Information sharing in competitive insurance markets

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Abstract

We rationalize a special type of sharing information which can typically be found in markets for occupational disability insurances. There, firms share information about acceptances and rejections of an applicant. We set up a multiple-step signalling model with uninformed agents and endogenize competing principals’ decisions to acquire information on risk types. We formalize the idea that information exchange also serves as a tool to signal an applicant’s switching type. This may lessen competition and increase industry profits or result in a higher share of uninsured applicants as compared to a market without information sharing. In any case, consumer welfare is reduced. Our model also helps to understand why access to the system is not made dependent on the provision of own data. In addition, we rationalize the existence of anonymous prequalification tests that allow consumers to gain information about their risk type without risking to enter a system entry.

Keywords: Insurances; Information sharing; Asymmetric information; Informed principal

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1 Introduction

It is a common feature of insurance industries that provide economic coverage for a biometric risk (e.g. life, health or disability insurances) to exchange customer specific information. Information sharing in insurance industries is a well established topic in the economic literature. Most of the work restricts attention to the exchange of risk information. We propose instead that information sharing systems may be set up in order to provide information on consumer behavior which may automatically result in the partial revelation of risk information.

In the market for private occupational disability insurance, firms screen and evaluate consumer applications but do not explicitly report results, i.e. risk information. For instance, the German Hinweis- und Informationssystem (HIS) allows firms to report whether a consumer application has been accepted or rejected.\footnote{These systems officially serve as a tool to prevent fraud and to reduce costs for risk assessment. We discuss this topic in more detail in section \ref{sec:5}.} There, the application process works as follows: if a person wishes to buy private occupational disability insurance, he is required to provide inter alia detailed information on his medical record.\footnote{Although a risk screening is based exclusively on the information provided by the consumer, there are no incentives for misreporting. A consumer would receive insurance, but the insurer will rescind the contract upon submittance of claims. Premiums are then not payed back.} Risk screening is based exclusively on this information, and the information is stored in the information exchange system. Subsequently, a company either accepts or rejects the application and enters this decision into the system. In case that an applicant has been accepted, the insurance specifies the premium. Note that participation is completely voluntary on the part of firms. That is to say, access to the system is not made dependent on an obligation to share own information.

In this paper, we rationalize the existence of information sharing systems which firms use to share their decisions about whether an application has been accepted or rejected and we give an intuitive explanation for the fact that firms voluntarily share their own information. Our insights can be used to evaluate the economic effect of a ban of this information exchange system.

First of all, it is not obvious why rejections are expressed at all. With informed consumers, higher risk types should not remain uninsured because of their higher willingness to pay for insurance. On the other hand, firms dispose of advanced technological means to estimate the statistical risk for occupational disability. Although a consumer is aware of his medical condition, he usually does not have the necessary experience to evaluate his risk. A relatively young stream of literature considers the possibility that insurances are better informed than consumers. In particular, \cite{Villeneuve2005} demonstrates that if consumers can only infer
their risk types from the price offers they obtain, high risk types may remain uninsured even in competitive environments. In his work, an uninformed consumer with either a low or a high default probability faces two competing firms which can observe the risk type at no costs. The firms make simultaneous offers from which the consumer can choose. High risk consumers may remain uninsured because they refuse to believe to have a high default probability whenever they receive whatever contract offer. At the same time, these consumers are not willing to pay at least the fair price for high risk types. In such a regime, the only way for an insurer to convince a consumer to actually be a high risk type is to reject him. Villeneuve (2005) also shows that these equilibria even survive the Intuitive Criterion (Cho and Kreps (1987)).

For our purposes, we slightly modify this setting. At the beginning of the game, the risk type, that can now either be low, medium or high, is unknown to all players in the market, although firms have the possibility to acquire information at a certain cost. For the applicant himself, however, as in Villeneuve (2005), there is no way of finding out about his risk type, he can only infer conclusions from the offers received. Firms play subsequently in the following way: a firm that is approached by an applicant decides whether to acquire information. Based on this screening the firm contingently makes a price offer or rejects the application. The consumer can subsequently apply to the competitor firm, obtain a second offer and negotiate prices.

If both firms acquire information competition is perfect and yields both firms zero profits on negotiating consumers (we assume the presence of non-switching consumers in the market). Therefore, a firm that is aware hereof will prefer not to test. If firms share information on whether an applicant has been accepted or rejected, this has two effects: first, a firm signals that an applicant who approaches the competitor firm must be a negotiating (or switching) type, thereby inducing this firm not to test.

Second, information sharing on risk types is partial, i.e. a firm only reports whether or not the risk type is above some equilibrium threshold. In that case, the competitor who remains uninformed can draw conclusions on the risk type (only) up to a certain degree. This yields the informed firm an informational advantage on low risk consumers. On the other hand, if beliefs are accordingly, following the logic of Villeneuve (2005), higher risk types will be rejected in the first place. The competitor shares consumer beliefs if she remains uninformed. Therefore, every contract offer by the competitor should not influence consumer beliefs which ensures that a switching consumer will never end up uninsured.

\footnote{As opposed to Villeneuve (2005), we apply a stricter equilibrium refinement rule in order to uniquely select (intuitive) efficient equilibria. This implies that even in equilibria without information sharing, all switching consumers end up insured and paying the fair prices.}
Interestingly, even the uninformed firm may benefit from information sharing. If a high risk consumer refuses to trust a second offer by the informed firm, her competitor might even make strictly positive profits on consumers that have been rejected previously. This case arises if the share of non-switching consumers in the market is low. Then, incentives to reject lower risk types, and thereby make even higher profits, are high. On the other hand, non-switching types never accept high prices. Therefore, a rejection of lower types comes at the cost of loosing these customers.

