Insurance Markets When Firms Are Asymmetrically Informed: A Note

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Any imperfections are of course our own.

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Abstract

We examine the welfare effect of the presence of a single well-informed insurance firm in a competitive insurance market populated by uninformed firms. We show that the effect depends on the structure of the market. If competitive insurers rely on the standard self-selection mechanism of a menu of contracts, then the presence of a single well-informed firm which can discriminate costlessly between consumer risk types increases welfare. In contrast, if consumers do not know their risk type, then the well-informed insurer reduces welfare.

Keywords

Insurance Markets, Asymmetric Information, Event Data Recorders

Introduction

Economic analysis of insurance markets has typically assumed that insurers are symmetrically informed about consumers' risk types. However, in many situations, this assumption may not be correct. We examine welfare in competitive insurance markets when one insurer has information about consumer characteristics superior to that possessed by other insurers.

Our study is particularly motivated by the development of Event Data Recorders (EDRs) and GPS systems (collectively referred to as EDRs) which are capable of generating, transmitting, analyzing, and storing data indicative of the risk-type of the individual automobile driver.[3] EDRs can provide real-time data that can be a powerful predictor of the frequency and severity of automobile accidents. Without EDRs, insurance firms must rely on less refined estimates of expected losses which are based on age, gender, and other easily observable characteristics of the driver. With EDRs, insurers can have access to extremely good information about the driving characteristics of insured drivers, including where and when they drive, adherence to posted speed limits, and severe braking incidents. This improved information enables an insurer to differentiate between

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[3] We use the term EDRs to refer to a wide group of technologies that allow insurers to capture data on vehicle usage in real-time in addition to the original usage of EDRs which was the collection of data after an accident occurred.

consumers in regards to their risk type. EDRs can thus substantially mitigate adverse selection, and may also be useful in addressing issues of moral hazard.[4]

EDRs may even allow the insurer to know more about the risk type of the consumer than the consumer knows about himself. Indeed, Chiappori and Salanié (2000, p. 73) note that it is not always true that the consumer has better information about his risk than the insurer. Villeneuve (2005) similarly notes that competitive insurers may possess information about risk superior to that of the insured consumers themselves. He shows that this information may not be perfectly revealed to consumers, and that the resulting allocations will be inefficient.[5] While we consider both the case in which consumers do not know their risk type and the case in which they do, our focus is on the effect on the market equilibrium of a single insurer who is better informed than other insurers.

Barros (1993) briefly noted that a well-informed insurer would be able to earn non-negative profits in a competitive market where some other insurers were not as well-informed of risk types. We extend his analysis by examining efficiency, and by considering how the situation changes when consumers are uninformed about their risk type. It is in this latter case that an interesting welfare result arises, in which the presence of a single well-informed insurer actually leads to an increase in deadweight loss.

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[4] The U.S. Department of Transportation, National Highway Traffic Safety Administration R&D Event Data Recorder Working Group (2001, p. 67) noted that “studies of EDRs in Europe and the U.S. have shown that driver and employee awareness of an onboard EDR reduces the number of crashes by 20 to 30 percent, lowers the severity of such crashes, and decreases the associated costs.”

[5] Chassagnon and Villeneuve (2005) raise the related point that even well-informed consumers might not know how to interpret the information about themselves to correctly infer their risk type.

If neither competitive insurers nor consumers know the consumers' own risk type, pooling is inevitable. The well-informed insurer using EDR technology, however, destroys the pooling equilibrium, leaving high-risk types to other insurers. As we show, this can result in higher premia for both low- and high-risk consumers. In contrast, when consumers are informed about their type, the well-informed insurer can increase the efficiency of the market. These results, we suggest, are not merely of academic interest, given the advent of patented EDR technologies which create informational advantages to the patentee.

If consumers do not know their risk type, adverse selection will not be identified by the econometrician. As found by, among others, Saito (2006) and Dionne, Gouriéroux, and Vanasse (2001), there is little evidence of adverse selection in automobile insurance markets.

