Separating equilibria in insurance markets: A new theoretical perspective

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Abstract

The objective of this paper is to prepare the theoretical ground for more ample research into the behavior of consumers and insurance companies in the presence of adverse selection. As noted by Mimra and Wambach (2014), there has been little progress in testing the importance of adverse selection and the prevalence of separating vs. pooling equilibria. The proposed way forward is to model consumers in their search for maximum coverage at a given premium and insurers in their effort to stave off high risks (and attract low ones). Reaction functions are derived for the two players giving rise to Nash equilibria in efforts space, which typically are separating between high and low risks. These equilibria are then projected into the wealth level space of the Rothschild-Stiglitz (1976) model. Moreover, displacements of the Nash equilibria due to (i) community rating of premiums, (ii) provision of information to consumers free of charge, and (iii) learning from loss experience by insurers are used to extend the set of empirically testable predictions beyond conventional approaches.

Keywords: Adverse selection; Separating equilibria; Insurance; Consumer search; Selection effort

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1. Introduction and motivation

Ever since the seminal article by Rothschild and Stiglitz (1976), hereafter abbreviated as RS, economists and policy makers have worried about the effects of asymmetric information on insurance markets. Since an equilibrium pooling high and low risks cannot be sustained according to RS, an insurance company (IC henceforth) enrolling both types can be challenged by a competitor who launches a policy with limited coverage but a low premium that attracts low risks only. However, the challenger may in turn lose its favorable risks to still another IC, raising the scepter of a 'death spiral' in insurance markets. The objective of this paper is to prepare the theoretical ground for more ample research into the behavior of consumers and ICs in the presence of adverse selection. As noted by Mimra and Wambach (2014), there has been little progress in testing the importance of adverse selection. The innovation is to introduce costly search effort on the part of consumers and risk selection effort on the part of the IC. Nash equilibria for high and low risks are derived and found to be generally of the separating type. Their displacements in response to several exogenous changes can be used to generate a number of new testable predictions. Nash equilibria and their displacements can be projected from efforts space into the wealth levels space of the RS model, generating several new predictions once again.

The next section contains a literature review covering both the theoretical and the remarkably smaller body of empirical research devoted to extending and testing the RS paradigm. In Section 3, a simple game-theoretic model is developed to determine the Nash equilibria for high and low risks in efforts space and project them into the wealth levels space of the RS model. Three exogenous changes causing these equilibria to be displaced are introduced in Section 4, viz. premium regulation in the guise of community rating, free provision of information to consumers, and learning from loss experience by insurers. Section 5 presents a comparison of the predictions derived from the present approach with those of the conventional RS model and mentions a possibility for obtaining discriminating evidence.

2. **Review of the literature**

In 1976, RS presented a static model of a market for insurance, which relaxed the assumption of homogeneous accident probabilities and costless information. High- and low-risk consumers exist and possess private information regarding their risk type. RS hypothesized the possibility of a separating equilibrium, where high and low risks accept different premium-coverage contracts. The concept of non-linear pricing without cross-subsidization challenged earlier models of insurance markets with linear pricing, making policyholders pay the same average price for insurance and resulting in cross-subsidization (Arrow, 1970; Pauly, 1974).

Much of the analysis that has followed has used game theory to precisely define the nature of the interaction between insurance companies and customers (Rothschild and Stiglitz, 1997). Immediately after publication of RS, a number of theoretical papers sought to demonstrate the existence of an equilibrium in insurance markets by including IC behavior in their models (Jaynes, 1978; Riley, 1979; Spence, 1978; Wilson, 1977).[1]

Wilson (1977) stated that while no equilibrium may exist if the IC has static expectations of challenger ICs, a pooling equilibrium can exist if expectations can be revised. Spence (1978) extended Wilson's (1977) analysis to include a contract of menus, and showed an equilibrium with separating, cross subsidizing contracts. Riley (1979) posited that if a challenger IC can respond with a new contract, a separating equilibrium is possible. Engers and Fernandez (1987) generalize Riley's (1979) reactive equilibrium to allow a game whereby multiple new contracts may be added to the market. Jaynes (1978) relaxes the assumption that contracts are exclusive and allows ICs to cooperate. Firms that share information may offer a pooling contract while firms that do not share information may underwrite contracts for high-risk policyholders.

