# WHEN IGNORANCE IS BLISS: SELF SELECTION AND THE VALUE OF INFORMATION IN INSURANCE MARKETS

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## ABSTRACT

Models of adverse selection assume that consumers are endowed with knowledge of their risk type, but this information is unobservable by insurers. If consumers were not so endowed, would they have an incentive to become informed? If all consumers are initially uninformed, then the equilibrium value of information to consumers is negative, and adverse selection would never arise. If some consumers are endowed with information, then information may (but need not) have positive value to the remaining initially uninformed consumers. When information is endogenous, competitive insurance markets are not generally informationally efficient, and, if the equilibrium value of information is positive, the equilibrium depends discontinuously on information costs.

# WHEN IGNORANCE IS BLISS: SELF SELECTION AND THE VALUE OF INFORMATION IN INSURANCE MARKETS

## I. INTRODUCTION

An important feature of insurance markets is that insurers typically do not have direct information on the risk type, or more generally the loss distributions, of consumers. That is, there is potentially a problem of adverse selection. Self selection mechanisms are a device by which information on the underlying loss distributions of policyholders will be reflected in market transactions. Insurers offer a menu of contracts designed to induce policyholders to reveal their risk class through their contract choices. The resulting separating equilibrium, if it exists, will be informationally efficient (see, e.g., Rothschild and Stiglitz 1976, Wilson 1977, Spence 1978).[1]

An important assumption in existing models of self selection mechanisms is that consumers are exogenously endowed with full knowledge of their risk type. Clearly, this is a strong assumption, but in some cases it is may be a reasonable one. For example, when applying for life insurance, the individual clearly knows whether he is a smoker or nonsmoker; this information may be treated as endowed to the individual but observable by the insurer only at some cost. Other information relevant to risk type is not trivially endowed, but may be ascertained only by conscious decision. Illustrations are HIV testing, mamograms, and testing for genetic markers that predict genetic predisposition for several diseases.

These examples suggest the assumption that consumers are endowed with knowledge of their risk type is not always appropriate. More importantly, its implications for insurance market equilibria and the value of information have not been examined. The outcome of the decision to invest in information (as well as the type of information revealed) influences the set of insurance contracts that will be made available. Thus, one would suppose that individual investment in information is more

[1] Categorical discrimination is another way that information on policyholders' loss distributions in reflected in market transactions. Categorical discrimination requires that insurers be able to observe loss distributions imperfectly, possibly at some cost. See, e.g., Hoy (1982), Dahlby (1980, 1983), Crocker and Snow (1986).

likely when information increases the expected value of the set of contracts offered. In such circumstances, it is more appropriate to treat information as endogenous in characterizing the insurance equilibrium.

The purpose of this paper is to examine the nature of equilibrium and the equilibrium value of information in competitive insurance markets when consumers' decision to invest in information is endogenous. Instead of assuming that consumers are endowed with full knowledge of their loss distribution, we make the weaker assumption that the consumers have a comparative advantage in observing their own loss distribution. We use the standard two state model of insurance markets to show that the private value of information to consumers is negative. More specifically, we show that policyholders will choose not to acquire information on their risk type when this information can be observed costlessly by insurers. Similarly, information has negative value to policyholders when the information is not monitored directly by insurers. Thus, "ignorance is bliss" in the sense that if consumers do not know their risk class ex ante, they are better off not finding out.

The reason that information has negative value is intuitive. Assume a competitive insurance market with two risk classes and symmetric information. This implies that consumers, whether informed or uninformed, purchase full insurance at actuarially fair prices. If she decides to become informed, the policyholder then faces a lottery between the high risk and low risk policies. Alternatively, uninformed policyholders can remain ignorant and purchase insurance at the pooled fair odds; the premium equals the average of the high and low risk premiums. Risk averse consumers will choose the expected value over the lottery.

However, if information endowments differ across consumers, then there may be a cost to remaining ignorant. Suppose that some consumers are endowed with knowledge of their risk type, and that risk type cannot be observed directly by insurers. Then, if they cannot be identified as such, uninformed consumers must incur the cost of signalling that they are not informed bad risks. As a result, information has positive value to initially uniformed policyholders. If the cost of information is sufficiently low, the uninformed policyholders will choose to learn their risk type. If a separating equilibrium exists, it is fully informationally efficient. If the costs of information are too high, then separating equilibria have both informed and uninformed policyholders, and are not informationally efficient.

That information may have negative value is not an entirely new result. Hirschleifer (1971) and Arrow (1978), extending the work of Dreze (1960), showed that improved public information may make everyone worse off (by eliminating opportunities to reallocate risk through trade). Milgrom and Stokey (1982), building on Hirshleifer (1971) and Marshall (1974), show that if parties negotiate *ex ante* efficient contracts in a complete markets setting, then subsequently generated information does not expand allocative opportunities and has a social value of zero. Crocker and Snow (1990) show that when parties are asymmetrically informed prior to negotiations, subsequent information reduces signalling costs by permitting finer sorting of agents and therefore has positive social value.

