On the Use of Information in Repeated Insurance Markets

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Abstract

One unresolved puzzle in insurance markets is the existence of “unused observables” – that is information which a) insurance companies collect or could collect, b) is correlated with the risk experience, but c) insurance companies choose not to use to set prices. While in one-shot models the occurrence of unused observables cannot be explained, we show that in repeated insurance markets equilibria exist in which companies do not use all risk-relevant information in order to sustain collusion. These equilibria may persist even if we allow for communication among companies and market entry.

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JEL classification codes: C72, G22, L13

1 Introduction

It is a well-established fact, at least in the theoretical literature, that the presence of asymmetric information in insurance markets can lead to sub-optimal consumption levels of insurance and thus to welfare losses. Numerous recent studies have empirically tested the predictions of theoretical models of insurance markets regarding the distribution and

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use of information and its effects on market transactions.\footnote{See, for example, Chiappori et al. (2006) on general testable implications on insurance markets, Chiappori and Salanie (2008) on empirical issues in modeling competition and market equilibrium in insurance markets, Cutler, Finkelstein and McGarry (2008) on preference heterogeneity in insurance markets, Finkelstein and Poterba (2006) on testing for adverse selection using unused observables.} Several empirical results are hard to reconcile with the standard theoretical models. One of them is the puzzle of “unused observables”. In theory, profit-maximizing insurance companies should exploit any risk-relevant information available to them.\footnote{Insurance markets are almost always formalized as one-shot games. In these models, insurance companies will always use all risk-relevant information, regardless of the mode of competition: Under perfect competition, companies will use all information in order to charge the fair premium. A monopolist will use all information in order to maximize profits through price discrimination.} Empirically, however, there is evidence of unused observables in insurance markets, that is information which a) insurance companies collect or could collect, b) is correlated with the risk experience, but c) insurance companies choose not to use to set prices.

For example, according to Finkelstein and Poterba (2006), the address of the insured person is almost always collected, but seldom used in pricing insurance, although there is a correlation between geographic information and other individual attributes that affects both the demand for insurance and the risk type. They use data on annuity purchases in the UK to illustrate that the information on the annuitant’s residential location would help to predict future mortality risk, but that it does not influence the insurance premium.

Gender is another example of an unused observable that is usually collected by default, but that is not used for pricing in certain insurance markets, the most prominent example being the automobile insurance and the long-term care insurance market. In both markets, the expected costs for the insurer differ substantially for men and women.\footnote{See, for example, Finkelstein and Poterba (2006) or the “Gesamtverband der deutschen Versicherungswirtschaft”, (www.gdv.de), the association of German insurance companies.} Further empirical evidence on unused observables is provided by Carter (2005) who describes the evolution of the use of information in the US market for automobile insurance. Finkelstein and Poterba (2006) conclude their article by stating that “a complete understanding of the limited use in pricing of available or collectible risk-related information on insurance buyers remains an open issue”\footnote{They mention a number of possible reasons for the existence of unused observables, e.g. regulation or implementation costs, but show that these cannot fully explain the puzzle.}.

This article contributes to the discussion on unused observables by providing a theoretical model which shows that in case of repeated interaction between insurance companies in an oligopolistic market, we can explain the puzzle of unused observables. Its premise is
that insurance companies take into account the impact of pricing decisions on competitors’ actions. The majority of theoretical models in the insurance market are one-shot models of either perfect competition or monopolistic behavior of insurance companies. There are only few articles that model oligopolistic competition\(^5\), although the empirical evidence seems to suggest that there is some market power for at least some types of insurance.\(^6\)

In the basic version of our model, individuals face either high or low risk of damage. In every period, insurance companies announce their premia to insure these risks. Customers purchase the amount of insurance that maximizes their expected utility from the company with the lowest insurance rate for their risk type. In this repeated oligopolistic market, companies interact strategically and preconceive the effect of their pricing decision on the prices set by their competitors in subsequent periods. If companies fear a price war after adjusting their prices, they may refrain from doing so. We show that equilibria exist in which (1.) insurance companies charge the same insurance premium to both risks, (2.) both risk types purchase positive amounts of insurance (however, low risks potentially acquire less insurance than high risks). Thus, we derive an equilibrium with unused observables.