[1] Mimra and Wambach (2014) provide an excellent summary of the literature that has reviewed RS (1976).

Hellwig (1987) first casts the RS model in the mold of a two-stage game where in the first stage uninformed ICs offer contracts and in the second stage, informed consumers choose contracts. He then adds realism to the model by including a third stage, where ICs can reject consumers' applications; in contradistinction to Wilson (1977), loss-making contracts are not signed to begin with, resulting in a sustainable pooling equilibrium. Hellwig (1987) notes quite generally that the exact formulation of the game may change predictions substantially.

Asheim and Nilssen (1996) vary the conditions of the game by allowing ICs to renegotiate contracts with their policyholders, such that the revised contract is made universally offered to all policyholders, while Netzer and Scheuer (2014) allow the IC to exit from the market altogether. Both models predict a separating equilibrium.

Although an evolving theoretical literature has sought to test the conclusions of RS by developing new game-theoretic models of markets for insurance, empirical analysis is rare. In their review of developments in adverse selection Mimra and Wambach (2014) have stated,

> [c]uriously, although there is by now a substantial empirical literature investigating whether adverse selection is prevalent and important in insurance markets[2], the question of whether the allocation in these markets is of the RS-type or the Miyazaki-Wilson-Spence (MWS) type has so far been neglected. (p. 15)

Indeed, there seem only two research papers that have tested for evidence of a separating equilibrium in a market for insurance. The first, written by Dionne and Doherty (1994), importantly introduces experience rating into the RS model. They model the effect of semi-commitment with renegotiation (defined as insurance with an option to renew with pre-

[2] For example, in markets for health insurance empirical research has reported that ICs are able to control adverse selection (Pauly et al 2007; Marton et al 2015). However, empirical evidence of a "death spiral" was reported by Cutler and Reber (1998), in comprehensive health insurance coverage sponsored by Harvard University within two years of the subsidy was removed. Frech III and Smith (2015) also find evidence suggesting a 'death spiral'; however, the spiral moves so slowly as to give ICs plenty of time to withdraw loss-making contracts.

specified conditions) and contrast its implications with single-period and no-commitment, models. Under competitive conditions, they propose that an IC would offer a pooling policy with partial coverage in the first period and an experience-rated, separating set of policies in the second period. They test their theoretical predictions using aggregated Californian automobile insurance data.

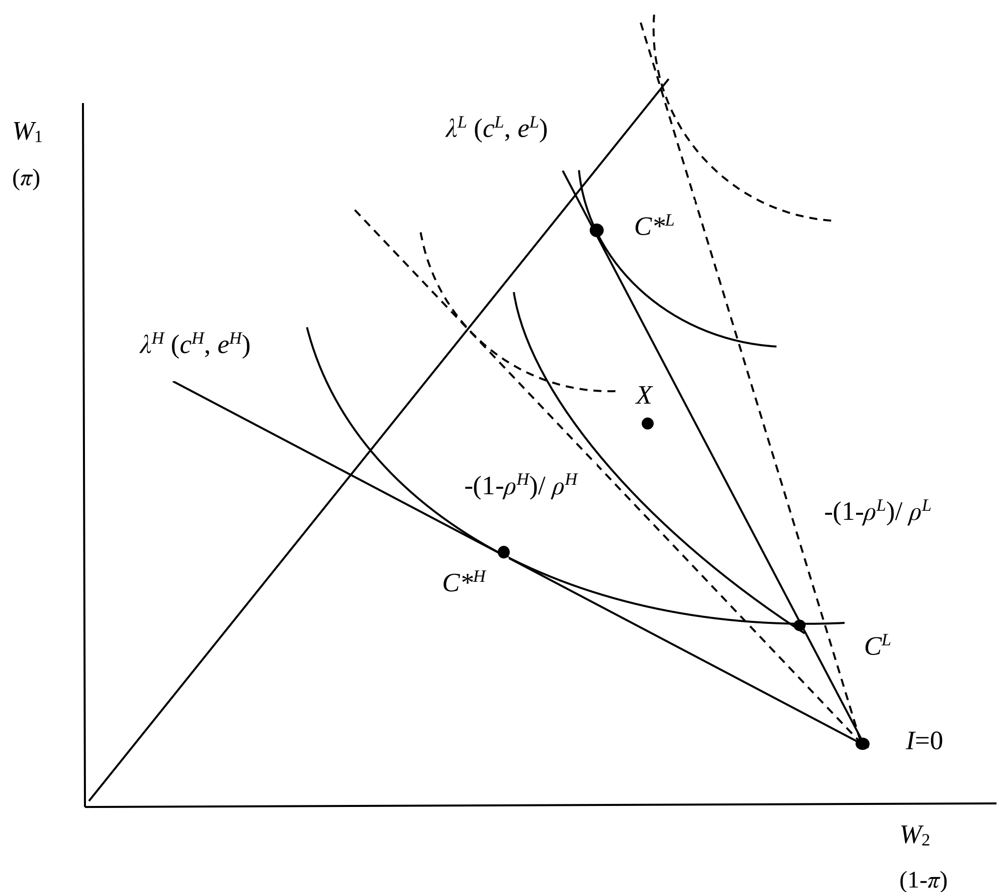
The second paper, by Puelz and Snow (1994), uses claims data from an automobile crash insurer to test whether there was adverse selection and if so, whether the equilibrium was of the pooling or separating type. Despite some criticism [Chiappori (1999), Chiappori and Salanié (2000), Dionne et al. (2001)], this paper still offers the best empirical test of the proposition contained in the RS paradigm.