This literature is concerned with the social value of information that is exogenously generated. However, whether contracting parties are symmetrically or asymmetrically informed when they negotiate contracts depends on whether the parties have private incentives to acquire information. In insurance markets, the private value of information depends on the sets of contracts available with and without such information. Thus, the relationship of our paper to Milgrom/Stokey and Crocker/Snow is that we examine whether intitally symmetric or asymmetric information will prevail at the time contracts are negotiated.[2]

In Section II we analyze markets in which no consumers are endowed with knowledge of their risk type. In Section III, we consider a market in which some consumers are initially endowed with knowledge of their risk type, and in Section IV we examine the effect of information costs. Section V provides brief concluding remarks.

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[2] We do not address the social value of information obtained subsequent to the negotiation of contracts.

## II. HOMOGENEOUS INFORMATIONAL ENDOWMENTS

Throughout the paper we use the standard two state model of insurance markets. There is a continuum of consumers who are assumed to be identical in all easily observable respects. Each consumer has a fixed endowment of wealth w, and the von Neumann Morgenstern utility function v(w), which is increasing and concave. Each consumer faces a possible loss, $\ell$, where $0 < \ell < w$. Consumers may be one of two types - high risk, with probability of loss $p_H$, or low risk, with probability of loss $p_L$; $0 < p_L < p_H < 1$. We assume that $p_H$ and $p_L$ are fixed, so that no moral hazard problem exists. The population proportions of high and low risk types are $\theta_H$ and $\theta_L$, where $0 < \theta_H$, $\theta_L < 1$ and $\theta_H + \theta_L = 1$. These parameters are assumed to be common knowledge.

An insurance contract is described by $c = (\alpha, \beta)$, where $\alpha$ is the premium and $\beta$ is the gross indemnity. The expected utility received by a consumer with probability of loss p under the insurance contract c is

$$V(c, p) = (1 - p)v(w - \alpha) + pv(w - \alpha - \ell + \beta). \tag{2.1}$$

Consumers choose the contract that maximizes expected utility. We assume that the insurers are risk neutral expected profit maximizers and that the insurance market is competitive so that in equilibrium insurers earn zero expected profit. We let $c^* = (p\ell, \ell)$ denote a contract offering full insurance at an actuarially fair rate.

Adverse selection models traditionally assume that individuals are endowed with *a priori* knowledge of their true risk type. We assume that consumers are not endowed with this information, but it may be acquired at the discretion of the individual concerned. We assume throughout that all parties form priors on risk type equal to the population proportions, and let $p_U$ denote the prior probability of loss for uninformed consumers. Throughout the paper, the value of information is taken to mean the gross value.

*A. The value of symmetric information.* We temporarily assume that when this information is acquired by the policyholder, it is costlessly transmitted to the insurer. Thus, for the time being, information on risk type does not give rise to adverse selection.

*Proposition 1*: Assume consumers can choose to observe their risk type at zero cost and this information will also become available to insurers. Then (a) information has negative value to consumers and (b) the equilibrium contract set is $\{c_U^*\}$.

*Proof.* Since the market is competitive with symmetric information, type t consumers purchase $c_t^*$, i.e., full insurance at actuarially fair rates. Then $V(c_t^*, p_t) = v(w - p_t\ell)$. The value of information to consumers is the expected change in utility from acquiring the information:

$$I_S = [\theta_H v(w - p_H\ell) + \theta_L v(w - p_L\ell)] - v(w - p_U\ell). \tag{2.2}$$

Now $p_U = \theta_H p_H + \theta_L \theta_L$. Since $v(\cdot)$ is concave, Jensen's inequality implies $I_S < 0$. Since consumers choose not to learn their risk type, in equilibrium the only policy purchased is $c_U^*$. *Q.E.D.*

Figure 1 illustrates Proposition 1, and shows both the "no information" equilibrium and the symmetric full information equilibrium. Without information on risk type, consumers purchase policy $c_U^*$, while with information consumers purchase either $c_H^*$ or $c_L^*$. Since information endowments are homogeneous, $c_U^*$ is the population average of $c_H^*$ and $c_L^*$.

Uninformed consumers know that they are high risk with probability $\theta_H$ and low risk with probability $\theta_L$. Since information is distributed to insurers, policyholders that decide to learn their risk type face a lottery over a bad risk premium $\alpha_H$ and a good risk premium $\alpha_L$. If they remain uninformed, policyholders pay with certainty the uninformed premium $\alpha_U$, which is the mean of the high and low risk premiums. Being risk averse, they prefer the mean with certainty to the lottery. That is, the policyholder who decides to become informed is subject to the uninsured "classification risk" of being classified as bad or as a good risk. For risk averse policyholders, this classification risk is an implicit cost of deciding to become informed. Deciding not to become informed effectively insures against this classification risk.[3] At any nonnegative (explicit) information cost policyholders would choose to remain ignorant; "when ignorance is bliss, 'tis folly to be wise".

[3] A similar point has been made with respect to experience rating in insurance by Boyer, Dionne and Kihlstrom [1989].

*B. The value of asymmetric information.* We again assume that policyholders are identical in all respects but risk type, and do not have endowed information on risk type. However, we now assume that if this information is acquired by the policyholder, it is not directly transmitted to the insurer. Thus, such information may lead to selective behavior on the part of policyholders and to compensating strategies by insurers.

If consumers choose not to become informed, there is no informational asymmetry. The insurer and policyholder share the same estimate of the latter's probability of loss, the premium is perceived by all to be actuarially fair given the absence of information and individuals purchase full insurance.