In the next step, we analyze the robustness of our model with regard to two extensions. First, we allow for market entry. Outside firms can enter the market incurring some entry costs and become incumbent firms for the rest of the game. Second, we allow for explicit collusion between firms, i.e. they can agree on charging the profit maximizing insurance premia for low and high risks. If they can negotiate with each other, companies are likely to charge a higher premium for the high risks (and thus exploit their information). We show that if entry costs are sufficiently low, insurance premia must be different for low and high risks in any equilibrium in which incumbent firms make positive profits. More importantly, we show that there exist equilibria with unused observables in which incumbent companies cannot gain by explicit collusion if entry costs are neither too high nor to low. The logic behind this result is as follows: If incumbent companies decide to increase their period profits by charging different premia for low and high risks, outside companies can enter the market profitably by making a one-shot gain. Likewise, if on the other side one incumbent company undercut the insurance premium of its competitors,

\(^5\)Some of the few exceptions are Ania and Wambach (2002) who re-examine the equilibrium non-existence problem of Rothschild and Stiglitz (1976) in a dynamic setting, and Buzzacchi and Valletti (2005) who provide a model of strategic price discrimination in compulsory insurance markets.

\(^6\)Brown and Goolsbee (2002) suggest that in the life insurance industry, search costs create the potential for market power. Buzzacchi and Valletti (2005) infer from the high concentration indices for the top 5 non-life insurance companies in European countries that the market structure is oligopolistic. Chiappori et al. (2006) use a French dataset of automotive insurers to test for the presence of asymmetric information. Their results suggest the presence of market power.
it triggers a price war, which wipes out all gains of this deviation. We therefore show that equilibria with unused observables can be robust to explicit collusion and to the threat of market entry.

Our model interprets the presence of unused observables as a sign of collusion. This is in accordance with experience in the US automotive insurance market where, as long as companies were making extensive profits, contracts were almost not differentiated by risk class (compare Carter 2005). However, as profits in the market started to deteriorate in the late 1990s, one insurance company (Allstate), changed the number of pricing categories from 3 to over 1,500. As a consequence, Allstate’s return on equity almost doubled in the following two years. However, as the author points out, this strategy might not be of lasting success, as other insurance companies also start to change their pricing system, and a price war in the auto insurance market seems on its way.

The rest of the paper is organized as follows: The next section outlines the basic model and derives an equilibrium with unused observables. We include explicit collusion and market entry into the model in section 3. In section 4, we discuss the issues of equilibrium selection, welfare and policy implications. The last section concludes.

2 A repeated Insurance Market

2.1 Framework

Time is discrete and denoted by $t \in \{0, 1, \ldots\}$. The stage game is the simplest version of an insurance market. In each period, there is a continuum of customers of mass 1. These can be the same customers or different ones in each period. Each customer has wealth $W$ in each period, and faces the risk of losing an amount of $d < W$. She may have either a high-risk probability of $\pi_H$ or a low-risk probability $\pi_L < \pi_H$. Let $\lambda$ be the fraction of high-risk individuals. All customers have the same von Neuman-Morgenstern utility function $U(W)$. For our results we will need the following assumption:

**Assumption** $U(W)$ is twice continuously differentiable. Further, we have $U'(W) > 0$ and $U''(W) < 0$.

There are $N > 1$ long-lived risk-neutral insurance companies in the market. Let $I = \{1, \ldots, N\}$ be the set of insurance companies. We assume that these companies can

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7 As formalized, for example, in Rees and Wambach (2008).
8 There may be also a certain in- and outflow of individuals in each period. As long as not all customers are locked into a specific contract for all periods, the results of the model do not change.
distinguish between high- and low-risk customers. In each period, each company $i \in I$ offers any positive amount of insurance. Let $\alpha_{i,t}^H (\alpha_{i,t}^L)$ be the insurance premium for high-risk (low-risk) individuals offered by company $i$ in period $t$. If an individual of risk $j \in \{L, H\}$ purchases an insurance cover $D_j \geq 0$ in period $t$ from company $i$, she pays $D_j \alpha_{i,t}^j$ to the company in any case. If the damage occurs, she gets $D_j$ from the company, i.e. $D_j = d$ implies full coverage. We say that company $i$ uses the information about insured risk in period $t$ if $\alpha_{i,t}^H \neq \alpha_{i,t}^L$.