As found by Mimra and Wambach (2014), the verdict on the importance of adverse selection and the prevalence of separating vs. pooling equilibria is not out yet. This may motivate a new theoretical perspective, to be expounded below. However, the RS paradigm is first presented as the benchmark. Premiums contain proportional loadings throughout for added realism. To avoid overburdening, the indifference curves are not labelled in the figures; as always, they are defined as a locus of constant expected utility.

Figure 1 thus displays the familiar fair insurance lines with slopes $-(1-\rho^H)/\rho^H$ and $-(1-\rho^L)/\rho^L$, respectively (dashed because they neglect proportional loading, which is common in insurance). Here, $\rho^H > \rho^L$ symbolizes the probability of loss. Actual insurance lines reflecting loadings are labelled $\lambda^H(c^H, e^H)$ and $\lambda^L(c^L, e^L)$, respectively, with $\partial\lambda^H / \partial c^H > 0, \partial\lambda^H / \partial e^H > 0$ and $\partial\lambda^L / \partial c^L > 0, \partial\lambda^L / \partial e^L > 0$, for future reference. Both consumer search (c^H, c^L) and IC's selection effort (e^H, e^L) cause administrative expense that needs to be covered by the premium [for the formula of these insurance lines, [see eq. (8) below, taken from Zweifel and Eisen (2012), ch. 3.3.1]. Also, $\lambda^H > \lambda^L, \forall\, c^H, e^H, c^L, e^L$ since the loading imposed on the high risks typically exceeds that for the low risks.

There are two major reasons for this. First, each loss triggers some administrative expense, causing the loading to increase with the probability of loss. Second, high risks are characterized not only by a high expected value but also by variance of loss, which calls for holding costly extra capital reserves for maintaining solvency. The incumbent IC therefore offers a pair of contracts resulting in the optimum C^{*H} for the high risks and the rationed contract C^{L} for the low risks (their true optimum would be C^{*L}, with a higher degree of coverage). Depending on the share of low risks in the population and their degree of risk aversion in the neighborhood of C^{L}, a challenger can attract them by offering a contract such as the one symbolized by point *X*. The challenger's endeavor induces a positive partial correlation between the status of 'low risk' and degree of coverage. To the extent that high-risk status causes a high loading that in turn induces a reduction in coverage [see eq. (8) below], it results in a negative partial correlation between it and the degree of coverage.

Figure 1. Separating equilibrium in the RS model



Prediction 1. In the presence of a proportional loading and a perfect indicator of risk type, the separating equilibrium in the RS model is characterized by a positive partial correlation between the indicator of low risk and the degree of coverage and a negative partial correlation between the indicator of high risk and the degree of coverage.

However, the actual launch of separating contracts requires a stepwise procedure. First, the IC offers a policy with a relatively high degree of coverage (full coverage in the case of fair premiums) combined with a high premium. Consumers who purchase this policy are identified as high risks. Next, it launches a contract with very limited coverage but favorable premium designed to attract low risks.