A second result is also worth mentioning. The set of equilibrium allocations is higher if information is shared. In particular, if market conditions are such that only high risk types are being rejected if information is not shared, then this does not rule out equilibria where also medium types remain uninsured if information is shared. In the first case, if a low type is willing to pay at least the fair premium for a medium type, these never get rejected since profits on switching types are necessarily zero. On the contrary, with information sharing and if beliefs are accordingly, a firm may make positive profits on medium switching types. An acceptance decision then comes at a cost, namely that of giving up profits on switching types.

Therefore, social welfare effects are ambiguous. While information sharing always decreases consumer welfare, industry profits may either increase or decrease. Overall social welfare increases if only high risk types are rejected and the informed firm can be trusted not to reject other than these customers, because volatility in prices strictly decreases. Overall welfare decreases if also medium types get rejected. For the remaining case, the effect is ambiguous. The fact that information is shared partially results from the market environment. The reason is that the second firm, if she is approached by a person listed in the system, could always ask this person to reveal his previous contract offer. As a result, only the signalling effect plays a role. Systems that require firms to report acceptance or rejection decisions like the HIS are outcome equivalent to systems that demand more general information like the American medical information bureau (MIB). Whether full information revelation is feasible or not depends on whether consumers have access to the system or not. However, even if access was restricted, full information sharing on risk types could never be profitable for any of the firms.

This model also helps us to understand a related phenomenon in insurance industries: some insurances, but not all, offer anonymous prequalification tests that tell consumers whether or not their application would be accepted or rejected. On first sight, this seems counterintuitive given the presence of an information sharing system. Note however, that these tests are conducted anonymously. Therefore, a firm commits to not collecting information on a special person. A consumer thereby remains in the industry that would otherwise be kept
from applying out of fear to be rejected.

Related literature. A large stream of literature treats the effects of information sharing in competitive markets (see for instance Vives (1984), Gal-Or (1985), Spulber (1995), Kühn and Vives (1995) and Vives (2008)). These works trade-off the ex-ante effects of decreasing uncertainty against those of a changing competitive environment. There, the symmetrically imperfectly informed firms agree ex-ante on a certain way of sharing information and are subsequently bound to report honestly. Our model is conceptually different. It favors the sharing party by keeping competitors from entering the competitive game. Therefore it is rather related to the literature on limit pricing (starting with Milgrom and Roberts (1982)), although signalling - information sharing in our model - is then costly. As pointed out by several authors (e.g. Hellwig (1988), Sharpe (1990), de Garidel-Thoron (2005)), firms do not voluntarily share their information because it strengthens competition and thereby reduces profits. The effect is present also in this study: firms would rather not share information on risk types. They do because the market environment is accordingly. That is to say, reporting false information, in particular that a customer has a high risk although not true, is at the cost of loosing non-switching consumers. Therefore, the coercion is not explicit, as proposed by Hellwig (1988), but implicitly given by the market mechanism. Some papers on information sharing focus exclusively on insurance (e.g. de Garidel-Thoron (2005), Jansen and Stenbacka (2011)) or credit markets (e.g. Sharpe (1990), Pagano and Jappelli (1993), Padilla and Pagano (2000), Gehrig and Stenbacka (2007)). They assume informed agents. Furthermore, these works are qualitatively different from the present paper because only information about risk types (Jansen and Stenbacka (2011); about population risk) is shared whereas here, information sharing also refers to the switching type of an applicant. Jansen and Stenbacka (2011) analyze a model that endogenizes the acquisition of information. Because firms then do not acquire information both firms remain uninformed in the information sharing case. Therefore, like here, the interpretation of information sharing is reversed: firms are informed if information is not shared.

Methodologically, our model is an adverse selection game with informed principals, a topic that was first treated by Maskin and Tirole (1992). As opposed to this, our paper exhibits up to two informed parties. This intensifies the equilibrium selection problem. Bagwell and Ramey (1991) have proposed a rule which we apply to our setting. In contrast to this, Villeneuve (2005) applies a weaker equilibrium definition which allows for more equilibria.
2 The setup

Let there be a mass one of risk averse consumers in the market whose utility is described by a VNM-function \( u(\cdot) \) where \( u'(\cdot) > 0, u''(\cdot) < 0 \). We denote \( W \) their initial wealth level and \( W - d < W \) their wealth level if a damage occurs. In the following, we will normalize \( d \) to 1. A damage occurs with some probability \( \theta \in \{L, M, H\} \) where \( 0 < L < M < H \leq 1 \). We say \( \theta \) is a consumer’s risk type. Let \( q_\theta \) with \( \sum_\theta q_\theta = 1 \) be the commonly held priors on the distribution of risk types in the population. At the beginning of the game, \( \theta \) is unobservable for all players.

A share \( \lambda > 0 \) of consumers is non-switching. These consumers consider exactly one contract offer. Contrarily, a share \( 1 - \lambda \) can switch between firms at no cost. We say consumers are \( T_\lambda \) or \( T_{1-\lambda} \) types respectively. Consumers remain privately informed about their switching types throughout the game. Furthermore, we consider two competing risk-neutral insurance companies \( i \in \{A, B\} \). The firms can perfectly observe an individual’s risk type (but not his switching type) after having invested some arbitrarily small but strictly positive amount \( \Gamma \). Whether a firm has acquired information is her private information throughout the game. If a firm does not acquire information, prior beliefs are preserved except if the firm receives some meaningful signal from an informed firm.

The general game proceeds as follows:

1. Nature chooses a consumer’s risk type \( \theta \) and the switching type

2. The consumer gets to know their switching type

3. The consumer selects one of the firms with probability \( \frac{1}{2} \) and applies.

4. The firm chooses her investment from \( \gamma_i \in \{0, \Gamma\} \)

5. The firm contingently observes \( \theta \) and makes some offer.

6 a.) If consumer’s type is \( T_\lambda \), he accepts the offer or selects the reservation contract (no insurance) and the game ends.

