**Comment on Joseph Stiglitz's Paper
« Risk, Incentives and Insurance :
The Pure Theory of Moral Hazard »**

by Oliver D. Hart *

A paper by Joseph Stiglitz is usually both interesting and stimulating, and this one is no exception. I shall comment on three of the issues raised in the paper : (1) the nature of insurance equilibrium when contracts are observable ; (2) the nature of equilibrium when contracts are unobservable ; (3) externalities associated with equilibrium in the presence of moral hazard.

Consider a competitive insurance market. Following Stiglitz, assume that all consumers are alike and each wishes to insure against the possibility of an accident, which occurs with probability p . Each consumer's (expected) utility is given by

$$(1) \quad U(w - \beta)(1 - p) + U(w - d + \alpha) p - e,$$

where U is a concave von Neumann-Morgenstern utility function, w is consumer wealth in the absence of an accident, d is the loss of wealth due to the accident, β is the premium paid to the insurance company, α is the benefit (net of premium) received from the insurance company in the event of accident, and e is the effort or care devoted by the consumer to preventing the accident (assumed unobservable to the insurance company).

Naturally, p depends on e : $p = p(e)$. Since we would expect greater care to reduce the probability of accident, we assume that p is decreasing in e . The consumer's choice of e will depend on the insurance contract (α, β) offered. Consider first the case where each insurance company can observe whether a consumer has purchased insurance from any other company. In this case one can assume without loss of generality that each consumer purchases insurance from just one company. Stiglitz characterises the competitive equilibrium in this case in Section 3 of his paper. I shall present an alternative treatment which may clarify some issues.

Since insurance companies are competitive and there is free entry, it is a simple matter to show that each company will make zero profit in equilibrium. As Stiglitz notes, it follows that equilibrium is characterised by the condition that each company offers a single contract (α, β) which maximises a typical consumer's expected utility (see (1)) subject to the constraints that

* Professor at the London School of Economics.

(2) the consumer chooses e to maximise $U(w-\beta)\{1-p(e)\} + U(w-d+\alpha)p(e)-e$ and

$$(3) \quad \{1-p(e)\} \beta = p(e) \alpha,$$

i.e. the company makes zero profit. For if such a contract (α^*, β^*) is not offered, then a new company can enter the industry, offer a contract "close" to (α^*, β^*) , and thereby tempt away customers of existing companies and make strictly positive profits. Call the above maximisation problem A .

To see what the solution of problem A looks like, one may adopt the approach of Grossman and Hart [1982]. Suppose for simplicity that there are finitely many effort levels $e_1, \dots, e_n$, where $e_1 < e_2 < \dots < e_n$. Then we can rewrite problem A as: Choose α, β, i to

$$(4) \quad \text{Maximise } U(w-\beta)\{1-p(e_i)\} + U(w-d+\alpha)p(e_i) - e_i$$

subject to

$$(5) \quad \begin{aligned} &U(w-\beta)\{1-p(e_i)\} + U(w-d+\alpha)p(e_i) - e_i \\ &\geq U(w-\beta)\{1-p(e_j)\} + U(w-d+\alpha)p(e_j) - e_j \end{aligned}$$

for all $j = 1, \dots, n$,

$$(6) \quad \{1-p(e_i)\} \beta = p(e_i) \alpha.$$

Now it is shown in Grossman and Hart [1982] that at an optimum, where the consumer chooses e_i , (a) none of the "moral hazard" or "incentive compatibility" constraints in (5) with $j > i$ is binding (i.e. "the consumer never expends too much effort"); (b) if the optimal $i > 1$, at least one of the constraints with $j < i$ is binding. Consider first the case where $n = 2$. Then if the optimal $i = 1$, it follows that none of the constraints (5) is binding, and so the solution of (4)–(6) call for complete insurance, i.e.

$$(7) \quad w - \beta = w - d + \alpha.$$

Let the unique solution of (6) and (7) be $(\hat{\alpha}, \hat{\beta})$.

On the other hand, if the optimal $i = 2$, (5) is binding, i.e.

$$(8) \quad U(w-\beta)\{1-p(e_2)\} + U(w-d+\alpha)p(e_2) - e_2 = U(w-\beta)\{1-p(e_1)\} + U(w-d+\alpha)p(e_1) - e_1.$$

If we combine this with (6), we can solve uniquely for α, β ; write the solution as $(\hat{\alpha}, \hat{\beta})$.

Thus the solution to (4)–(6) or to problem A is either $(\hat{\alpha}, \hat{\beta}, 1)$ or $(\hat{\alpha}, \hat{\beta}, 2)$. To see which, it is enough to compare the values of the objective function (1), i.e. to see whether

$$(9) \quad U(w-\hat{\beta})\{1-p(e_1)\} + U(w-d+\hat{\alpha})p(e_1) - e_1 \gtrless U(w-\hat{\beta})\{1-p(e_2)\} + U(w-d+\hat{\alpha})p(e_2) - e_2.$$

It is easy to generalise this analysis to the case $n > 2$. For each $i > 1$ and $j < i$, solve (5) and (6). Let the (unique) solution be $(\alpha_{ij}, \beta_{ij})$. Now for each i choose that $j < i$ which minimises β_{ij} ; write this j as $j(i)$. Finally choose $i = 1, \dots, n$ to maximise

$$(10) \quad U(w-\beta_{ij(i)})\{1-p(e_i)\} + U(w-d+\alpha_{ij(i)})p(e_i) - e_i,$$

where $(\alpha_{ij}, \beta_{ij}) = (\hat{\alpha}, \hat{\beta})$ when $i = 1$.