To counter the threat of a challenger with its contract X, the IC keeps increasing coverage until its original customers begin to migrate away from their contracts. This defines point C^L. Alternatively, the search procedure may involve separate geographic markets, particularly in federated countries where insurance is regulated at the state level. The IC may launch the two contracts simultaneously in regions A and B, followed by an increase in coverage in the one in B designed to attract the low risks. It reaches point C^L as soon as customers from region A begin to apply for a contract in region B.

3. **A game-theoretic model**

In this section, a simple game-theoretic model is developed to determine Nash equilibria for high and low risks in effort space, which are then projected into wealth levels space. Starting in efforts space takes account of costly consumer search, which is implicit in the RS model (otherwise, there would be no risk of high risks infiltrating the contract designed for the low ones). It also permits to integrate risk selection effort on the part of the IC (developing contract variants is a costly activity). In the present model, search effort and risk selection effort are the decision variables controlled by the respective players.

3.1 Consumers

Consumers are seen as expected utility maximizers who undertake search effort for securing a maximum amount of coverage at the going premium, which they view as exogenous.

$$\underset{c}{EU}^{H}=\rho^{H}\upsilon^{H}\left[W_0+I^{H}(c,e)-L-P^{H}\right]+\left(1-\rho^{H}\right)\upsilon^{H}\left[W_0-P^{H}(c)\right]-c \qquad (1a)$$

$$\underset{c}{EU}^{L}=\rho^{L}\upsilon^{L}\left[W_0+I^{L}(c,e)-L-P^{L}\right]+\left(1-\rho^{L}\right)\upsilon^{L}\left[W_0-P^{L}(c)\right]-c \qquad (1b)$$

Here, EU^{H} (EU^{L}) denotes expected utility, $\upsilon^{H}\left(\upsilon^{L}\right)$, VNM risk utility functions with $\upsilon^{H'}>0\left(\upsilon^{L'}>0\right)$ and $\upsilon^{H''}<0\left(\upsilon^{L''}<0\right)$, W_0 , exogenous initial wealth, $I^{H}(c)$ $[I^{L}(c)]$ which depends on search effort c with $\partial I^{H}/\partial c>$ $\partial I^{L}/\partial c>0$ (superscripts are omitted wherever possible). The ranking of derivatives can be justified by noting that the premium for the high risk is higher than for the low risk, causing search for a favourable policy to have a higher marginal return. For simplicity, search effort by consumers is assumed to have unit cost of one. However, insurance coverage also depends on the insurance company's (IC's) selection effort e, with $\partial I^{H}/\partial e<0$ but $\partial I^{L}/\partial e>0$, reflecting the IC's attempt to prevent high risks from having excess coverage while offering low risks as much coverage as possible to attract them. Finally, P^{H} (P^{L}) symbolizes the respective premium paid, with $P^{H}>P^{L}$ in view of the loadings included.

The first-order conditions for an interior optimum are given by

$$\frac{dEU^{H}}{dc}=\rho^{H}\upsilon^{H'}\cdot\left[\frac{\partial I^{H}(c,e)}{\partial c}\right]-1=0 \qquad (2a)$$

$$\frac{dEU^{L}}{dc}=\rho^{L}\upsilon^{L'}\cdot\left[\frac{\partial I^{L}(c,e)}{\partial c}\right]-1=0 \qquad (2b)$$

Note that unless the derivatives of the utility and $I(c,e)$ functions differ substantially (for which there is no apparent reason), the high risks are predicted to undertake more effort than the low ones since $\rho^H > \rho^L$, indicating that the marginal benefit of search is higher for them.

Now introduce an exogenous shock $d\alpha > 0$, with $d\alpha$ symbolizing one of the changes to be specified below. In the case of eq. (2a) e.g., this gives rise to the comparative static equation (applying the implicit function theorem),

$$\frac{\partial^2 EU^H}{\partial c^2} dc + \frac{\partial^2 EU^H}{\partial c \partial \alpha} d\alpha = 0$$

which can be solved to obtain

$$\frac{dc}{d\alpha} = -\frac{\partial^2 EU^H / \partial c \partial \alpha}{\partial^2 EU^H / \partial c^2} \tag{3}$$

Since $\partial^2 EU^H / \partial c^2 < 0$ in a maximum, the sign of $dc / d\alpha$ is determined by the sign of the mixed second-order derivative, $\partial^2 EU^H / \partial c \partial \alpha$. In deriving the predictions below, any impact on $\partial^2 EU^H / \partial c^2$ in eq. (3) is neglected because it must be minor, lest $\partial^2 EU^H / \partial c^2$ change signs, turning a maximum into a minimum.