6 b.) If consumer’s type is \( T_{1-\lambda} \), he applies to other firm (see subgame below)

Offers. We denote by \( \Omega \) the set of possible price offers. Firm \( i \)’s offer \( p_i \in \Omega \) includes acceptable and non-acceptable price offers. Formally, a rejection is identical to a price that is never acceptable to any consumer whatever his beliefs may be. To make rejections more explicit, we denote \( \delta \) the set of all offers in \( \Omega \) that are not acceptable to a consumer believing
to be a $H$-type. A consumer will accept an offer if his expected utility from it is at least as high as his expected utility from not buying any insurance (his reservation utility). If a consumer ends up without insurance, we say that the equilibrium allocation is $p^0$. In particular, we denote $\hat{\theta}(\cdot) \in [L, H]$ the expected risk probability at some point in the game (his belief). Then, his expected utility $U(\cdot)$ from accepting an offer $p_i$ is given by

$$U(p_i) = u(W - p_i),$$

while his expected utility from not buying any insurance is

$$U(\hat{\theta}, p^0) = (1 - \hat{\theta})u(W) + \hat{\theta}u(W - 1).$$

A consumer considers an offer $p_i$ acceptable if $U(p_i) \geq U(\hat{\theta}, p^0)$. In the following we denote $\tilde{p}(\hat{\theta})$ the maximum price that a consumer is willing to pay given his beliefs. Note that this critical price is strictly increasing in $\hat{\theta}$. From the definition of $\delta$ follows that all prices in $\delta$ are greater than $\tilde{p}(H)$. A firm’s interim profit is $\pi_i(p_i) = p_i - \theta$ if her offer is selected by a consumer and zero otherwise. The lowest price a firm asks if she is informed about $\theta$ is the fair price $p_i = \theta$.

Switching consumers. Switching consumers turn, after having received an offer $p_i$, to the second firm, thereby hoping to receive a lower price offer. Once made offers are binding.\footnote{Therefore, it is without loss of generality to ignore the case where consumers immediately accept offers.}

The subgame following step 6 b) then proceeds as follows:

i) Firm $j$, $j \neq i$ chooses her investment from $\gamma_j \in \{0, \Gamma\}$

ii) Firm $j$ contingently observes $\theta$ and makes price offer $p_j$.

iii) Firm $j$ observes $p_i$ and contingently offers $p'_j$.

iv) Firm $i$ observes $p'_j$ and contingently offers $p'_i$.

v) The consumer selects the most preferable offer (the offer from $i$ if he is indifferent) or the reservation contract.

Intuitively, an informed firm should benefit from an informational advantage. If it holds that firm $j$ always makes, in iii), the best offer of all between which he is indifferent, then this way of modeling the game has this property, but on the other hand ensures that if both firms are fully informed, the perfect competition outcome arises. To secure according results, we make the according assumption.
Assumption 1 Let $\Phi$ be the set of contracts that maximizes firm $j$’s profits in stage iii) of the subgame. Then $p_j' = \inf_{p \in \Phi} p$.

Alternatively, one might consider a Bertrand game which yields the informed party lower profits. However, Bertrand games may not have equilibria if utility functions exhibit discontinuities (see e.g. Dasgupta and Maskin (1986)). This problem arises here because consumers update their beliefs based on the obtained contract offers which may make lower offers be unacceptable. A different way of modeling is used in de Garidel-Thoron (2005) and Sharpe (1990). There, the informed firm moves first. This disciplines this firm, thereby yielding positive but not moderate profits and additionally exhibits a unique subgame equilibrium. On the other hand, it requires the uninformed party to observe the distribution of contracts but not individual offers. In our setting, however, the consumer will always have an interest in revealing his previous contract offer, at least in this subgame. Note however that our results are without loss of generality although equilibrium profits are higher than in other game specifications.

Equilibrium selection. A common issue in signalling games is equilibrium selection. Here, whenever both firms are informed, even the Intuitive Criterion by Cho and Kreps (1987) still allows for many non-intuitive equilibria. Bagwell and Ramey (1991) propose a two-step equilibrium refinement that turns out to uniquely select the efficient separating equilibrium. Moreover, it corresponds to the Intuitive Criterion if a consumer must rely on the signal by only one firm. They propose the following: Whenever the uninformed party (parties) observe(s) an off-path behavior, he (they) then count the number of deviating firms that are necessary to reach this (these) particular disequilibrium offer(s). The belief will then be according to the lower number of deviations. If this lowest number is equal for more than one equilibrium (which is always the case if only one party is informed), the Intuitive Criterion applies. It turns out to be sufficient to consider beliefs at two points in the game: a non-switching consumer bases his belief $\hat{\theta}_\lambda(\cdot)$ about his risk type on one single price offer $p_i$. By contrast, a switching consumer may form his belief based upon all received offers ($p_i, p_j, p_i', p_j'$). Let $\hat{\theta}_{1-\lambda}(\cdot)$ be the according belief. We denote $(P_i, P_j)$ a set of offers $(p_i, p_j, p_i', p_j')$. Then, the collection of

(a) a set of offers $(p_i^\ast(\gamma_i, \theta), p_j^\ast(\gamma_j, \theta), p_i'^\ast(\gamma_i, \gamma_j, \theta, p_i, p_j), p_j'^\ast(\gamma_i, \gamma_j, \theta, p_i, p_j))$,

(b) the set of investments $(\gamma_i^\ast, \gamma_j^\ast)$ and

(c) a belief system $\hat{\theta}(\cdot) = (\hat{\theta}_\lambda(p_i), \hat{\theta}_{1-\lambda}(P_i, P_j))$

Bagwell and Ramey (1991) define a very similar concept which they call the $\epsilon$-Intuitive Criterion.
forms a PBE. We require the following:

1. Actions are sequentially rational: at any point in the game, any firm $i$ maximizes her (expected) profit given the equilibrium actions of firm $j$ and the consumer and given her actions’ impacts on beliefs $\hat{\theta}(\cdot)$. A consumer maximizes his expected utility given his beliefs.