Now suppose that individuals choose to learn their risk type. The probabilities of this information revealing each to be a high or low risk are determined by the population proportions. This information is not monitored directly by the insurer. The expected utility maximizing levels of insurance for those revealed to be bad or good risks will depend on the strategy adopted by the insurer for coping with the information asymmetry. We assume that insurers adopt a self selection mechanism which yields a Rothschild/Stiglitz (1976) separating equilibrium.[4] We let $c_t'$ denote the equilibrium separating contracts. In the separating equilibrium, high risk types are fully insured, so $c_H' = c_H^*$, while, since low risks are rationed to less than full insurance, $c_L' = (p_L k'\ell, k'\ell)$, $0 < k' < 1$.

> *Proposition 2*: Assume consumers can choose to observe risk their type at zero cost and this information does not become available to insurers. Then (a) information has negative value to consumers and (b) the equilibrium contract set is $\{c_U^*\}$.

*Proof.* If consumers remain uninformed, there is no informational asymmetry. Then consumers purchase policy $c_U^*$, and receive expected utility $V(c_U^*, p_U) = v(w - p_U\ell)$. If consumers choose to become informed, then a separating equilibrium holds. Then high risk consumers buy the policy $c_H^*$,

[4] Here, and throughout the paper, we simply assume that such separating equilibria exist.

which yields expected utility $V(c_H^*, p_H) = v(w - p_H\ell)$. Low risk consumers buy the policy $c_L'$, which yields expected utility

(2.3) $$V(c_L', p_L) = (1 - p_L)v(w - p_Lk'\ell) + p_Lv(w - p_Lk'\ell - (1 - k')\ell).$$

The value of information is

(2.4) $$I_A = [\theta_Hv(w - p_H\ell) + \theta_LV(c_L', p_L)] - v(w - p_U\ell).$$

Now $V(c_L', p_L) < V(c_L^*, p_L)$, so $I_A < I_S < 0$. Again, it follows that consumers choose not to learn their risk type, and that in equilibrium the only policy purchased is $c_U^*$. *Q.E.D.*

Figure 1 also illustrates Proposition 2, showing both the "no information" and the separating equilibria. Without information on risk type, consumers purchase policy $c_U^*$, while with information consumers purchase either $c_H^*$ or $c_L'$. Again, $c_U^*$ is the population average of $c_H^*$ and $c_L^*$.

The intuition is the essentially same as that underlying Proposition 1. The decision to become informed again implies consumers are faced with a lottery over the high and low risk contracts. In a separating equilibrium, actuarially fair premiums will be charged to each risk type, but insurance coverage will be rationed to low risk individuals; low risk policyholders reveal their type by foregoing some insurance protection. This implies that the terms of the lottery are worse in the asymmetric information case than in the symmetric information case. As a result, the value of information is negative.

Further, since $I_A < I_S < 0$, the value of information is lower in the asymmetric information case than in the symmetric information case. Suppose that policyholders knew that they would learn their risk type. Then, ex ante, they would prefer that this information be credibly revealed to insurers.

If no policyholders are in possession of knowledge of their risk type, this result asserts that a "no information" equilibrium will prevail and all policyholders will fully insure. The incentive for policyholders to invest in information, given they anticipate that insurers will offer a self selecting menu of contract, is negative. For their part, insurers realize that there is a negative incentive to invest in information and offer a pooling contract to all policyholders. Thus, no information asymmetry will arise and the market will not exhibit adverse selection.

It may be noted that the "no information" equilibrium differs from a pooling equilibrium with information asymmetry. In the latter case, each policyholder knows his or her risk type, thus the pooled contract is attractive to bad risk but not to good risks. Accordingly, the contract is chosen predominantly by bad risks, good risks drop out of the market, and the equilibrium fails.

## III. HETEROGENEOUS INFORMATION ENDOWMENTS.

To this point we have assumed that consumers are homogeneous with respect to their informational endowments, and have shown that, since consumers choose to remain uninformed, no adverse selection problem arises. This result suggests that adverse selection can only arise if at least some policyholders are endowed with knowledge of their risk type. This situation has some descriptive appeal and may characterize many insurance markets. For some policyholders information on their loss type may arise as a joint output of some other economic activity. Some health insurance policyholders know their state of health since, quite unrelated to any insurance decision, they have recently been diagnosed and treated for some ailment or had simply had a routine checkup. We now address the properties of equilibrium when informational endowments are heterogeneous.

Specifically, we assume that the proportions $\lambda_H$ and $\lambda_L$ of the population are endowed with the information that they are high and low risks, while the proportion $\lambda_U$ is not endowed with this knowledge; $0 < \lambda_H, \lambda_L, \lambda_U < 1$, and $\lambda_H + \lambda_L + \lambda_U = 1$. Let $\pi_H$ and $\pi_L$ be the proportions of uninformed consumers that are high and low risks; $0 < \pi_H, \pi_L < 1$ and $\pi_H + \pi_L = 1$. We then have $\lambda_t + \pi_t\lambda_U = \theta_t$, $t = H, L$. These proportions are assumed to be common knowledge. The probability of loss for uninformed consumers is $p_U = \pi_H p_H + \pi_L p_L$. Observe that $p_U$ does not equal the population average probability of loss $p_A = \theta_H p_H + \theta_L p_L$ unless $\pi_H = \theta_H$.