Call the solution, i^* . In Grossman and Hart [1982], it is shown that the solution to problem A is then $(\alpha_{i^*j(i^*)}, \beta_{i^*j(i^*)}, i^*)$.

This provides us with a characterisation of the equilibrium contract (α, β) and the corresponding care level e_i in the case where contracts are observable. As Stiglitz

notes, equilibrium in general has the property that each consumer would like to buy more insurance at the going "prices" than he is permitted to, i.e. he is rationed. This can be seen from the fact that a risk-averse consumer offered a menu of *all* fair-odds net benefit-premium points (α, β) , where $p(e)\alpha = \{1 - p(e)\}\beta$, will choose complete insurance, i.e. the point (α, β) satisfying $w - d + \alpha = w - \beta$. But it then follows from (2) or (5) that $e_i = e_1$, i.e. the consumer takes no care. Thus, if the equilibrium $e_i > e_1$, consumers must be rationed.

As Stiglitz observes, rationing is difficult to implement once we drop the assumption that an insurance company can observe consumer purchases from other companies. Stiglitz notes that some limitations on the amount of insurance are still possible since each company can ration the amount of insurance it sells to its customers. Stiglitz ignores this point in his analysis, however, and considers the nature of competitive equilibrium under the assumption that a consumer can purchase any non-negative (not necessarily integral) fraction or multiple of any contract offered. Under these conditions, he argues that competitive equilibrium may be very different in nature from what it is in the observable contracts case. First, it may not exist. Secondly, if it exists, some companies may be making positive profits.

Stiglitz gives the following intuitive argument for the non-existence of a zero profit equilibrium. If such an equilibrium exists, it will involve complete insurance if consumers buy any insurance at all (since consumers are risk-averse and face the linear fair-odds feasible set $\{(\alpha, \beta) \mid p(e)\alpha = (1 - p(e))\beta\}$). But this means, as we have seen, that consumers will take no care, i.e. $e = e_1$. This in turn means that (α/β) may be so low that no consumer wants to buy any insurance. But there cannot be an equilibrium in which no consumer buys insurance since then one insurance company will have an incentive to offer incomplete insurance under better odds than (α/β) , thereby attracting customers and making positive profits.

This argument seems plausible, but it needs to be spelled out more formally, as does the argument that a positive profit equilibrium may not exist either. For example, both arguments implicitly assume that all companies offer the same contract. Might there possibly, however, be an asymmetric equilibrium in which different companies offer different contracts? One would also like to know whether, in the absence of a pure strategy equilibrium, a mixed strategy equilibrium exists.

The possible non-existence of equilibrium is perhaps not all that surprising in view of the similar results which have been obtained in the adverse selection literature. Of more interest, in my opinion, is the possibility of a positive profit equilibrium. The intuition here, I think, is that, given the equilibrium set of contracts, consumers may be indifferent between taking a lot of care and not much insurance or a little care and a lot of insurance. The equilibrium may involve consumers taking a lot of care and insurance companies thereby making positive profits. If a new firm enters and undercuts existing firms, however, consumers may strictly prefer low care and the profits of all firms may then become strictly negative.

Let me turn finally to Section 4, which deals with externalities. The basic point that Stiglitz makes here is that once one moves slightly away from the simple partial equilibrium model discussed in Sections 1-3, interdependencies between insurance arrangements in one market and those in other markets, in the form of externalities,

become important. As a result, there is no presumption that the invisible hand works, i.e. that competitive equilibria are (constrained) Pareto optimal. This is an important point which can be illustrated by two examples. Suppose that a consumer wishes to take out health insurance. The insurance company would like to make the terms of the contract conditional on how many cigarettes a week the consumer smokes, but this is assumed to be unobservable. If cigarettes are cheap, the consumer is assumed to smoke a lot of them and so in equilibrium the insurance premium will be high. Suppose now that the government taxes cigarettes. Then the consumer will smoke less and the terms of the insurance contract will become more favourable. The improved insurance possibilities may be so important to the consumer that he is made better off in spite of the increased price of cigarettes. In fact it may even be the case that the cigarette companies can be compensated for the reduction in sales, so that a Pareto improvement is possible (the insurance companies are indifferent since they make zero profit).

This example is in the spirit of Stiglitz's case of "interdependence through price effects". The second example of externalities which I shall give has a rather different flavour. It is concerned not with accident insurance but with the question of managerial incentives. Consider a competitive product market consisting of firms and consumers. Assume that some firms are run by managers and that the firms' owners can observe neither the actions of the managers nor the costs of the firms' inputs. Then in order to get the manager to work on their behalf the owners will gear his salary to the observed performance of the firm, say profits. Even with an optimal incentive scheme of this sort, however, the manager will generally choose to slack to some extent when input costs are low and profit is high.

Now suppose that the input costs of different firms are positively correlated, and that some firms are profit-maximisers, i.e. they are run by entrepreneurs rather than by managers. Then if there is a general fall in input costs (total and marginal) the profit-maximising entrepreneurial firms will expand, thereby driving down product prices. This in turn will force managers to slack less than if only their own input costs had fallen and product prices had not changed, since otherwise they fail to meet their profit targets. Thus the presence of entrepreneurs imposes an externality on the managers and causes a reduction in managerial slack relative to the situation of no entrepreneurs. In Hart [1981] it is shown that it may, as a result, be desirable to subsidise entrepreneurial activity.

These are just two examples of the externalities that can arise with moral hazard. Many others can surely be provided. The attempt to provide a general characterisation and theory of externalities under moral hazard will certainly be an important research project for economic theorists over the next few years.

REFERENCES

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