2. Beliefs are consistent with Bayes’ rule: whenever both firms are informed, then the consumer must, if he observes some price vector that is only played for given $\theta$, believe $\hat{\theta}(\cdot) = \theta$. If equilibrium pricing is pooling for some $\theta', \theta''$, then the consumer believes $\hat{\theta}(\cdot) = \frac{\sum_{\theta'} \theta'' q_{\theta''} \theta}{\sum_{\theta'} \theta'' q_{\theta''} \theta}$. If only one firm is informed, then consumer beliefs are independent of the other firm’s strategy. Then, if equilibrium pricing by the informed firm is fully separating, the consumer and the uninformed firm, upon observation of some price vector that is only played for given $\theta$, believe $\hat{\theta}(\cdot) = \theta$. If equilibrium pricing by the informed firm is pooling for some $\theta', \theta''$, then the belief is $\hat{\theta}(\cdot) = \frac{\sum_{\theta'} \theta'' q_{\theta''} \theta}{\sum_{\theta'} \theta'' q_{\theta''} \theta}$. If no firm is informed in equilibrium, priors are preserved.

3. Consider a disequilibrium pricing tuple $(P_i, P_j) \neq (P_i^*(\theta), P_j^*(\theta))$, and denote $N(\theta) \in \{1, 2\}$ the number of informed deviating firms required to generate $(P_i, P_j)$. Then, $\hat{\theta}_{1-\lambda}(P_i, P_j) = \theta'$ if $N(\theta') < \min\{N(\theta''), N(\theta''')\}$. If $N(\theta') = N(\theta'') < N(\theta''')$, then $\hat{\theta}_{1-\lambda}(P_i, P_j) = E[\theta|\theta', \theta''].$

4. Consider a disequilibrium pricing strategy $(P_i, P_j)$ for which $N(\theta') = N(\theta'') = N(\theta''')$. The belief $\hat{\theta}_{1-\lambda}(P_i, P_j)$ satisfies: if $\pi_i(P_i, P_j^*(\theta)) < \pi_i(P_i^*(\theta), P_j^*(\theta))$ for some $\hat{\theta}$, zero probability is assigned to $\hat{\theta}$. If $p_i$ is a disequilibrium strategy, $N(\theta) = 1$ for all $\theta$, and the belief $\hat{\theta}_{\lambda}(p_i)$ satisfies: if $\pi_i(p_i) < \pi_i(p_i^*(\theta))$ for some $\hat{\theta}$, zero probability is assigned to $\hat{\theta}$.

From this equilibrium selection rule, it follows that $T_{1-\lambda}$ consumers never end up uninsured. To understand why, consider the following cases: first, let there be an equilibrium where both firms are informed and where at least some risk type is rejected. Obviously, $L$-types never end up uninsured. For instance, consider the case where the $H$-type is rejected by both firms. Then, $(p_A(H), p_A'(H), p_B(H), p_B'(H)) \in \delta$. A firm would like to deviate to an offer that is profitable on $H$ and that is considered acceptable by the consumer given his beliefs. Because $p_i \in \delta$ is played only on $\theta = H$, the consumer belief $\hat{\theta}_{1-\lambda}(P_i \in \delta, P_j \in \delta)$ must be $H$ by the Bayes-consistency requirement. Therefore, if firm $i$ deviates to a price $\hat{p}(H) \geq p'_i > H$, $N(H) = 1$, whereas $N(L) = N(M) = 2$ and the off-bath belief must be $H$ too. But then, $(p_A(H), p_A'(H), p_B(H), p_B'(H)) \in \delta$ is not an equilibrium. The argument for the $M$-type is accordingly. Second, if only one firm is informed and switching consumers must be insured
just because beliefs are never based on the behavior of an uninformed firm. Because both consumers and an ignorant insurer share the same beliefs, and because the consumer is risk averse, this firm can always make an offer that is acceptable to the consumer. The same logic holds for the third case where both firms are ignorant.

### 3 Information sharing system

As we have demonstrated, switching consumers never remain uninsured. However, rejections can be observed in insurance markets that exhibit information sharing systems. In the following, we propose an equilibrium that rationalizes rejections which are addressed towards non-switching consumers. Intuitively, non-switching consumers should not be influenced by the presence of an information sharing system except if market conditions change such that held beliefs cease to support an equilibrium. As will be shown below, this might indeed happen if information sharing would be abolished. For all beliefs $\theta(p_i)_\lambda$ that sustain equilibria in the no information sharing case, equilibria with the same belief exist. This might however not be true in the reverse direction. For brevity and because it suffices to make our point clear, we restrict our analysis to one special case.

**Assumption 2**

$M \leq \tilde{p}(L) < \max\{\tilde{p}(E[\theta]), \tilde{p}(M)\} < H < \tilde{p}(E[\theta|\theta \geq M])$

This assumption rules out the case where all types always end up insured. Second, because $\tilde{p}(L) > M$, if firms play competitively in the subgame, $M$-types never remain uninsured. $\tilde{p}(M) < H$ ensures that an equilibrium always exists if information is shared.

In the following, we start by analyzing equilibria that arise in markets that do not exhibit any form of information sharing. We then show that these equilibria cease to exist if information is shared.

**No information sharing.** If no information is transmitted, firms, if approached by an applicant, never know whether they are in step 4) of the general or in step i) of the game following 6 b). Therefore, both firms find themselves in the same position and the only equilibrium is one where firms are symmetrically informed. If $\Gamma$ is sufficiently small, which we have assumed, and if $\tilde{p}(E[\theta|\theta \leq M]) < H$, which follows from $\tilde{p}(M) < H$, the following are unique equilibrium allocations.