Both EDR hardware technology and the business process of using the information generated by EDRs for the pricing of insurance are patented. The business process patents imply (in the absence of legal challenges) that for the duration of the patents, only one insurer can use EDR-generated information regarding consumer risk types for the pricing of automobile insurance.[6]

Although we are particularly motivated by the EDR scenario in which one insurer has superior information, we also think this research applies to other situations in which

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[6] Progressive Casualty Insurance Company has related business-process patents: U.S. Patent Nos. 5,797,134; 6,064,970; 6,868,386, and 7,124,088. Davis Instruments has a patent for an EDR "module for monitoring vehicle operation through onboard diagnostic port," U.S. Patent No. 6,832,141.

insurers are asymmetrically informed. For example, an insurer who has a superior technology for using existing data (data that is available to all insurers) would also have a competitive advantage in identifying risk types.[7] Similarly, an incumbent insurer who has more information on risk types in a population would have an advantage over new-entrant competitive insurers for some duration of time.

Our efficiency results contrast with those of Crocker and Snow (1986), who demonstrated that costless categorical discrimination in insurance markets always improves efficiency and that costly discrimination permits an improvement if the per capita resource cost savings exceed the per capita cost of categorization. The reason for the difference is that Crocker and Snow's competitive model assumes that *all* insurers obtain more information from costless categorical discrimination, while we consider the case in which only *one* insurer is able to costlessly discriminate and become well-informed.

To facilitate reading, we follow the notation of the seminal Rothschild and Stiglitz (1976) model, adding one firm that is well-informed regarding consumer risk type. We consider two different situations: one in which competitive insurers respond to adverse selection with separating contracts, and one in which there is pooling as consumers do not know their own risk type.

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[7] For example, US patent No. 7,240,016 is a "method and apparatus for improving the loss ratio on an insurance program book." It may also be the case that other technologies such as specific genetic tests which are patented may create asymmetric information among insurers.

A Model

An individual has income W if he has no accident. He has income of $W - d$ in case he is unlucky. He can insure himself against the accident by paying a premium α_1, and in case of an accident he will be compensated $\hat{\alpha}_2$ by the insurer. Given insurance, his income is $(W - \alpha_1, W - d + \alpha_2)$ in the case of (no accident, accident), where $\alpha_2 = \hat{\alpha}_2 - \alpha_1$. The vector $\alpha = (\alpha_1, \alpha_2)$ completely describes the insurance contract.

Individual *i*'s expected utility may be described as $(1 - p_i)U(W - \alpha_1) + p_i U(W - d + \alpha_2)$. We will assume that all individuals are identical in all respects except for their probability of having an accident, which may be either p_L or $p_H > p_L$. The proportion of high-risk individuals in the population is $\lambda \in (0,1)$.

Insurers are assumed to be risk-neutral. Thus a contract α when sold to individual *i* has expected value to the firm of $\alpha_1 - p_i(\alpha_1 + \alpha_2)$. Insurers are assumed to have sufficient financial resources so that they are willing and able to sell contracts they expect to be profitable. Further, the market is competitive in that there is free entry. These assumptions, as in Rothschild and Stiglitz, ensure that any contract which is demanded and which is expected to be profitable will be supplied.

Competitive insurers are assumed to know p_H, p_L, λ, *W*, *d*, and the shape of the utility function. However, with the exception of one well-informed insurer, they do not know the accident probabilities of any individual consumer, and hence cannot discriminate on the basis of observable characteristics.

In order to address the well-known equilibrium existence problem in these models, we define equilibrium using the refinement suggested by Wilson (1977). Thus, equilibrium in a competitive insurance market is a set of contracts such that, when consumers choose contracts to maximize their expected utility, (i) no contract in the equilibrium set makes negative expected profits; and (ii) there is no contract outside the equilibrium set that, if offered by some firm *j*, will make non-negative expected profits, subject to anticipated changes in the contracts offered by other firms in response to the contract offered by firm *j*. Thus the equilibrium concept incorporates the notion that firms anticipate the offerings of other firms, and does not permit a firm to offer a contract which is only profitable because other firms have not had an opportunity to change their own contract offers in response to it.