*A. The value of symmetric information.* The value of information depends on whether information is initially symmetric or not. Suppose that information is symmetric, so that the risk type of informed consumers is known to insurers. This implies that insurers can identify uninformed consumers.

> *Proposition 3*: Assume consumers can choose to observe their risk type at zero cost and this information will also become available to insurers. Then (a) information has negative value to consumers and (b) the equilibrium contract set is $\{c_H^*, c_L^*, c_U^*\}$.

*Proof.* The proof is identical to that of Proposition 1, with $\pi_t$ replacing $\theta_t$. In addition, consumers known to be high (low) risks purchase the policy $c_H^*$ ($c_L^*$), so these policies also belong to the equilibrium contract set. *Q.E.D.*

The intuition here is the same as for Proposition 1. Uninformed consumers again have a choice between a lottery and the expected value of the lottery. The fact that some consumers are informed affects the probabilities in the lottery, but does not affect the decision of uniformed consumers.

*B. The value of asymmetric information.* Now suppose that insurers can distinguish informed from uninformed consumers, but cannot directly observe the risk type of informed consumers. This implies that, if uninformed policyholders choose to learn their risk type, this is (costlessly) known to insurers, but the risk type is not directly observed by insurers. Then insurers must separate high and low risk informed consumers; again, let $c_t$' denote the separating contracts for the two types. However, since informed and uninformed consumers can be distinguished, uninformed consumers can be offered the contract $c_U^*$.

> *Proposition 4*: Assume consumers can choose to observe their risk type at zero cost, informed and uninformed consumers can be distinguished, but risk type is not directly observed by insurers. Then (a) information has negative value to consumers, and (b) the equilibrium contract set is $\{c_H', c_L', c_U^*\}$.

*Proof*. The proof is identical to that of Proposition 2, with $\pi_t$ replacing $\theta_t$. In addition, informed consumers choose from the separating contracts $\{c_H', c_L'\}$, so these policies also belong to the equilibrium contract set. *Q.E.D.*

Propositions 3 and 4 imply that heterogeneous informational endowments alone are not sufficient for information to have positive value.

Now assume that the insurer is unable to observe which policyholders know their risk type and which do not. Again, the insurers are unable to observe the risk type of informed consumers. The insurer is thus assumed to be unable to distinguish among high risk, low risk and uninformed policyholders. It is straightforward to construct a single period Nash separating equilibrium for such a market. The fact that insurers cannot distinguish among high risks, low risks and the uninformed means that a menu of self selecting policies must prevent high risks masquerading as uninformed and uninformed as low risks. The requirements for such an equilibrium are that each risk type select a policy that makes nonnegative profits for the insurer, and that there do not exist other contracts which could be offered which would be profitable. Let $c_t''$ denote the type t equilibrium contract in this case; the contracts have the form $\alpha_t'' = p_t k_t'' \ell$, $\beta_t'' = k_t'' \ell$, where $0 < k_L'' < k_U'' < 1 = k_H''$. The equilibrium contracts also satisfy

(3.1a) $V(c_H'', p_H) > V(c_L'', p_H)$
(3.1b) $V(c_U'', p_U) = V(c_L'', p_U)$

along with the other self selection constraints.

In this "mixed information" separating equilibrium, uninformed consumers must sacrifice some insurance protection to distinguish themselves from high risks who might pretend not to know their risk class. Thus, the uninformed consumers bear a cost in signalling their position. This puts further pressure on the good risks who must distinguish themselves, not only from bad risks, but also from the uninformed. Thus good risks signal their risk type by sacrificing even more insurance than they would in a simple two class equilibrium. Thus, $V(c_L'', p_L) < V(c_L', p_L)$. The net effect is that the value of information on risk type is unambiguously positive.

The value of information is ascertained in two steps. In the first step, a policy $c_H^\circ$ is defined such that, were it offered to bad risks in place of policy $c_H''$, then uninformed individuals would be indifferent between not knowing risk type and having policy $c_U''$ with certainty or deciding to become informed and having $c_H^\circ$ if one is a bad risk or $c_L''$ if a good risk. In the second step, we show that a lottery between $c_H'$ and $c_L'$ is preferred to a lottery between $c_H^\circ$ and $c_L''$. This implies that the value of private information on risk type is positive.

*Proposition 5*: Assume consumers can choose to observe their risk type at zero cost, informed and uninformed consumers cannot be distinguished, and risk type is not directly observed by insurers. Then (a) information has positive value to consumers and (b) the equilibrium contract set is $\{c_H', c_L'\}$.

*Proof.* Consider a policy $c_H^\circ$ on the high risk indifference curve through $c_L''$, i.e.:

(3.2) $$V(c_H^\circ, p_H) = V(c_L'', p_H).$$

Define the value X by:

(3.4) $$X = \{\pi_H V(c_H^\circ, p_H) + \pi_L V(c_L'', p_L)\} - V(c_U'', p_U).$$

Then using (3.2) and (3.1b), equation (3.4) can be restated as:

(3.5) $$X = \{\pi_H V(c_L'', p_H) + \pi_L V(c_L'', p_L)\} - V(c_L'', p_U)\}$$

$$= (\pi_H p_H + \pi_L p_L - p_U)\{v(w - k''_L p_L \ell - (1 - k''_L)\ell) - v(w - k''_L p_L \ell)\}.$$

Since $p_U = \pi_H p_H + \pi_L p_L$, then $X = 0$.