**Proposition 1**

$\gamma_A = \gamma_B = \Gamma$. The following contracts are offered in equilibrium: $p_i^*(H) \in \delta$, $p_i^*(L) = p_i^*(M) = \tilde{p}(E[\theta|\theta \leq M])$ for $i \in \{A, B\}$ and $p_i'(\theta)^* = p_i'((\theta)^* = \theta$ for all $\theta$.

We have seen above that $T_{1-\lambda}$-consumers never remain uninsured. By Assumption, these consumers are even offered fair prices in equilibrium. The non-insurance logic of Villeneuve...
still applies to consumers of type $T_\lambda$. These basically face a monopolistic insurer who charges them their highest willingness to pay (given his profits are positive). Therefore, if they allowed for the possibility to be a $H$-type, they would also be paying more. If on the other hand, beliefs are as given in Proposition 1, $L$ and $M$-types are better off while the $H$-type ends up rejected and uninsured.

Information sharing. Now consider the following situation: After step 5) of the general game, i.e. after a firm made an offer, she reports her contract offer to the system. Note that this is equivalent to a system where firms report accept or reject decisions. Because a firm, knowing that a consumer has applied to another firm before, can always ask this consumer to reveal his contract offer, reporting prices is equivalent to reporting no information on risk types. Therefore, we assume that price offers are reported honestly, i.e. if a firm sends misleading signals this is directed towards both consumer and competitor. If information is shared, the equilibrium as given in Proposition 1 ceases to exist because the second firm cannot make positive profits on switching types. The following Proposition characterizes the set of possible equilibrium allocations.

**Proposition 2.** Any equilibrium with information sharing has $\gamma_i = \Gamma, \gamma_j = 0$.

1. An equilibrium with the following properties always exists: $p_i^*(H) \in \delta, p_i^*(L) = p_i^*(M) = \bar{p}(E[\theta | \theta \leq M])$ and $p_j^*(\theta)^* = p_j^*(\theta)^* = M$ for $\theta \in \{L, M\}$. If $\lambda \geq \hat{\lambda} \in (0, 1)$, then $p_i^*(H) = p_j^*(H) = \bar{H}$. Otherwise, $p_i^*(H) \in \delta, p_j^*(H) = \bar{p}(H)$.

2. (a) An equilibrium with the following properties exists if and only if $\lambda \in [\hat{\lambda}, \bar{\lambda}]$: $p_i^*(H) = p_i^*(M) \in \delta, p_i^*(L) = \bar{p}(L), p_i^*(L)^* = p_j^*(L)^* = L$ for $\theta = L$. $p_i^*(\theta) = p_j^*(\theta) = \bar{H}$ for $\theta \in \{M, H\}$.

(b) An equilibrium with the following properties exists if and only if $\lambda \in [\hat{\lambda}, \bar{\lambda}]$: $p_i^*(M) \in \delta, p_i^*(L) = \bar{p}(L), p_i^*(L)^* = p_j^*(L)^* = L$ for $\theta = L$. $p_i^*(\theta) = p_j^*(\theta) = \bar{p}(M), p_i^*(H) \in \delta, p_j^*(H) = \bar{p}(H) = \bar{p}(E[\theta | \theta \geq M])$.

It holds that $\frac{1}{2} < \hat{\lambda} < \bar{\lambda}$ and $\bar{\lambda} < \tilde{\lambda} < 1$. $\hat{\lambda}, \bar{\lambda}, \bar{\lambda}, \tilde{\lambda}$ are given in the appendix.

The first part of the Proposition states that if firms are asymmetrically informed in equilibrium, the informed party strictly benefits from her informational advantage if the consumer has a low risk. On the other hand, this firm never earns positive profits on $M$-types. This is because her competitor can infer from her former offer that the risk type must be either $L$ or $M$ (beliefs are consistent in equilibrium) which restricts the informational advantage.
As opposed to this, consider the case where $\theta = H$. In equilibrium, in order to accept the possibility that his risk is indeed high, the consumer must have been rejected previously. Whether or not the consumer will in the second round accept an offer by the informed party depends on the market situation. We say that the insurer is credible if $L$ and $M$-types are still accepted in the first round even if the firm can hope to earn a price $H$ on all switching consumers in the second round. Obviously, this calculation is driven by the share of non-switching consumers in the market that would have to be given up in exchange for higher profits on switching consumers. On the other hand, if credibility is not given, we need that beliefs being preserved after the second round, i.e. that $\tilde{\theta}(p_i, p'_i) = E[\theta|\theta \leq M]$ if $\min\{p_i, p'_i\} \leq \tilde{p}(H)$. Therefore, if the informed party is not credible, the ignorant firm benefits from her quasi-monopoly position and accordingly earns strictly positive profits.

In the second part of the Proposition, non-switching $M$-types are also rejected. An according equilibrium does not exist if information is not shared, because $\tilde{p}(L) > M$. Given these beliefs, then a firm would always prefer to offer this price to an $M$-type and therefore deviate from an equilibrium that leaves $M$-types uninsured. Here, things are different because firms take into account the proceeding of the game. In this equilibrium, the informed firm makes positive profits on $M$-types. A deviation on that type therefore implies to give up regular income. This will only be profitable if the share of non-switching consumers in the market is very high. On the other hand, $\lambda$ must also not be too low, because this then incentivizes the firm to reject even $L$-types. Also note that credibility is necessary for an equilibrium that leaves $M$-types uninsured to exist because $\tilde{p}(L) > M$. In the (b) part, consumers only believe to be a $H$-type if rejected twice by the informed firm. The logic is in analogy to the first part.

Welfare effects of information sharing. It is intuitive to assume that non-switching consumers should not be influenced if information sharing was abolished. However, if the equilibrium with information sharing is one as proposed in the second part of Proposition 2, an according equilibrium does not exist and beliefs must therefore change. Comparing both equilibria to the one characterized in Proposition 1 we identify the following welfare effects:

**Proposition 3**

(a) If the information sharing equilibrium is as given in Proposition 2, (1), then if no information is shared, the welfare of $T_{1-\lambda}$-consumers strictly increases, $T_\lambda$-consumers are indifferent and expected industry profits strictly decrease.