We consider two different situations in this market, one with the standard self-selection mechanism of partial insurance for the low-risk type, and one in which consumers who do not know their different risk-types are offered a pooling contract. In both situations we consider the effect on prices and welfare of the presence of a single well-informed insurer.

Equilibrium with Informed Consumers

In this section, we assume that consumers know their own risk type. The outcome if all insurers are competitive and cannot identify consumer type is well known. Figure 1 replicates the standard diagram, with wealth in the two states of the world, accident and no accident, on the vertical and horizontal axes. A full-insurance contract leaves the consumer on the 45º line regardless of the state of the world. Without insurance, consumers are at point Ω_0, and the fair odds lines, for insurance which is fairly priced, are shown as dotted lines for the two consumer risk types.

As shown in Figure 1, competitive insurers will offer two contracts. High-risk consumers will be offered a full-insurance contract with $\hat{\alpha}_2 = d$ and $\alpha_1 = p_H d$. The contract for high-risk consumers allows them to reach point Ω_H in the diagram. Low-risk consumers will be offered a separating partial insurance contract at fair odds which will be designed to prevent high-risk consumers from accepting the contract. This is at point Ω_S.

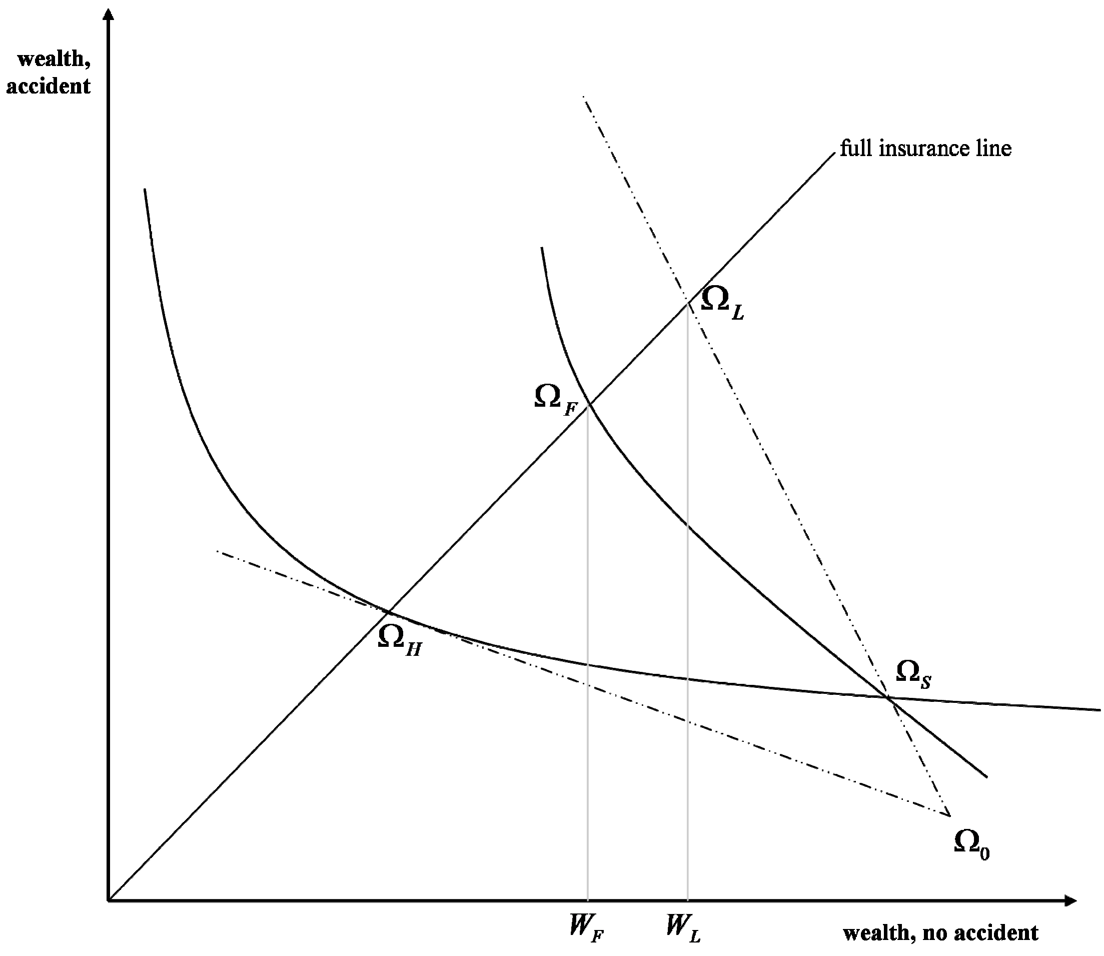

Figure 1

If all insurers had perfect information about consumer type, the competitive outcome would enable all consumers to obtain full information at fair odds. That is, consumers would be offered a contract with $\hat{\alpha}_2 = d$, with a type-dependent premium of $\alpha_1 = p_H d$ for high-risk types and $\alpha_1 = p_L d$ for low-risk types. Low-risk types would thus obtain a contract leaving them at point Ω_L.

We now consider the effect of having only one well-informed insurer who can costlessly identify high- and low-risk types, in an industry with competitive insurers. Since high-risk consumers can buy full insurance at fair odds from competitive uninformed insurers, the well-informed insurer will not be able to earn any profits on them. However, low-risk consumers are obtaining incomplete insurance from the competitive uninformed insurers. Since they are risk averse, it will be possible for the well-informed insurer to offer a profitable contract which is preferred by low-risk consumers. Low-risk consumers will only accept a contract which leaves them at least as well off as the competitive contract, so that it is on or above the indifference curve passing through Ω_S. The most profitable contract meeting this competitive constraint will be on the full-insurance line at point Ω_F. The expected profits for the well-informed insurer are given by the distance between W_L and W_F. (In the case that the informed insurer has higher costs – perhaps owing to the EDR system used in the automobile – the additional cost per insured consumer must be less than or equal to $W_L - W_F$.[8]) Note that the decision to use the EDR technology is