The value of information is:

(3.6) $$I_A' = \{\pi_H V(c_H', p_H) + \pi_L V(c_L', p_L)\} - V(c_U'', p_U).$$

Combining equations (3.1a) and (3.2), we have $V(c_H'', p_H) > V(c_H^\circ, p_H)$. Using the facts that $c_H'' = c_H'$ and $V(c_L'', p_L) < V(c_L', p_L)$, it follows that $I_A' > X = 0$. Since $I_A' > 0$, uninformed consumers choose to learn their risk type, and the equilibrium is the two-class separating equilibrium. Thus, the equilibrium contract set is $\{c_H', c_L'\}$. *Q.E.D.*

Proposition 5 is illustrated in Figure 2. If uninformed consumers remain uninformed, the contracts offered are $c_H''$ (= $c_H^*$), $c_U''$ and $c_L''$, while if they become informed, the contracts offered are $c_U'$ (= $c_H^*$) and $c_L'$. From (3.2), the contract $c_H^\circ$ can be any policy on the high risk indifference curve through $c_L''$. Since X = 0, uninformed policyholder are indifferent between $c_U''$ with certainty, and the lottery over $c_H^\circ$ and $c_L''$. However, uninformed consumers actually face a lottery over $c_H^*$ and $c_L'$. But since $c_H^*$ is preferred to $c_H^\circ$ by high risks and $c_L'$ is preferred to $c_L''$ by low risks, the lottery over $c_H^*$ and $c_L'$ is preferred to $c_U''$ with certainty and the equilibrium value of information is positive.

Thus, in equilibrium, policyholders have an incentive to acquire information on risk type. In the other cases considered this did not occur since uninformed consumers could always be identified as such.[5] As a consequence, if they chose to remain uninformed they received the actuarially fair full insurance contract $c_U^*$. There is, in effect, no cost to remaining ignorant, but, due to classification risk, there is an implicit cost to becoming informed. The critical difference in the present case is that uniformed consumers cannot be identified. Thus, if they choose to remain uninformed, they must accept less than full insurance to signal their uninformed status and distinguish themselves from the bad risks. This signalling cost is the cost of remaining uninformed. By deciding to become informed, policyholders avoid this signalling cost, consequently, the equilibrium value of information is positive.

## IV. INFORMATION COSTS

The fact that information has positive value does not guarantee that all policyholders will invest in learning their risk type. The cost of information also is relevant, since, *ceteris paribus*, only those with sufficiently low information costs will acquire the information. To this point we have not considered these costs; we now introduce them explicitly into the analysis.

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[5] In Propositions 1 and 2, all consumers are known to be initially uninformed. In Proposition 3, this holds as a result of symmetric information, while in Proposition 4 it is assumed directly.

We retain the assumptions that informational endowments are heterogeneous, the risk types of informed policyholders are not observed directly, and insurers are unable to observe which policyholders know their risk type and which do not. The explicit costs of information are $\gamma_H > \gamma_L \geq 0$, and for simplicity, utility is assumed to be separable in this cost. We assume that information costs are distributed independently of uninformed policyholders inherent risk type. Since insurers cannot distinguish informed and uninformed policyholders, they also cannot identify individuals by their information costs; however, uninformed consumers are assumed to know their own information costs.

> *Proposition 6*: Assume consumers can choose to observe their risk type at cost $\gamma_H$ or $\gamma_L$ and information costs are distributed independently of risk type. Assume informed and uninformed consumers cannot be distinguished, and risk type is not directly observed by insurers. Then (a) if $\gamma_H < I_A'$, the equilibrium contract set is $\{c_H', c_L'\}$, and (b) if $\gamma_H > I_A'$, the equilibrium contract set is $\{c_H'', c_L'', c_U''\}$.

*Proof*. (a) If $I_A' > \gamma_H$, then the net value of information is positive for all uninformed policyholders. They all choose to learn their risk type, and the equilibrium set of contracts is $\{c_H', c_L'\}$.

(b) If $I_A' < \gamma_H$, then the net value of information is negative for uninformed policyholders with high information costs and these individuals choose not to learn their risk type. Thus, there are three types of consumers in the market. Since information costs are distributed independently of risk type, $p_U$ is invariant to whether or not low information cost policyholders learn their type. Thus, the equilibrium contract set is $\{c_H'', c_L'', c_U''\}$. *Q.E.D.*

At one level this result is quite intuitive - the equilibrium contract set depends on information costs. However, there is a discontinuity in the equilibrium contract correspondence, which is a step function in information costs.[6] That is, for fixed values of the other parameters, the equilibrium contract set is constant at $\{c_H', c_L'\}$ for $\gamma_H < I_A'$, then jumps to $\{c_H'', c_L'', c_U''\}$ for $\gamma_H > I_A'$. The reason

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[6] The equilibrium contract correspondence is continuous in the other parameters so long as $I_A' - \gamma_H$ does not change sign.

for this is given in the proof of part (b) of the Proposition.[7] Once high information cost consumers decide not to become informed there are three types of policyholders in the market, informed high and low risks and the uninformed. Thus, insurers offer the appropriate set of separating policies for three, rather than two, types.