(b) if the information sharing equilibrium is as given in Proposition 2, (2), no information sharing pareto dominates information sharing.
If information was not shared, consumer welfare would always increase. Non-switching consumers are indifferent if their beliefs do not change and strictly prefer no information transmission in the other case. This effect arises although non-switching consumers pay their full willingness to pay given they believe \( L \) or \( M \) and are therefore indifferent between being insured or not. However, if the \( M \)-type remains uninsured, volatility increases which in turn decreases the welfare of these consumers. It is notable that even firms will prefer not to share their information in this case. Information sharing is profitable on switching types but only at the cost of giving up some non-switching types. Therefore, if \( \lambda \) was sufficiently small, information sharing would increase industry profits. It can be shown however that this critical value never exceeds \( \lambda \). Obviously, then, social welfare increases if information is not transmitted. If beliefs \( \hat{\theta}_\lambda \) can be preserved however, the effect is ambiguous. For great \( \lambda \), social welfare increases since volatility decreases. If \( \lambda < \hat{\lambda} \), however, the volatility either increases or decreases.

4 Prequalification tests

In some countries, some but not all insurance companies offer consumers the possibility to anonymously prerequest a risk screening which is linked to a no system entry promise. Anonymity is secured by the use of a mediator. Furthermore, if accepted, a consumer still has to apply afterwards. In this subsection, we want to give a rationale for this offer.

Consider the case where consumers experience a subjective damage from being rejected. This might be because laws usually allow insurance companies to base their risk screening on a limited period only, e.g. five years. Without information sharing, consumers might have the possibility to reapply in a few years, hoping for a better risk profile. Only non-switching consumers really end up uninsured.\(^6\) Hence only non-switching consumers should suffer this damage in our model if they are high risk types. If this damage is sufficiently high (or the probability of being rejected), they might refrain from applying in the first place. Then, a prequalification test brings back these consumers to the industry, because they can be sure that a possible rejection is not entered into the system. Then if consumers keep on mixing between both firms and given they wish to apply, there should be exactly one firm offering a prequalification test if this involves costs. Furthermore, a firm will be interested in committing itself to anonymity. If not, a switching consumer might easily establish the no information sharing situation by then applying to the other firm.

\(^6\)We abstract from the fact that if risk profiles can change over time, this might influence consumer and firm strategies over time. Furthermore, we shamelessly leave aside thoughts on how reliable risk screenings are and whether they should, in the assumed consequence impact reservation utilities.
An interesting question is why firms then do not set up a system where only acceptance decisions are entered. If only acceptance decisions are entered, prequalification tests are redundant, but the switching $H$-type necessarily gets the fair contract, instead of $\tilde{p}(H)$ if $\lambda < \tilde{\lambda}$, because the consumer is then free to hide his contract if he was rejected before. Therefore, if the additional costs from offering prequalification tests are sufficiently low, and so is $\lambda$, it is most profitable to set up a system where all offers are entered into the system in combination with offering prequalification tests.

5 Discussion

We have given a very intuitive rationale for information sharing in insurance markets. In particular, we have analyzed the question of why in some countries, insurers share information on their acceptance or rejection decisions. Our explanation is simple: what firms really do is to share information on the switching type of an applicant, thereby inducing the firm not to collect information. Interestingly, it may happen that not only the informed firm benefits from information sharing here. If the share of non-switching consumers in the market is low, the non-informed firm may make monopoly profits on previously rejected risk types. Information about the switching type is implicitly transmitted by the provision of minimal personal data. A firm does not need to collect information on switching types. Only the fact that a consumer whose name has been entered into the system implies that it must be a switching type. Sharing information on acceptance or rejection decisions is nothing more if contract offers are in written form, which we have implicitly assumed: the competitor insurer can always ask a consumer to reveal his formerly received offer. If this assumption is invalid, price signalling is directed only towards consumers whereas firms would have to base their offers on less information. It is not obvious which system would then be advantageous from an industry point of view. Therefore, the reason that we observe information sharing systems that basically reveal no information may be for the two reasons mentioned above. However, it is straightforward that full information revelation cannot be optimal. A nice property of this model is that information sharing is voluntary. Even after having collected information on an applicant’s risk type, a firm has no incentive to not share information. She would have an incentive to provide false information if she was not bound to send identical signals to consumer and competitor.

Our analysis focuses on the economic effects of information sharing. But information exchange systems officially serve as a tool to prevent fraud, most importantly over-insurance. Because the insurance industry emphasizes the potential use for honest insurees that would
thereby pay less, these systems are widely accepted across all political camps.

However, our analysis suggests that information sharing may serve as a tool to keep prices up and may therefore have a converse effect. On the other hand, with information sharing, equilibria may arise that leave more consumers uninsured. We have demonstrated that this is disadvantageous also for the insurance industry. In that case, systems are set up although being detrimental to industry welfare. On the other hand, it is hard to understand why sharing information during the application status should be able to prevent fraud. Insurers often state that the system protects competitors because once rejected, consumers tend to manipulate their applications. But whether or not a consumer has honestly reported his health status is verified only upon submittance of a claim. Because a consumer cannot make a repayment claims then, an insurance would benefit from uncovering misreporting. Therefore, it seems likely that economic reasons have played a role when these pooling systems were designed first.