[8] The online list price from Davis Instruments Corporation for a basic automobile EDR, the *CarChip Model 8211*, is $139 per unit (June 2007).

endogenous in this case, with only low-risk consumers using EDRs as a way to demonstrate their risk-type.

From a welfare perspective, the presence of an insurer with superior information is positive. Consumers obtain the same utility in either case; competitive firms earn the same zero profits; but the well-informed firm earns positive profits by providing desired insurance to low-risk consumers.

Equilibrium with Uninformed Consumers

We now turn to the more interesting case in which, in the absence of the well-informed insurer, risk types are pooled. We assume here that consumers have even less information than the competitive insurers: consumers infer their risk from the contracts they are offered, but each does not know his own risk or the distribution of risk-types. This implies that consumer preferences over insurance are not well formed. We assume that consumers prefer to obtain full insurance at the lowest premium. If consumers do not know their own risk, the standard separating contracts are not feasible. We do, however, assume that firms know the distribution of risks.

In a competitive insurance market with no well-informed insurer, lack of information about each consumer's riskiness will lead to a pooling contract: all consumers will be offered the same contract with full insurance at fair odds for the entire group. This pooling contract will have $\hat{\alpha}_2 = d$ and $\alpha_1 = \alpha^P \equiv (\lambda p_H + (1-\lambda) p_L) d$. Consumer preferences are the same for both high- and low-risk types since their expectation of an accident does not differ—they are uninformed. (Indeed, given their knowledge about risk, these consumers's preferences cannot be properly represented by indifference curves:

their preferences are lexicographic along the full-insurance line with lower prices leading to higher utility.)

We now consider the outcome if one of the competitive insurers is well-informed. For the purposes of the model, one could think of this insurer as having already invested in installing EDR technology in all vehicles and collecting relevant data which makes him well-informed about consumers' risk types. This insurer will, of course, be able to discriminate between consumers who would otherwise appear similar, and will selectively cherry-pick the low-risk consumers. The presence of such an insurer undermines any pooling equilibrium as competitive uninformed insurers will be left with only high-risk types and they will have to offer a contract which is suitable for only high-risk types. This contract will offer full-insurance at fair odds for high-risk consumers, who will thus end up at Ω_H. In this case, the informed insurer will be able to offer a contract for low-risk consumers with $\hat{\alpha}_2 = d$, and $\alpha_1 = p_H d - \varepsilon$, i.e. at a price which is epsilon less expensive than the contract offered to high-risk types; thus low-risk consumers will obtain virtually the same contract as high-risk consumers.