We do not model customers as strategic players: in each period, they purchase the utility maximizing insurance cover from the company that offers at the cheapest premium for their risk. If more than one company has the lowest insurance rate, the customer randomizes with equal probability from which company she buys insurance. The sequence of events in each period $t$ is as follows:

1. Insurance companies announce the insurance rates $\{(\alpha_{i,t}^L, \alpha_{i,t}^H)\}_{i \in I}$.

2. Customers purchase insurance.

3. Nature decides about the occurrence of damage and payoffs are realized.

Now fix
\[ \alpha_{i,-1}^L = \alpha_{i,-1}^H = 0 \]
for all $i \in I$. For $t \in \{0, 1, \ldots\}$, we denote by $h_t$ the history of all insurance rates that were charged by all insurance companies up to period $t$:
\[ h_t = \left( \{(\alpha_{i,t}^L, \alpha_{i,t}^H)\}_{i \in I}, \{(\alpha_{i,0}^L, \alpha_{i,0}^H)\}_{i \in I}, \ldots, \{(\alpha_{i,t-1}^L, \alpha_{i,t-1}^H)\}_{i \in I} \right). \] (1)

The set of all possible histories at date $t$ will be denoted by $H_t$. A strategy of company $i$ is an infinite sequence of action functions $\alpha_{i,t}^j$ for every $t \in \{0, 1, \ldots\}$, where $\alpha_{i,t}^j$ determines $\alpha_{i,t}^L$ and $\alpha_{i,t}^H$ as a function of the history $h_t$:
\[ \alpha_{i,t}^j : H_t \to \mathbb{R}^2. \] (2)

We therefore concentrate on pure strategies. The strategies of companies determine the sequence of insurance rates
\[ \left\{ \{(\alpha_{i,t}^L, \alpha_{i,t}^H)\}_{i \in I} \right\}_{t=0}^{\infty}. \] (3)

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9Our analysis can easily be extended to an environment where insurance companies cannot perfectly distinguish risks, but have imperfect information (variables which are imperfectly correlated with risk types) which can be used to categorize risks, as in Hoy (1982).
From this sequence, we can derive the profit \( G^{i,t} \) of company \( i \) in period \( t \). Insurance companies discount future gains by \( \delta \). The sum of normalized discounted profits of company \( i \) is then given by

\[
G^i = (1 - \delta) \sum_{t=0}^{\infty} \delta^t G^{i,t}.
\]  

(4)

The insurance market is in equilibrium if no company \( i \) can increase its profit \( G^i \) by choosing unilaterally another strategy.

2.2 Equilibria in an oligopolistic insurance market

We start by analyzing the demand for insurance. Assume for a moment that company \( i \) offers the lowest insurance premium to individuals with risk \( j \in \{L, H\} \) in period \( t \). A customer with risk \( j \) purchases the utility maximizing amount of insurance:

\[
\tilde{D}_j(\alpha_j^{i,t}) = \arg \max_{D_j} \pi_j U (W - d + D_j(1 - \alpha_j^{i,t})) + \pi_j (1 - \pi_j) U (W - D_j\alpha_j^{i,t}).
\]  

(5)

This demand is implicitly given by

\[
U'(W - d + \tilde{D}_j(\alpha_j^{i,t})(1 - \alpha_j^{i,t})) = \alpha_j^{i,t} (1 - \pi_j) \pi_j.
\]  

(6)

As \( U' \) is continuous, \( \tilde{D}_j(\alpha_j^{i,t}) \) must also be continuous. The fair insurance premium under which the customer purchases full coverage is given by

\[
\alpha_f^j = \pi_j,
\]  

(7)

while the highest insurance premium such that the customer is indifferent between purchasing a marginal unit of insurance cover or not is uniquely defined by

\[
\alpha_j^{\max} = \frac{\pi_j}{(1 - \pi_j) U''(W) + \pi_j}.
\]  

(8)

For insurance premia \( \alpha_j^{i,t} \in (\alpha_f^j, \alpha_j^{\max}) \) demand is positive and company \( i \) earns a positive profit from contracts with individuals of risk \( \pi_j \). For higher insurance premia, profits are 0, for lower insurance premia, profits are negative. Note that if \( \pi_L \) is sufficiently close to \( \pi_H \), we have \( \alpha_f^H < \alpha_f^L \).