In the last section, we have rationalized the concept of anonymous prequalification tests in the industry. The fact that we actually observe these tests leads us to the conclusion that the share of switching consumers should be rather high and testing costs rather low. With respect to our formerly stated results, this implies that banning information sharing will rather result in an equilibrium where all firms acquire information. Although the anticompetitive effect prevails, social welfare will rather not be affected.
References


A Appendix

Proof of Proposition 1

First, if both firms are informed, the unique equilibrium is the perfect competition outcome. Suppose not, then there exists a \( \theta \) such that \( p'_A(\theta), p'_B(\theta) > \theta \). Let \( A \) be the firstly approached firm. Then by Assumption 1, \( B \) wants to deviate to a lower price. If this price is not played for any other \( \theta' \) in equilibrium, then \( N(\theta) = 1 \) and \( N(\theta') = 2 \). Therefore, beliefs do not change and the deviation is profitable. From Assumption 1, \( B \) always plays a pure strategy. Then, there is always a price offer where deviation is profitable and that is not played for any other \( \theta' \) in equilibrium.

Second, we show that this equilibrium exists for small \( \Gamma \). The following belief system yields price offers as listed in Proposition 1:

\[
\hat{\theta}_\lambda(p_i) = \begin{cases} 
L & \text{if } p_i < M \\
E[\theta|\theta \leq M] & \text{if } M \leq p_i \leq \tilde{p}(H) \\
H & \text{otherwise}
\end{cases}
\]  

\[
\hat{\theta}_1(p_i) = \begin{cases} 
L & \text{if } \min\{p_i, p_j\} < M \\
M & \text{if } M \leq \min\{p_i, p_j\} < H \\
H & \text{otherwise}
\end{cases}
\]

Therefore, \( p_i = \tilde{p}(E[\theta|\theta \leq M]) \). Expected equilibrium profits are

\[
\Pi^*_i(\Gamma, \Gamma) = \frac{\lambda}{2 - \lambda}(q_L + q_M)(\tilde{p}(E[\theta|\theta \leq M]) - E[\theta|\theta \leq M]) - \Gamma
\]

If a firm decides to deviate to \( \gamma_i = 0 \), the deviation price must be either \( p_i \geq H \) which yields \( \Pi^D_i(\Gamma, \Gamma) = 0 \) or \( p_i = \tilde{p}(E[\theta|\theta \leq M]) \). Then the deviation profit is

\[
\Pi^D_i(\Gamma, \Gamma) = \frac{\lambda}{2 - \lambda}(\tilde{p}(E[\theta|\theta \leq M]) - E[\theta]) - \frac{2(1 - \lambda)}{2 - \lambda}q_M(H - \tilde{p}(E[\theta|\theta \leq M]))
\]

Therefore, this equilibrium exists if and only if

\[
\Gamma \leq \min\left\{\frac{\lambda}{2 - \lambda}(q_L + q_M)(\tilde{p}(E[\theta|\theta \leq M]) - E[\theta|\theta \leq M]), q_M(H - \tilde{p}(E[\theta|\theta \leq M])\right\}
\]

which is strictly greater than zero. Third, this equilibrium allocation is unique. We have shown that the competitive outcome is the unique allocation for the subgame. From \( \tilde{p}(L) > M \), \( \hat{\theta}_\lambda(p_i) = L \) if \( p_i \leq \tilde{p}(H) \) and \( \hat{\theta}_\lambda(p_i) = E[\theta|\theta \geq M] \) cannot be an equilibrium. Suppose it is. Then, in equilibrium, \( p_i(M) = \delta \). But a deviation to \( p_i(M) > M \) is profitable for any belief. Furthermore, from \( \tilde{p}(E[\theta]) < H \), there is no equilibrium in which \( \hat{\theta}(\theta)_\lambda(p_i) = E[\theta] \) if \( p_i \geq H \). Suppose it was. Then, by the Bayes-consistency requirement, \( p_i \geq H \) is played on
all \( \theta \). Therefore, all types would remain uninsured. A deviation is then always profitable at least on \( \theta = L \).

**Proof of Proposition 2**

Let \( A \) be the firstly approached firm, \( \gamma_A = \Gamma \) and \( \gamma_B = 0 \).

(1) First, consider an equilibrium with \( \hat{\theta}_\lambda(p_i) = E[\theta|\theta \leq M] \) if \( p_i < \bar{p}(H) \) and \( H \) otherwise. Under Assumption \( \text{I} \) because \( \bar{p}(L) > M \), \( p_A(L) = p_A(M) = M \) must the unique allocation in the subsequent subgame. Let \( \theta = H \) and consider \( \hat{p}'(H) = p'_j(H) = H \). This can be an equilibrium only if \( i \) does not want to deviate to this strategy, thereby inducing belief \( \hat{\theta}_1 = H \) for any \( \theta \) different from \( H \). This is given if the following conditions are met:

\[
\begin{align*}
\lambda(\bar{p}(E[\theta|\theta \leq M]) - L) + (1 - \lambda)(M - L) & \geq (1 - \lambda)(H - L) \\
\lambda(\bar{p}(E[\theta|\theta \leq M]) - M) & \geq (1 - \lambda)(H - M)
\end{align*}
\]

which transforms to

\[
\begin{align*}
\lambda & \geq \lambda_L \equiv \frac{H - M}{H - M + \bar{p}(E[\theta|\theta \leq M]) - L} \\
\lambda & \geq \lambda_M \equiv \frac{H - M}{H - M + \bar{p}(E[\theta|\theta \leq M]) - M}
\end{align*}
\]

If at least one of the conditions is not met, \( \hat{p}'(H) = p'_j(H) = H \) is not an equilibrium. Instead, consider an equilibrium where \( p'_i(H) = \delta \). If at least one of the conditions is not met, then all \( p''_i(H) > H \) are admissible on either \( \theta = L \) or \( \theta = M \) or both. Because all \( \bar{p}(L), \bar{p}(M) \) and \( \bar{p}(E[\theta|\theta \leq M]) \) are smaller than \( H \), this equilibrium is not eliminated. On the other hand, if both conditions are met, \( p'_i(H) = \delta \) cannot be an equilibrium strategy because then \( p''_i(H) = H \) is dominated on \( \theta = L \) and \( \theta = M \). Therefore, \( \hat{\theta}_{1-\lambda} \) is then \( H \) and this equilibrium is eliminated.