If high information cost consumers decide not to become informed, the value of information to low information cost consumers is

(4.1) $$I_A'' = \{\pi_H V(c_H'', p_H) + \pi_L V(c_L'', p_L)\} - V(c_U'', p_U).$$

Since $V(c_H', p_H) = V(c_H'', p_H) > V(c_H^o, p_H)$ while $V(c_L'', p_L) < V(c_L', p_L)$, we have $I_A' > I_A'' > 0$. Uninformed consumers with low information costs decide to become informed if $\gamma_L < I_A''$. However, whether these policyholders decide to become informed or not, there are three types in the market.

The assumption that information costs are independent of risk type is not critical to the proof of Proposition 6. Its main value is to simplify determining the equilibrium set of contracts and the value of information by making $p_U$ constant. However, it does imply that the equilibrium contract set does not depend on $\gamma_L$. If the independence assumption is relaxed, the equilibrium contract correspondence is still a step function, but will depend on both $\gamma_H$ and $\gamma_L$.

To see this, suppose that information costs and the probability of loss are correlated. Then uninformed policyholders' priors on their probability of loss will depend on their information costs. Since this divides the uninformed into two groups, there are initially four groups in the market, and insurers offer the appropriate self selection menu of policies. Thus, uninformed policyholders face different signalling costs and different classification risks depending on their information costs.

Suppose there is a positive correlation between information costs and probability of loss. The positive correlation implies that the prior probability of loss will be lower for consumers with low information costs. This in turn implies that signalling costs are higher and classification risks are

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[7] Part (a) of the Proposition is a straightforward extension of Proposition 5, where it was assumed that $\gamma_H = \gamma_L = 0$.

lower for low information cost consumers. Consequently, the value of information will be higher for low information cost consumers. It follows immediately that the net value of information will be higher for low information cost consumers. Then if low information cost consumers choose not to invest in information, neither do high information cost consumers, and the initial four group separating equilibrium is sustained. Conversely, if high information cost consumers find it worthwhile to learn their risk type, so do low information cost consumers, and the equilibrium contract set is that for a two group separating equilibrium. Finally, low cost consumers may choose to invest in information while high information cost consumers do not, and there is a three group equilibrium.

Now suppose the correlation between information costs and probability of loss is negative. Then the prior probability of loss is greater for policyholders with low information costs. This implies that signalling costs are lower, but classification risks are greater, for low information cost policyholders than for high information cost policyholders. Then, in general, the value of information for low information cost consumers may be either higher or lower than for high information cost policyholders. It is possible that the net value of information is higher for high information cost policyholders. Then if only one group finds it worthwhile to become informed, so there are three groups in the market, the equilibrium contract set will be different depending on whether this is the high information cost or low information cost group of policyholders.

## V. CONCLUSION.

We have modelled a market for information jointly with an insurance market. We assume policyholders knowledge of their risk type is endogenous; they must decide whether or not to invest in information and learn their risk type. When knowledge of risk type is endogenous, the incentive for policyholders to invest in information depends on how this information will be reflected in market transactions. If they decide to become informed, consumers are faced with a lottery over the high risk and low risk policies; the classification risk imposes a cost on risk averse consumers. So long as uninformed consumers can be identified, they prefer the "uninformed" policy with certainty. Rational policyholders fail to invest in information and the informational asymmetry that generates adverse selection will not arise.

This result is related to the paradox regarding the lack of incentive to invest in information in a rational expectations equilibrium (Grossman and Stiglitz, 1980). Our paradox is that the extant adverse selection literature assumes policyholders are fully informed about their risk type, but, had they not been so endowed, there would be a negative incentive to invest. Why then would consumers invest in information with negative value? The answer, of course, is that they would not, and we derive the competitive equilibria for such cases.

We are able to resolve the paradox by assuming informational endowments are heterogeneous, risk type cannot be directly observed by insurers, and informed and uninformed policyholders cannot be distinguished. The assumption that informed and uninformed policyholders cannot be distinguished is critical. If uninformed policyholders choose to remain so, they must signal their uninformed status to distinguish themselves from the informed bad risks. The signalling cost of remaining uninformed outweighs the classification risk cost of becoming informed and the equilibrium value of information is positive. Then whether all, some or none of the uninformed policyholders will invest in information depends on the distribution of information costs. When information is endogenous, the resulting competitive equilibrium will, in general, fail to be informationally efficient.

For adverse selection to exist, some exogenous information is needed; some policyholders must be endowed with knowledge of their risk type. This leaves open the question of why some consumers are endowed with this information but others are not. A possible answer to this question is that such information may be generated as a joint output of some other economic activity. For concreteness, consider the problem of HIV testing. One would expect that some people will be tested for reasons unrelated to insurance. For example, some might be tested incidentally to the treatment of an existing medical condition. Thus, information is generated as a joint output of medical services. Others might be tested compulsorily because their employment exposes others to risk (i.e., recent proposals to require testing of all health care workers). On the other hand, there are many individuals who are untested even within high risk groups. At issue is whether or not this group will undertake testing when faced with an insurance decision.

This example illustrates some important policy issues. Most states have in place legislation and/or regulations related to HIV testing and insurance.[8] While these rules vary considerably across states, they typically determine whether insurers can require policy applicants to disclose whether they have been tested, whether insurers can require testing, and whether test results can be used for underwriting purposes. Most states do not forbid insurers from enquiring of prior HIV test history for individual life and health insurance. Thus, insurers in these states know which consumers are informed. These conditions reasonably approximate the assumptions of some exogenously informed consumers and ex post symmetric information (Proposition 3). Our results imply that the ex ante value of information to consumers is negative in this case. Apparently, current insurance regulations in these states create incentives that discourage testing.