This will be the only equilibrium outcome: while offering a pooling contract at a point on the full-insurance line above Ω_H would be profitable for competitive firms if they could attract both high- and low-risk consumers, this is not an equilibrium outcome given the Wilson equilibrium refinement, since uninformed insurers would anticipate the well-informed insurer to react by offering a slightly less expensive contract to low-risk types only. A necessary condition for the existence of this equilibrium is that the epsilon-cheaper insurance policy is not informative to the low-risk consumer.

It is important to understand why the slightly cheaper insurance policy need not be informative to the consumer. First, the consumer may not know that the informed insurer is informed about the consumer's risk. He may believe that the slightly lower premium offered by that insurer is because of some extraneous factor, such as a different appetite for new business on the part of that insurer. Second, even if the consumer knows that that insurer has different information, he may not be able to make an inference about risk: it is still possible that information of that insurer is only different and not better. Finally, since the consumer does not know the distribution of risk-types in the world, he is unable to make an appropriate inference about his own risk on the basis of an epsilon-lower premium. One interpretation of a *slightly* lower premium is that he may be a *slightly* better driver than average. Unless he has information about the distribution of risk types or of offers made to consumers, he cannot infer that he must be a "low-risk" individual. And even if he were informed about the distribution of offers made to consumers, his inference would be limited to knowing that his risk-type was an unknown amount lower than that of the consumers who obtained the higher-priced offer. In this equilibrium, the epsilon-lower price is the same no matter how large the difference between the two risk types, and so an epsilon-lower offer does not indicate anything about the magnitude of the difference between risk types.

As a corollary, uninformed insurers cannot learn consumer risk types if consumers are not informed of their type by the epsilon-different price that they pay. Uninformed insurers cannot learn consumers' types by market observation either—they cannot verify that the low-risk consumer does pay epsilon less since, if uninformed insurers are willing to offer lower premia to consumers who have a low-priced offer from the informed insurer, it is in every consumer's interest to claim that he has received such an offer.[9]

The effect on welfare of the presence of the well-informed insurer is negative. All consumers are worse off because they pay higher premia, but still obtain the same amount of insurance. The well-informed insurer, however, makes profits by charging a super-competitive price to low-risk types. To help illuminate the effects on welfare, we consider how the change in pricing affects deadweight losses in Figure 2.

The upper two panels of Figure 2 show aggregate demand curves for automobile insurance assuming competitive insurers only. The marginal cost of providing insurance to high- and low-risk types is given by $p_H d$ and $p_L d$, and the pooling price of insurance is α^P. This pooling price leads to deadweight losses for high- and low-risk markets, shown by areas *A* and *B* respectively. (In the context of automobile insurance, one can think of these deadweight losses as though some high-risk consumers participate in this market because their insurance is subsidized, while some low-risk consumers do not because of excessively expensive insurance.)

[9] Even if the uninformed insurer were to receive a copy of the consumer's supposed policy, he could not verifiably assume that the pricing stated on the policy is correct as consumers would have an incentive to falsify the information that they purport to be their policy.