Denote the set of profit maximizing insurance premia for customers of risk \( j \) by

\[
A_j = \left\{ \tilde{\alpha}_j \mid (\alpha_j - \pi_j)\tilde{D}_j(\alpha_j) \leq (\tilde{\alpha}_j - \pi_j)\tilde{D}_j(\tilde{\alpha}_j), \alpha_j \in \mathbb{R} \right\}.
\]  

(9)

This set is nonempty, as \( (\alpha_j - \pi_j)\tilde{D}_j(\alpha_j) \) is continuous on the closed interval \( [\alpha_f^j, \alpha_j^{\max}] \) and therefore attains its maximum. As we do not employ any restrictions on \( U'' \) except of being negative, \( A_j \) might contain more than one element.
Assume now that only company $i$ offers the lowest rates for customers of both types, but does not use the information about the insured risk, i.e. $\alpha_{i,t}^L = \alpha_{i,t}^H = \alpha_{i,t}^P$, where $\alpha_{i,t}^P$ is called the “pooling premium”. We then have

$$G_{i,t} = \lambda \tilde{D}_H(\alpha_{i,t}^P) (\alpha_{i,t}^P - \pi_H) + (1 - \lambda) \tilde{D}_L(\alpha_{i,t}^P) (\alpha_{i,t}^P - \pi_L)$$  \hfill (10)

Denote by $\alpha_{P0}$ the pooling premium at which the right-hand side of (10) is equal to 0 such that $\alpha_{i,t}^P < \alpha_{P0} < \alpha_H^\text{max}$ implies positive demand for insurance by at least the high-risk individuals and positive profits from the pooling contract. Note that $\alpha_H^f < \alpha_L^\text{max}$ implies $\alpha_H^f < \alpha_P < \alpha_H^f$. We then can state our first main result:

**Proposition 1** For each $\alpha \in (\alpha_{P0}, \alpha_H^\text{max})$ there is a $\delta(\alpha) < 1$ such that there exists a subgame-perfect equilibrium in which $\alpha_{i,t} = \alpha$ for all companies $i \in I$ and in all periods $t$ if $\delta \geq \delta(\alpha)$.

**Proof.** Consider the following simple grim-trigger strategy which is played by all companies $i \in I$: Charge $\alpha_{i,0} = \alpha$. In period $t > 0$, charge $\alpha_{i,t} = \alpha$ if and only if $\alpha_{L,\tau}^i = \alpha_{H,\tau}^i = \alpha$, $l \in I$, in all periods $\tau \in \{0, ..., t - 1\}$. Otherwise, charge $\alpha_{i,t} = \alpha_L^f$ and $\alpha_{i,t} = \alpha_H^f$. We employ the one stage deviation principle in order to show that this can be an equilibrium. If at least one company charges the fair insurance premia $\alpha_L^f$ and $\alpha_H^f$, no other company can make positive profits. Thus, the maximal normalized discounted profit from a deviation of company $i$ in period $t$ is given by

$$G_{i,d} = (1 - \delta) \left[ \lambda (\tilde{\alpha}_H - \pi_H) \tilde{D}_H(\tilde{\alpha}_H) + (1 - \lambda) (\tilde{\alpha}_L - \pi_L) \tilde{D}_L(\tilde{\alpha}_L) \right],$$

where $\tilde{\alpha}_H \in A_H$ and $\tilde{\alpha}_L \in A_L$. The normalized discounted profit from compliance is given by

$$G_{i,c} = \frac{1}{N} \left[ \lambda (\alpha - \pi_H) \tilde{D}_H(\alpha) + (1 - \lambda) (\alpha - \pi_L) \tilde{D}_L(\alpha) \right].$$

As $\alpha \in (\alpha_{P0}, \alpha_H^\text{max})$, this term is positive. Thus, if $\delta$ is sufficiently close to unity, we have $G_{i,c} > G_{i,d}$. ■

In the equilibria of theorem 1, insurance companies fear a price war if they change their insurance premia. Thus, they maintain a pooling premium, which guarantees them positive profits. This situation exhibits the following features:

- Although companies have more detailed information about insured risks, they do not use it. Thus, we have an equilibrium with unused observables.