HIV testing is usually considered desireable due to the public health externality. One way to use the insurance market to create a positive incentive for testing is to require all applicants be offered coverage, while requiring that insurers be barred from using any information regarding HIV tests (recall Proposition 5). However, the efficiency of insurance markets is hindered by constraints on categorical discrimination (Crocker and Snow, 1986, Hoy, 1989, and Bond and Crocker, 1991). This suggests that there is a conflict between the policy objectives of encouraging HIV testing and the efficient operation of insurance markets.

Our analysis suggests an alternative approach. Testing may be encouraged by increasing the costs of remaining ignorant to policyholders. One way to accomplish this is to allow insurers to deny

[8] See Health Insurance Association of America (1991) for a summary of state laws and regulations.

coverage for those who are unwilling to be tested. Many states permit insurers to require HIV tests before offering insurance and permit insurers to use the test results for underwriting and premium rating.[9] In this situation information is symmetric ex post, and insurance incentives encourage testing.

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[9] Permission to require testing is usually accompanied by strict notification and privacy provision, and requires the informed consent of the consumer. Moreover, some states restrict the use of testing to satisfy nondiscriminatory objectives, i.e., they prohibit HIV testing based on sexual orientation and/or lifestyle.

## REFERENCES


Arrow, K. J., 1978, "Risk Allocation and Information: Some Recent Theoretical Developments", Geneva Papers on Risk and Insurance, 8, 5–19.

Bond, E. W. and K. J. Crocker, 1991, "Smoking, Skydiving and Knitting: The Endogenous Categorization of Risks in Insurance Markets with Asymmetric Information," Journal of Political Economy, 99, 177–200

Boyer, M., G. Dionne and R. Kihlstrom. 1989, "Insurance and the Value of Publically Available Information", in Studies in the Economics of Uncertainty: Essays in Honor of J. Hadar, T. Formby and T. K. Seo (eds.)

Crocker, K. J. and A. Snow, 1986, "The Efficiency of Categorical Discrimination in the Insurance Industry", Journal of Political Economy, 94, 321–344.

_______, 1990, "Hidden Information," working paper, Penn State University.

Dahlby, B. G. 1980, "The Welfare Effects of Prohibiting Statistical Discrimination in Insurance Markets", Mimeo, University of Alberta.

------, 1983, "Adverse Selection and Statistical Discrimination: An Analysis of Canadian Automobile Insurance", Journal of Public Economics, 20, 121–130.

Dreze, J. H., 1960, "Le paradoxe de l'information", Economie appliquée, 13, 71–80.

Grossman S. and J. E. Stiglitz, 1980, "On The Impossibility of Informationally EfficientMarkets", American Economic Review, 70, 393–408

Health Insurance Association of America, 1991, HIAA AIDS Laws and Regulations.

Hirschleifer, J., 1971 "The Private and Social Value of Information and the Reward to Inventive Activity", American Economic Review, 61, 561–574.

Hoy, M., 1982, "Categorizing Risks in the Insurance Industry", Quarterly Journal of Economics, 97, 321–336

_______, 1989, "The Value of Screening Mechanisms Under Alternative Insurance Possibilities", Journal of Public Economics, 39, 177–206.

Marshall, J., 1974, "Private Incentives and Public Information," American Economic Review, 64, 373–390.

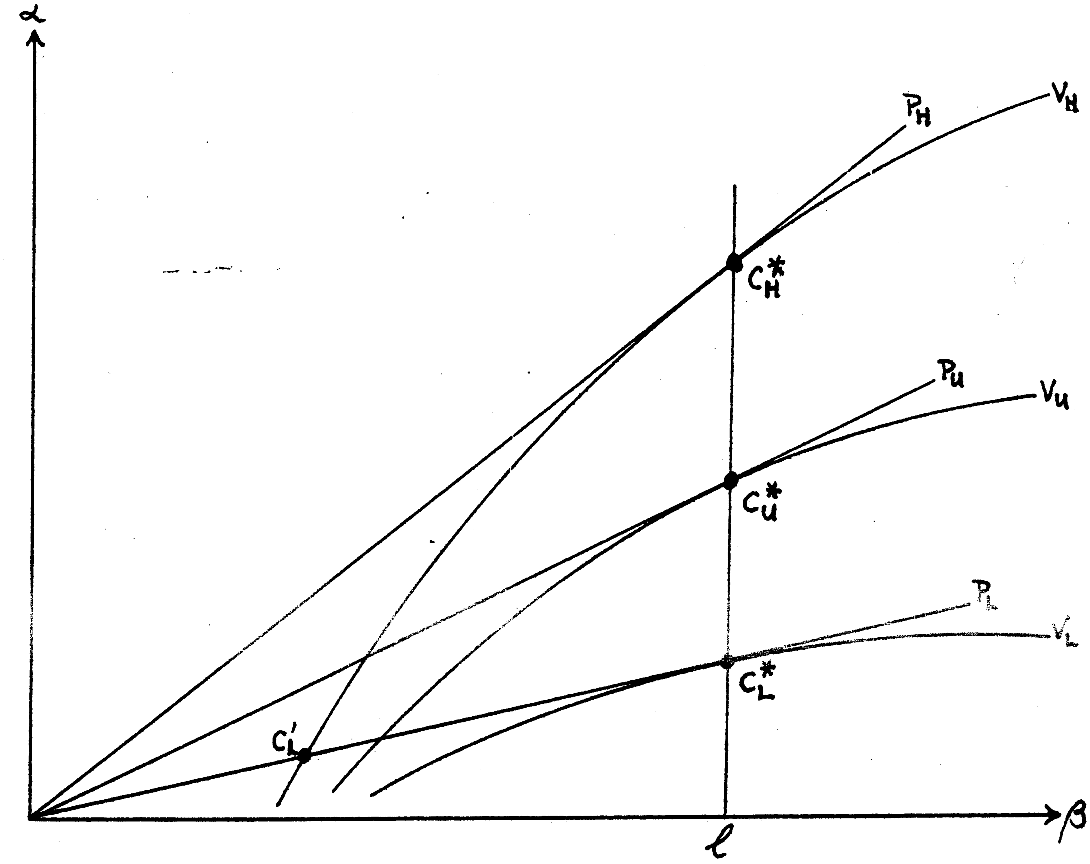
Milgrom, P. and N. Stokey, 1982, "Information, Trade and Common Knowledge," Journal of Economic Theory, 26, 17–27.