One such shock is an increase in IC's selection effort. Applying eq. (3), one obtains

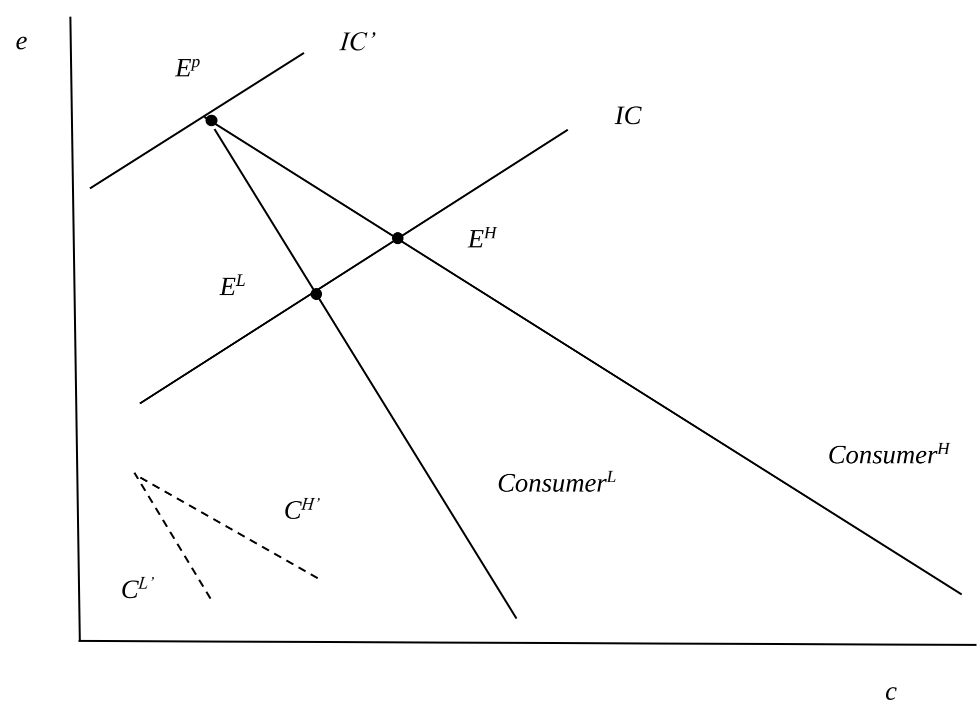
$$\frac{dc^H}{de} \approx \frac{\partial^2 EU^H}{\partial c \partial e} = \rho^H \left[\upsilon^{H''} \frac{\partial I^H}{\partial c} + \upsilon^{H'} \frac{\partial^2 I^H}{\partial c \partial e} \right] < 0 \tag{4a}$$

$$\frac{dc^L}{de} \approx \frac{\partial^2 EU^H}{\partial c \partial e} = \rho^L \left[\upsilon^{L''} \frac{\partial I^L}{\partial c} + \upsilon^{L'} \frac{\partial^2 I^L}{\partial c \partial e} \right] < 0 \tag{4b}$$

Since it can be realistically assumed that the marginal effectiveness of consumer search is lowered by the IC's selection effort, implying $\partial^2 I^H / \partial c \partial e < 0, \partial^2 I^L / \partial c \partial e < 0$. Regardless of risk type, consumers are made to provide additional information, which burdens them with additional transaction cost when searching for a favorable policy.

The two type-specific reaction functions are shown in Figure 2. They are drawn as straight lines since nothing can be said about the third derivatives of the functions $I^H(c,e)$ and $I^L(c,e)$. Note that as long as the second derivatives appearing in eqs. (4a) and (4b) are of similar magnitude, the reaction function for the high risk reacts more markedly to e than that for the low risk because $\rho^H > \rho^L$, causing it to run flatter in Figure 2. However, it runs farther out in the relevant domain because the respective probabilities are multiplied with first-order derivatives in eqs. (2a) and (2b), which must dominate the second-order ones lest they change sign from positive to negative, contradicting assumptions.