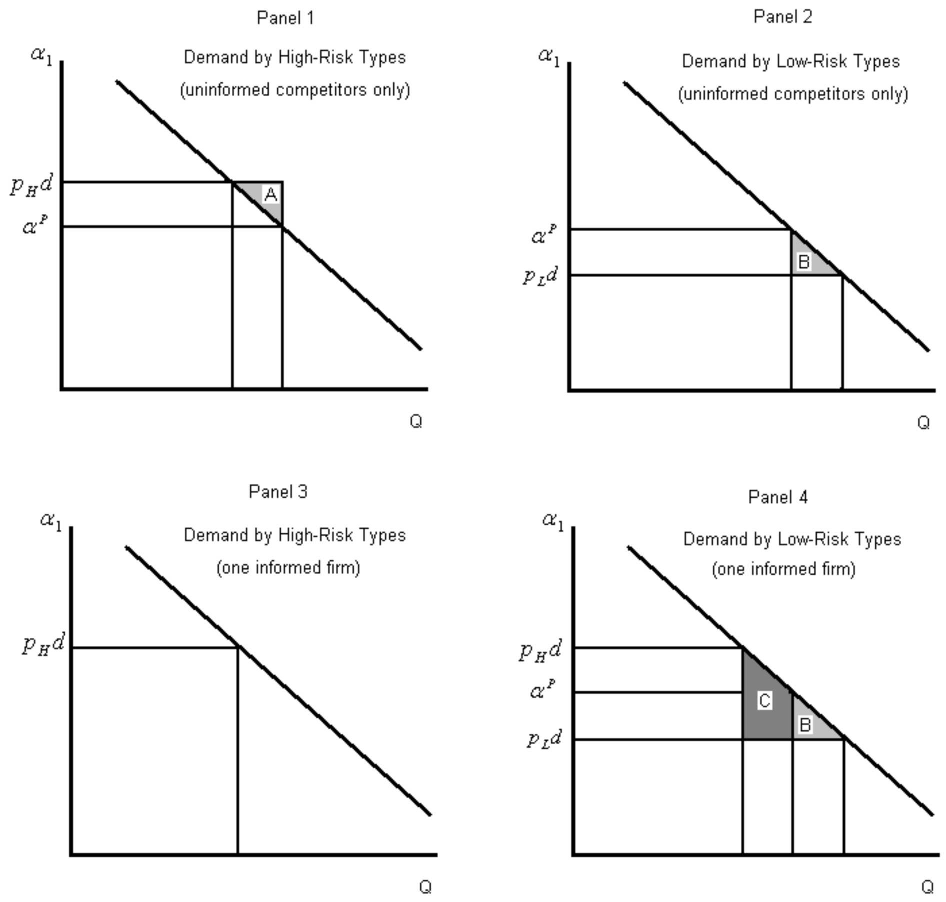

Figure 2

The lower two panels of Figure 2 show the situation given the presence of a well-informed insurer. High-risk consumers obtain a price of $p_H d$ for full insurance, and deadweight loss area A is thus eliminated. Low-risk consumers, however, face an even larger distortion than before, the sum of areas B and C, as shown in Panel 4.

The presence of a single well-informed insurer thus results in increases and decreases in efficiency in different components of the market. Deadweight loss caused by the underpricing of insurance to high-risk individuals is eliminated, causing an efficiency gain equal to $\lambda\int_{q(p_H d)}^{q(\alpha^P)}[p_H d - p(x)]dx$. (This is area A in Panel 1, Figure 2 above.) However, the deadweight loss caused by the overpricing of insurance to low-risk individuals is aggravated, causing an efficiency loss of $(1-\lambda)\int_{q(p_H d)}^{q(\alpha^P)}[p(x) - p_L d]dx$. (This is area C in Panel 4, Figure 2 above).

Thus, the net efficiency effect is given by the expression $\int_{q(p_H d)}^{q(\alpha^P)}[\lambda p_H d + (1-\lambda)p_L d - p(x)]dx$. When $\lambda = 1$, this is equal to zero. Since the derivative of this expression with respect to λ is the positive product $(p_H d - p_L d)[q(\alpha^P) - q(p_H d)] > 0$, the net efficiency effect of the informed insurer must be negative for all $\lambda < 1$.

It is worth emphasizing that the negative efficiency effect holds only for the case in which a single insurer is well-informed. If all insurers were well-informed, all consumers would obtain full insurance at actuarially fair prices, leading to the efficient outcome.

Conclusion

This brief paper has considered the effect of having a single well-informed insurer in a competitive insurance market. While if all insurers are well-informed, there is an increase in efficiency in the market, the same is not necessarily true if only one insurer is well-informed.

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