Rothschild, M. and J. Stiglitz (1976), "Equilibrium in Insurance Markets: An Essay on the Economics of Imperfect Information", Quarterly Journal of Economics, 90, 629–649

Spence, M. (1978), "Product Differentiation and Performance in Insurance Markets", Journal of Public Economics, 10, 427–447.

Wilson, C. (1977), "A Model of Insurance Markets with Incomplete Information", Journal of Economic Theory, 12, 167–207.

FIGURE 1. NO INFORMATION EQUILIBRIUM



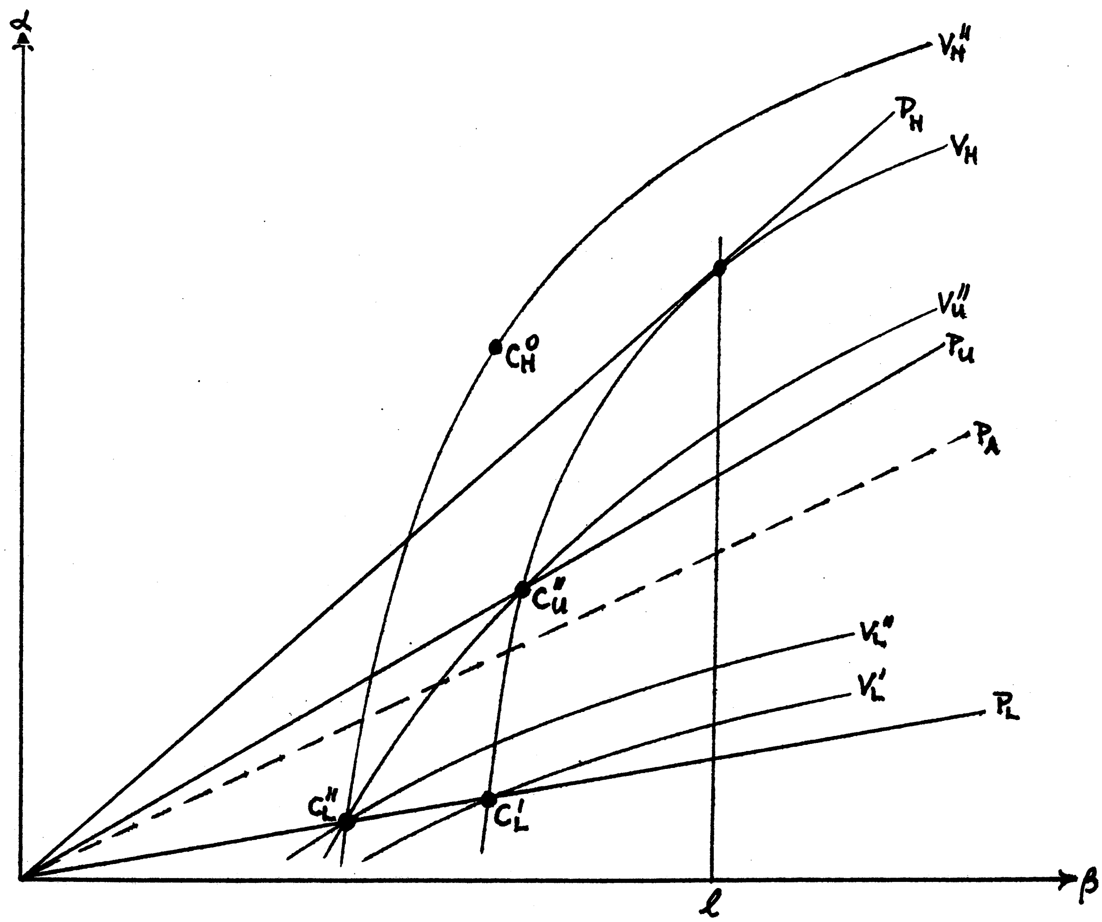




FIGURE 2. MIXED INFORMATION AND FULL INFORMATION SEPARATING EQUILIBRIA