Figure 2. Reaction functions and Nash equilibria



3.2 Insurers

Insurers are viewed as expected profit maximizers,

$$\underset{e}{E\prod} = \pi(e)[P^{H} - C^{H}(c)] + (1-\pi(e))[P^{L} - C^{L}(c)] - e \qquad (5)$$

with $E\Pi$ denoting expected profit, $\pi(e)$, the probability of enrolling a high risk depending on risk selection effort e (at unit cost of one for simplicity) with $\partial\pi/\partial e < 0$ and $\partial\pi^{2}/\partial e^{2} > 0$ indicating decreasing marginal effectiveness, P^{H} (P^{L}) premium income from a high (low) risk, and $C^{H} = I^{H} + A^{H}$ $(C^{L} = I^{L} + A^{L})$ covered loss plus administrative expense pertaining to a high (low) risk. This cost (expressed as a proportional loading in Section 2) depends positively on risk selection effort by consumers c (with $\partial^{2}C^{H}/\partial c^{2} > 0$ and $\partial^{2}C^{L}/\partial c^{2} > 0$) which not only drives up insurance coverage [see eqs. (1a) and (1b)] but also administrative expense, e.g. in the guise of documentation and explanation effort by sales agents. The first-order condition for an interior optimum reads,

$$\frac{dE\Pi}{de} = \partial\pi/\partial e \cdot \left\{\left[P^{H} - C^{H}(c)\right] - \left[P^{L} - C^{L}(c)\right]\right\} - 1 \qquad (6)$$

This shows that selection effort has a positive marginal return only if the margin on the high risks [$P^{H} - C^{H}(c)$] is smaller than that on the low risks [$P^{L} - C^{L}(c)$]. The difference between the two margins is particularly marked if $P^{L} - C^{L}(c)$ is negative, as is often the case under community rating. Conversely, perfect risk rating of premiums in competitive markets would result in equality of margins, zero marginal return to risk selection effort, and hence no risk selection effort (Pauly et al., 2007).

Now let this optimum be disturbed by an increase in consumers' search effort. The solution to the comparative-static equation is given by

$$\frac{de}{dc} \approx \frac{\partial^2 E\Pi}{\partial e \partial c} = \partial\pi / \partial e \cdot \left[-\frac{\partial C^H}{\partial c} + \frac{\partial C^L}{\partial c} \right] > 0 \qquad (7)$$

in view of the ranking below eq. (1b). The IC's reaction function is depicted in Figure 2; it is drawn linear for simplicity because on the one hand $|\partial\pi / \partial e|$ decreases with e, implying a decreasing slope; on the other hand, $\partial^2 C^H / \partial c^2 > \partial^2 C^L / \partial c^2$ is also a possibility, implying an increasing slope.

Prediction 2. The interaction of consumers searching for maximum coverage given the premium and the risk-selecting insurer is predicted to result in a Nash equilibrium (if it exists) characterized by high consumer search and selection effort for high risks and low consumer search and selection effort for low risks.

Clearly, E^H and E^L are separating equilibria in efforts space; however, neither need exist. All it takes is a very low search effort on the part of consumers as indicated by the two dashed lines marked $C^{H'}$ and $C^{L'}$ combined with substantial risk selection effort on the part of the insurer, as indicated by the line labelled *IC* in Figure 2.

In addition, equilibria need not be separating, even in the presence of search effort by consumers and selection effort by insurers. Indeed, equilibrium E^p where the two consumer reaction functions intersect is of the pooling type (again, in efforts space). It is characterized by little search effort by consumers but substantial selection effort by insurers (equilibria beyond E^p can be excluded because they contradict first-order conditions (1a) and (1b) predicting that high risks exert more effort than low ones). However, the likelihood of a pooling equilibrium occurring is low since three reaction functions have to intersect at the same point.