- Given that $\pi_L$ is sufficiently close to $\pi_H$, both low- and high-risk individuals purchase positive amounts of insurance. However, there is adverse selection: As we can derive from equation (6), low-risk customers purchase less insurance than high-risk customers.
As mentioned in the introduction, standard theory with one-shot interaction cannot explain unused observables. A framework with repeated interaction seems to be more appropriate in order to model the insurance market.

3 Explicit Collusion and Market Entry

The equilibria in the last section had a number of attributes that are inconsistent with the results of one-shot models of the insurance market. However, there remain two important issues:

- If an industry makes profits, we would expect market entry.
- If companies are able to sustain collusion, they should be able to increase their profits even further by using the information about insured risks, i.e. they may coordinate on an equilibrium in which \( \alpha_{i,t}^H = \tilde{\alpha}_H \) and \( \alpha_{i,t}^L = \tilde{\alpha}_L \) for all companies \( i \) and in all periods \( t \), where \( \tilde{\alpha}_H \in A_H \) and \( \tilde{\alpha}_L \in A_L \).

We will deal with both questions in this section and show that the equilibria of theorem 1 still can be robust against market entry and explicit collusion. Note that explicit collusion is illegal in most legislations and implicit collusion (i.e. collusion without communication between firms) hard to detect.\(^{10}\) We will not rely on this, but assume that firms can negotiate without being exposed to the danger of punishment.

Denote the set of incumbent companies in each period by \( I_t \), where

\[
I_0 = \{1, ..., N\}.
\]

In each period \( t \), there is an infinite number of outside firms \( k \in \mathbb{N} \setminus I_t \) which can enter the market at cost \( c > 0 \).\(^{11}\) These entry costs include the expenses of building up statistical experience that is used to calculate insurance premia.\(^{12}\) Incumbent firms might have an informational advantage. Furthermore, these could be the costs of acquiring the necessary distribution channels. If an outside company enters the market, it belongs to the set of incumbents in all future periods. Furthermore, we define:

\(^{10}\)For a discussion about the difference between explicit and implicit (“tacit”) collusion, see Rees (1993).
\(^{11}\)This also could be insurance companies which offer the same insurance contracts, but at substantially higher rates, such that only a small fraction of uninformed consumers purchases those contracts.
\(^{12}\)We did not model these costs explicitly in order to keep the model simple. However, even if some information about insured risks are not used to determine the insurance premium, many other variables are. An outside firm might not have the necessary data to calculate insurance premia, which generate non-negative profits from the start. This point is discussed in more detail in Poterba and Finkelstein (2006).
**Definition**  An equilibrium is robust against explicit collusion if there is no other equilibrium in which at least one incumbent company \( i \in I_0 \) earns strictly higher profits \( G^i \) and all other incumbent companies \( l \in I_0 \setminus \{i\} \) earn weakly higher profits \( G^{low} \).

If an equilibrium in which companies \( i \in I_0 \) do not use the information about insured risks is robust against explicit communication, any agreement on adjusting insurance premia to increase profits must result in a decrease of profits for at least one incumbent company, and therefore would not be accepted by this company. Note that robustness against explicit collusion is weaker than (weak) renegotiation proofness.\(^{13}\)

We assume that in each period, outside companies observe the insurance premia charged by incumbent companies and then decide about whether to enter the market or not. Thus, incumbent companies are Stackelberg leaders and market entry is endogenous as in Etro (2008). As tie-breaking rule we define that a company only enters the market if it can make strictly positive profits. The sequence of events now is as follows:

1. Insurance companies announce the insurance premia \( \{(\alpha_{L,i}^{t}, \alpha_{H,i}^{t})\}_{i \in I_t} \).
2. Outside companies decide whether to enter the market at cost \( c \) or not. If a company \( k \in \mathbb{N}\setminus I_t \) enters the market, it subsequently sets its insurance premia \( (\alpha_{L,k}^{t}, \alpha_{H,k}^{t}) \).
3. Consumers purchase insurance.
4. Nature decides about the occurrence of damage and payoffs are realized.
5. If a company \( k \in \mathbb{N}\setminus I_t \) has entered the market, then \( I_{t+1} = I_t \cup \{k\} \).

Clearly, as entry costs are positive, incumbents can price outside companies out of the market. Our next result confirms the suspicion that with market entry, equilibria in which companies operate profitably, but do not use the information about insured risks, might not exist.

**Proposition 2**  If \( c \) is sufficiently small, then in equilibrium all companies that make positive profits in period \( t \) use the information about insured risks in this period.

**Proof.**  Assume that this is not the case and an incumbent company \( i \in I_t \) charges \( \alpha_{P}^{i,t} \in (\alpha_{P0}, \alpha_{max}^{H}) \) and makes a positive profit in period \( t \). If follows that \( \alpha_{j}^{i,t} \geq \alpha_{P}^{i,t} \) for all

\(^{13}\)For details about renegotiation proofness, see Mailath and Samuelson (2006), pages 134 - 143. One also could construct weak renegotiation proof equilibria in our setting, however, their structure is not interesting for our purpose.
If an outside company \( k \in \mathbb{N} \setminus \mathcal{I}_t \) enters the market, then it earns at least

\[
-c + (1 - \lambda)(\alpha P_0 - \pi L)\bar{D}_L(\alpha P_0),
\]

by charging \( \alpha_{L}^{k,t} = \alpha P_0 \) and \( \alpha_{H}^{k,t} = \alpha_{H}^{t} \), given that there is no other outside company which enters the market. The term in (13) is positive if \( c \) is sufficiently low. Therefore, the situation outlined above cannot be an equilibrium outcome if \( c \) is sufficiently low.

Thus, the equilibria of Theorem 1 are not robust against market entry, if entry costs are sufficiently small. However, as we pointed out above, we do not expect entry barriers to be negligible for insurance markets. If \( c \) is sufficiently high, the existence of equilibria with pooling premia might be restored. Define

\[
A_P = \{ \hat{\alpha}_P \mid \lambda(\alpha - \pi_H)\bar{D}_H(\alpha) + (1 - \lambda)(\alpha - \pi_L)\bar{D}_L(\alpha) \leq \lambda(\hat{\alpha}_P - \pi_H)\bar{D}_H(\hat{\alpha}_P) + (1 - \lambda)(\hat{\alpha}_P - \pi_L)\bar{D}_L(\hat{\alpha}_P), \alpha \in \mathbb{R} \},
\]

which is the set of pooling-premia, such that the maximal gain from pooling contracts is attained, and

\[
\hat{\alpha}_P^* = \min \{ \hat{\alpha}_P \in A_P \},
\]

which is the smallest element in this set. Then denote

\[
G^{\text{high}} = \lambda(\hat{\alpha}_P^* - \pi_H)\bar{D}_H(\hat{\alpha}_P^*) + (1 - \lambda)(\hat{\alpha}_P^* - \pi_L)\bar{D}_L(\hat{\alpha}_P^*),
\]

\[
G^{\text{low}} = \max_{\alpha \in [\alpha_{L}^{t}, \alpha_{H}^{t}]} (1 - \lambda)(\alpha - \pi_L)\bar{D}_L(\alpha).
\]

\( G^{\text{high}} \) is the highest period profit from a pooling contract, \( G^{\text{low}} \) is the highest period profit that can be made by selling contracts only to low risks and by charging a premium in the interval \( [\alpha_{L}^{t}, \alpha_{H}^{t}] \). For \( \pi_H \to \pi_L \), we have \( \alpha_{H}^{t} \to \alpha_{L}^{t} \), such that \( G^{\text{low}} \to 0 \). Thus, if \( \pi_H \) is sufficiently close to \( \pi_L \), then \( G^{\text{high}} > G^{\text{low}} \). We then can show:

**Proposition 3** Assume that \( \delta > 1 - \frac{1}{N} \) and \( G^{\text{high}} > G^{\text{low}} \). If \( c \in (G^{\text{low}}, G^{\text{high}}) \), then there is a subgame-perfect equilibrium which is robust against explicit collusion and in which \( \alpha_{P}^{i,t} = \alpha, \alpha \in (\alpha_{H}^{t}, \hat{\alpha}_P^*) \), for all incumbent companies \( i \in \mathcal{I}_0 \) in all periods \( t \), while outside firms do not enter the insurance market.

**Proof.** Define for \( G \in (G^{\text{low}}, G^{\text{high}}) \)

\[
\alpha^G = \min_{\alpha} \left\{ \alpha \in (\alpha_{H}^{t}, \hat{\alpha}_P^*) \mid \lambda(\alpha - \pi_H)\bar{D}_H(\alpha) + (1 - \lambda)(\alpha - \pi_L)\bar{D}_L(\alpha) = G \right\}.
\]

Fix a value \( G^* \in (G^{\text{low}}, G^{\text{high}}) \). Assume that in each period, incumbent companies play a grim-trigger strategy that also deters entry: Charge \( \alpha_{P}^{i,t} = \alpha^G \) if and only if \( \alpha_{L}^{i,t} = \alpha_{H}^{i,t} = \alpha^G \), \( l \in \mathcal{I}_0 \), and \( I_{\tau} = \mathcal{I}_0 \) in all periods \( \tau \in \{0, ..., t - 1\} \). Otherwise, charge \( \alpha_{L}^{i,t} = \alpha_{L}^{t} \) and
\[ \alpha^i_H = \alpha^f_H. \] We show that this strategy can support an equilibrium. If a company \( i \in I_0 \) undercuts \( \alpha^G \) in period \( t \), then the definition of \( \alpha^G \), the continuity of \( \alpha \tilde{D}_j(\alpha) \) and the fact that \( G^* > G^{low} \) ensure that \( G^{i,t} < G^* \). Given that no outside company ever enters the market, an incumbent company complies to this strategy if

\[ \frac{1}{N} G^* > (1 - \delta) G^*, \tag{19} \]

which is equivalent to

\[ \delta > 1 - \frac{1}{N}. \tag{20} \]

Note that this condition is independent of \( G^* \). The tie-breaking rule implies that an outside company will never enter if and only if

\[ G^* \leq c. \tag{21} \]

Thus, if \( c \in (G^{low}, G^{high}) \) and (20) holds, then an equilibrium with no market entry, \( G^* = c, \alpha^i_H = \alpha^G \) for all \( i \in I_0 \) and all \( t \) exists and is robust against explicit collusion. ■

The logic of these equilibria is again simple. As incumbent companies play a grim-trigger strategy, they refrain from undercutting the pooling rates or changing their pricing schedule. The punishment is also triggered if an outside company enters the market. Therefore, the period profit is limited to entry costs, otherwise it would pay off for an outside company to enter the market and make a one-shot gain. Therefore, incumbent companies cannot coordinate on insurance premia, such that they earn strictly higher profits.

The upper bound on entry costs, \( G^{high} \), ensures that a period profit equal to \( \frac{1}{N} c \) per incumbent company can be attained by charging a pooling premium. If entry costs are much higher than \( G^{high} \), incumbent companies can increase their profits by explicit collusion and by using their information about insured risks. The lower bound, \( G^{low} \), is needed to make sure that no incumbent company can gain by undercutting the premium for customers with small risk if the period payoff is equal to \( \frac{1}{N} c \) for each incumbent company. If entry costs are lower, incumbent companies could still deter entry by charging low insurance premia, but they would have to use the information about insured risks in some periods, otherwise each incumbent company could gain by one-shot deviation. The measure of admissible values of \( c \) can be substantial: \( G^{low} \) strictly decreases in \( \lambda \) and will be small if \( \pi_H \) is close to \( \pi_L \), while \( G^{high} \) can be large if customers are very risk averse and ready to pay a high risk premium.

