{1} - \lambda_H$
	<b>50%</b> = $\delta_c$	<b>50%</b> = $\mathbf{1} - \delta_c$	

What is the probability that a consumer is High risk given that she's insured?

$$\Pr(H|I) = \frac{\Pr(H)}{\Pr(H) + \Pr(C) - \Pr(H = C = 1)}$$

Note that we subtract off the probability that a person is both  $H$  and  $C$  ( $\Pr(H = C = 1)$ ) because we would otherwise be double-counting these consumers (since they appear in both  $\lambda_H$  and  $\delta_c$ ).

- Plugging in values:

$$\begin{aligned}\Pr(H|I) &= \frac{\lambda_H}{\lambda_H + \delta_c - \Pr(H = C = 1)} \\ &= \frac{0.5}{0.5 + 0.5 + 0} = 0.5 = \lambda_H\end{aligned}$$

- In this case, the advantageous selection by the Cautious offsets the adverse selection by the High risk types. So, the insured do not have higher *LTC* needs than the baseline consumer.

#### 2.4.2 Case 2: Adverse selection dominates

- Consider a case where  $\frac{1}{2}$  the population is high risk ( $\lambda_H = 0.5$ ) and  $\frac{1}{2}$  the population is cautious ( $\delta_c = 0.5$ ). Moreover, assume that  $\frac{3}{5}$  of *H* people are reckless and  $\frac{3}{5}$  of *L* people are cautious. So, the contingency table would look as follows:

	Cautious	Reckless	
High Risk	20%	30%	<b>50%</b> = $\lambda_H$
Low Risk	30%	20%	<b>50%</b> = $\mathbf{1} - \lambda_H$
	<b>50%</b> = $\delta_c$	<b>50%</b> = $\mathbf{1} - \delta_c$	

Who buys *LTC* insurance? Everyone who is either High risk or Cautious or both. This is 80% of the population. Consumers who do not buy are neither *H* nor *C* (which is 20% of the population).

- What is the probability that a person who has purchased *LTC* insurance is type *H*? This probability is:

$$\Pr(H|I) = \frac{0.5}{0.5 + 0.5 - 0.2} = 0.625 > \lambda_H.$$

- Thus, despite the presence of advantageous selection, it's still the case that those who are insured have higher than baseline probability of *LTC*.

#### 2.4.3 Case 3: Advantageous selection dominates

- This case cannot occur in our simple setup because all high risk types *always* buy insurance. Thus, the insured population is always *at least as high risk* as the baseline population.
- But we can change model's parameters slightly to consider such a case. Continue to assume as above that 50% of the population is high risk and 50% low risk, and that 40% of high risk are cautious and 60% of low risk are cautious. Now, additionally assume that only 50% of reckless consumers buy insurance. Thus, because high risk consumers are also more likely to be reckless consumers, they are more likely to be the type of consumer who does not buy



insurance:

	Cautious	Reckless	
High Risk	20%(100%buy insurance)	30%(50%buy insurance)	<b>50%</b> = $\lambda_H$
Low Risk	30%(100%buy insurance)	20%(50%buy insurance)	<b>50%</b> = $\mathbf{1} - \lambda_H$
	<b>50%</b> = $\delta_c$	<b>50%</b> = $\mathbf{1} - \delta_c$	

- What is  $\Pr(H|I)$ ?

$$\Pr(H|I) = \frac{0.2 + 0.3 \times 0.5}{0.2 + 0.3 \times 0.5 + 0.3 + 0.2 \times 0.5} = 0.47 < \lambda_H$$

In other words, the insured have on average lower *LTC* claims than the baseline population.

- Conversely, the non-insured have higher *LTC* claims:

$$\Pr(H|I = 0) = \frac{0.3 \times 0.5}{0.3 \times 0.5 + 0.2 \times 0.5} = 0.60 > \lambda_H.$$

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