The Nash equilibria of Figure 2 can be projected into the (W_1, W_2)-space used by RS as follows (for simplicity, the insurance lines pertaining to fair premia are not shown). High risks are predicted to make relatively much effort to seek out the contract that gives them the maximum coverage at the going premium. However, the IC in turn is predicted to undertake relatively much risk selection effort. Taken together, these efforts result in a high loading causing a reduction of coverage; on the other hand, high risks are particularly keen to obtain a high degree of coverage. The location of their optimum C^{*H} in Figure 2´ ultimately depends on five parameters about which little is known, $\partial I^H / \partial c, \partial I^H / \partial e, \partial \pi / \partial e, \partial \lambda / \partial c$, and $\partial \lambda / \partial e$.

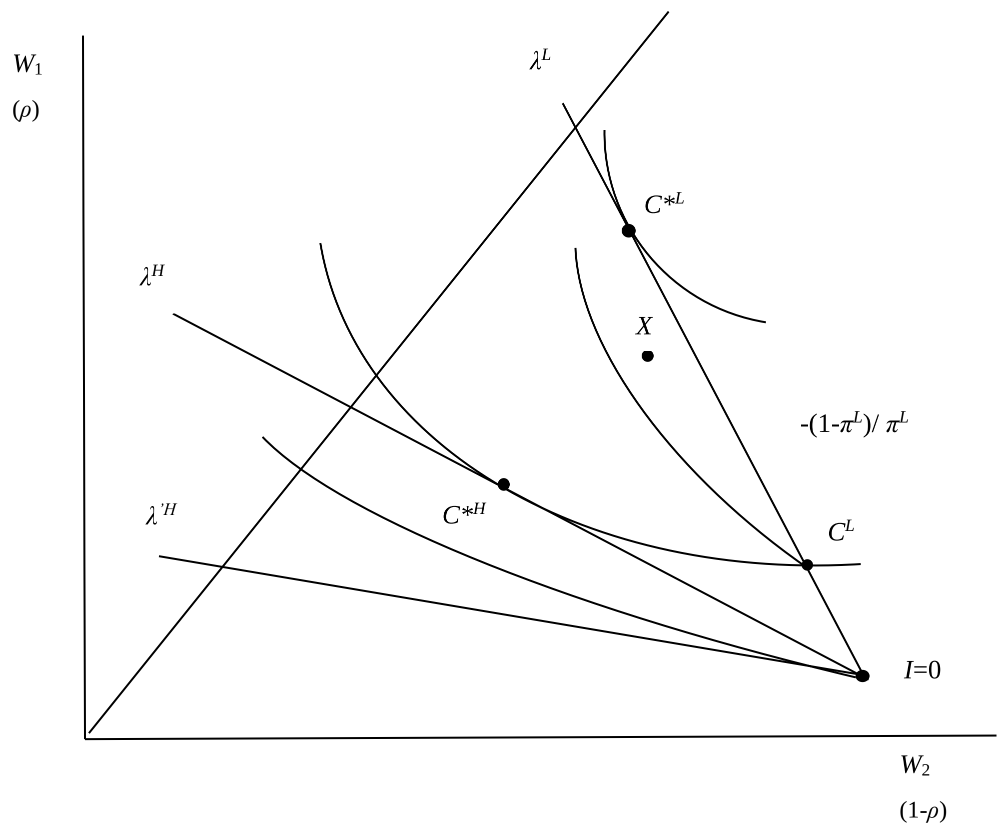
These efforts may even drive up the loading to such a high value [insurance line labelled (λ'^H) in Figure 2´] that the point $I = 0$ dominates all points on the insurance line, causing high risks to go without insurance coverage altogether. The outcome is an extreme case of separating equilibrium, not to be discussed any further. Indeed, the IC may shy away from it by cross-subsidizing the high-risk premium, fearing an outcry of public opinion about high risks being unable to obtain insurance coverage.

A less risky alternative that does not seem to have been discussed in the literature is to counter the threat of high-risk consumers infiltrating the contract designed for the low-risk ones by limiting choice. The IC can accommodate high-risk consumers by offering them comparatively high coverage but making it a take-it-or-leave-it offer. Thus, anyone who chooses a contract on the insurance line labelled λ^H is categorized as a high risk who is not allowed to opt for a reduced amount of coverage in later periods or different states of the country.

In Figure 2, both the low risks and the IC are seen as exerting comparatively little search and risk selection effort, respectively. This keeps the loading $\lambda^L(c^L, e^L)$ low, a welcome effect for the incumbent IC in view of the potential challenge by a contract such as X in Figure 2´.