The result of Proposition 3 remains valid if incumbents use other punishment strategies to deter market entry or deviation from pooling premia. However, the maximal period
profit for incumbent companies may decrease. Consider, for example, a tit-for-tat strategy where incumbent companies again start to charge profitable pooling premia after a finite number of periods $\tau$ with $\alpha^{i_H}_{\tau} = \alpha^{f}_{H}$ and $\alpha^{i_L}_{\tau} = \alpha^{f}_{L}$ for all $i \in I_0$. Then in an equilibrium with entry-deterrence, the period profit per incumbent company must be lower than $\frac{1}{N}c$. Otherwise an outside company could enter the market, cover its entry costs by capturing the whole market, and participate in future business profitably after the price war has been finished.

4 Discussion

4.1 Equilibrium Selection

An open question remains why the pooling equilibrium has emerged in the first place. One possible explanation is that it may have developed before the revolution in information technologies has enabled insurance companies to collect, analyze and make use of large amounts of information. Another possibility why, historically, information has not been used in insurance markets, are regulatory frameworks that basically prevented competition between insurance companies. To illustrate, before 1994, when the European Commission completed a series of directives in order to remove obstacles to competition, the insurance markets in several European countries such as Germany and Italy were tightly regulated. Considering the use of information in automotive insurance in Germany, risk categories were rather coarse and involved extensive pooling (compare Rees and Kessner 1999), while in Italy, companies were even restricted by law to a very limited number of parameters they could use in their pricing schemes (compare Buzzacchi and Valletti 2005). After deregulation, as a consequence of increased competition, premiums in automotive insurance have undergone large reductions, and at the same time companies introduced contracts with finer risk categorization, compare Rees and Kessner (1999) and Buzzacchi and Valletti (2005). However, in some markets, such as the annuity market in Germany, the companies remain in the equilibrium where contracts are almost not differentiated by risks classes at all.

4.2 Welfare and Policy Implications

The sole existence of unused observables is a signal of anti-competitive behavior in the insurance industry for the regulator. Therefore, the presence of unused observables could be used as a policy tool by competition authorities. Given that consumers are aware of their individual risk, equilibria with unused observables are clearly inefficient: as long as consumers are not forced to purchase full coverage (for example, by regulation), they will
buy too little insurance.

Considering the debate on whether insurance companies should be allowed to gather genetic information or not, there are cases where it might be welfare enhancing if not all information is used to set prices: if customers do not know their individual risk, genetic testing might impose ex-ante a classification risk on potential insurance buyers. However, our analysis shows that there are good reasons for insurance companies not to use genetic information in their pricing schedules: firstly, adjusting pricing schedules without coordination with other companies might trigger a price war. Secondly, using more information only makes sense for companies if profits rise. Companies might refrain from using all additional information in their pricing decisions for fear of market entry.14

5 Conclusion

Recently, several empirical findings have contradicted the predictions of the standard one-shot model of an insurance market. One of them is the puzzle of unused observables, defined as risk-relevant information that is not used by insurance companies in pricing decisions. Our model shows that when insurance companies repeatedly interact in an oligopolistic market, there are equilibria with unused observables. We show that these equilibria may persist even if there is market entry and firms can collude explicitly.

A number of extensions to our model can be made. For example, introducing adverse selection into our model could solve a second puzzle: in competitive insurance markets with asymmetric information, high risk individuals will buy larger quantities of insurance than low-risk individuals. In order for an insurance company to break even, theory predicts that marginal prices should rise with quantity. However, in reality, many insurance companies offer discounts in bulk, compare, for example, Cawley and Philipson (1999). This result could be achieved in our model by dropping the assumption that companies can distinguish between risks. As long as they earn positive profits with all risks, they can maintain a linear pricing schedule (or a schedule with discounts) in equilibrium if they fear a price war after adjusting their contracts.

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14 For an in-depth discussion of this issue consult Polborn et. al. (2006), Strohmenger and Wambach (1999) and the papers cited there.
References