\( \lambda_L > \lambda_M \). Therefore, \( \hat{\lambda} \) is given by

\[ \hat{\lambda} = \lambda_L \]

Next, we show that there exists an according equilibrium. These are examples of equilibrium
beliefs if $\lambda \leq \hat{\lambda}$:

$$\hat{\theta}_\lambda(p_i) = \begin{cases} L & \text{if } p_i < M \\ E[\theta|\theta \leq M] & \text{if } M \leq p_i < \tilde{p}(H) \\ H & \text{if } p_i \in \delta \end{cases}$$

$$\hat{\theta}_{1-\lambda}(p_i, p'_i) = \begin{cases} L & \text{if } \min\{p_i, p'_i\} < M \\ E[\theta|\theta \leq M] & \text{if } M \leq \min\{p_i, p'_i\} \leq \tilde{p}(H) \\ H & \text{if } \min\{p_i, p'_i\} \in \delta \end{cases}$$

and if $\lambda > \hat{\lambda}$:

$$\hat{\theta}_{1-\lambda}(p_i, p'_i) = \begin{cases} L & \text{if } \min\{p_i, p'_i\} < M \\ E[\theta|\theta \leq M] & \text{if } \min\{p_i, p'_i\} \geq M, p_i \leq \tilde{p}(H), p'_i < H \\ H & \text{if } p_i \in \delta, p'_i \geq H \end{cases}$$

We have as expected equilibrium profits:

$$\Pi_j(\Gamma, 0) = \begin{cases} 0 & \text{if } \lambda > \hat{\lambda} \\ q_H(\tilde{p}(H) - H) & \text{otherwise} \end{cases}$$

$$\Pi_i(\Gamma, 0) = \lambda(q_L + q_M)(\tilde{p}(E[\theta|\theta \leq M]) - E[\theta|\theta \leq M]) + (1 - \lambda)q_L(M - L) - \Gamma$$

It is straightforward that $p_i = \tilde{p}(E[\theta|\theta \leq M])$ is an equilibrium strategy. It remains to show that there exists some $\hat{\Gamma} > 0$ such that for all $\Gamma \leq \hat{\Gamma}$, these beliefs form, together with the price offers mentioned in Proposition 2, an equilibrium.

If firm $j$ deviates to $\gamma_j = \Gamma$, her deviation profit is $\Pi_j^2(\Gamma, 0) = -\Gamma$. Therefore, firm $j$ never deviates.

If firm $i$ deviates to $\gamma_i = 0$ and if it then offers a contract $p_i > \tilde{p}(E[\theta|\theta \leq M])$, her deviation profit is $\Pi_i^2(\Gamma, 0) = 0$. If $i$ offers $p_i = \tilde{p}(E[\theta|\theta \leq M])$, the deviation profit is $\Pi_i^2(\Gamma, 0) = \lambda(\tilde{p}(E[\theta|\theta \leq M]) - E[\theta]) + (1 - \lambda)\max\{0, (M - E[\theta])\}$. Therefore, an equilibrium for given beliefs exists if and only if $\Gamma \leq \hat{\Gamma}$ where

$$\hat{\Gamma} \equiv \min\{\lambda(q_L + q_M)(\tilde{p}(E[\theta|\theta \leq M]) - E[\theta|\theta \leq M]) + (1 - \lambda)q_L(M - L), \lambda q_H(H - \tilde{p}(H)) + (1 - \lambda)(q_L(M - L) - \max\{0, M - E[\theta]\})\}$$

Both terms are strictly positive.

(2) Consider an equilibrium with $\hat{\theta}_\lambda(p_i) = L$ if $p_i < \tilde{p}(H)$ and $E[\theta|\theta \geq M]$ otherwise. Under Assumption $[\Pi] p'_A(L) = L$ must the unique allocation in the subsequent subgame. Furthermore, because $\tilde{p}(M) < H$ and $\tilde{p}(E[\theta|\theta \geq M])$, the $T_{1-\lambda}$ consumer may either believe $M$ or $E[\theta|\theta \geq M]$ upon a second acceptance. This implies in the subgame that either
\[ p'_A(M) = \tilde{p}(M), \quad p'_A(H) = \delta \quad \text{or} \quad p'_A(M) = p'_A(H) = H. \]

Consider on the contrary \( p'_A(M) = p'_A(H) = \delta \). Then, \( p'_B \geq H \). But a deviation is profitable on \( M \) for any belief because \( \tilde{p}(L) > M \).

(a) \( p'_A(M) = p'_A(H) = H \) is an equilibrium if and only if

\[
\lambda(\tilde{p}(L) - L) \geq (1 - \lambda)(H - L) \\
(1 - \lambda)(H - M) \geq \lambda(\tilde{p}(L) - M)
\]

which transforms to

\[
\lambda \geq \lambda \equiv \frac{H - L}{H - L + \tilde{p}(L) - L} \\
\lambda \leq \lambda \equiv \frac{H - M}{H - M + \tilde{p}(L) - M}
\]

where \( \lambda < \lambda \).

(b) Similarly, \( p'_A(M) = \tilde{p}(M), \quad p'_A(H) = \delta \) is an equilibrium if and only if

\[
\lambda(\tilde{p}(L) - L) \geq (1 - \lambda)(\tilde{p}(M) - L) \\
(1 - \lambda)(\tilde{p}(M) - M) \geq \lambda(\tilde{p}(L) - M)
\]

which transforms to

\[
\lambda \geq \lambda \equiv \frac{\tilde{p}(M) - L}{\tilde{p}(M) - L + \tilde{p}(L) - L} \\
\lambda \leq \lambda \equiv \frac{\tilde{p}(M) - M}{\tilde{p}(M) - M + \tilde{p}(L) - M}
\]

The remainder of the proof is parallel to (1).