Prediction 2´. The interaction of consumers searching for maximum coverage given the premium and the risk-selecting insurer is predicted to result in a Nash equilibrium (if it exists) that has the same correlation properties as those described in Prediction 1. In addition, the degree of coverage of the high risks is below that of the low ones.

Figure 2´. Projecting Nash equilibria into (W_1, W_2)-space



The last statement of Proposition 2´ follows from eq. (3.29) in Zweifel and Eisen (2011), where the ratio of marginal utilities is given by

$$\frac{\upsilon'[2]}{\upsilon'[1]} = \frac{1/(1+\lambda)-\rho}{1-\rho} < 1 \tag{8}$$

Since the marginal utility of wealth is lower in the no-loss state than in the loss state, wealth in the no-loss state must be higher, indicating that a proportional loading causes less than full coverage to be optimal. Using eq. (8) for a high and a low risk with $\rho^H > \rho^L$ and $\lambda^H > \lambda^L$, respectively and dividing through shows that the resulting ratio has a value below one, implying that the degree of coverage is comparatively low for a high risk.

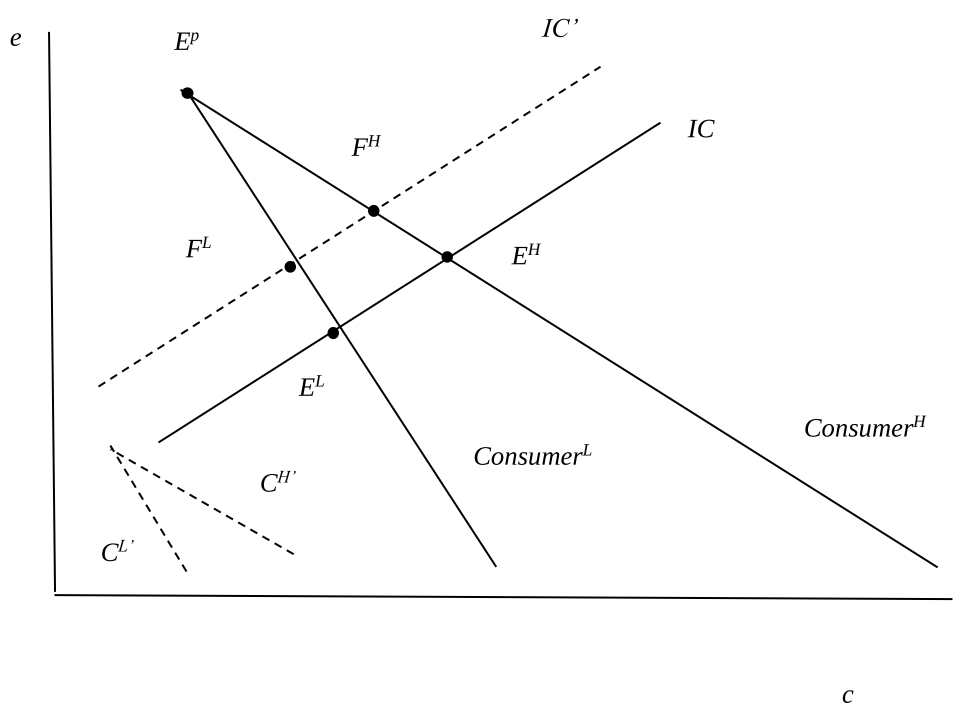
4 Displacements of Nash equilibria

In this section, three exogenous changes are introduced which displace the Nash equilibria in a way that is amenable to empirical testing, viz. premium regulation in the guise of community rating, free provision of information to consumers, and learning from loss experience by insurers.

4.1 Community rating of premiums

Community rating is a type of premium regulation designed to equalize premiums for high and low risks. Denote by Δ the difference in margins in eq. (6) and by r, the stringency of regulation, with $\partial\Delta/\partial r < 0$; in analogy to (5), one has

Figure 3. Displacements of equilibria due to community rating of premiums



$$\frac{de}{dr} \approx \frac{\partial^2 E\Pi}{\partial e \partial r} = \partial\pi / \partial e \cdot \left[\partial\Delta / \partial r\right] > 0 \tag{9}$$

Comparison of equilibria F^H with E^H and F^L with E^L, respectively in Figure 3 leads to

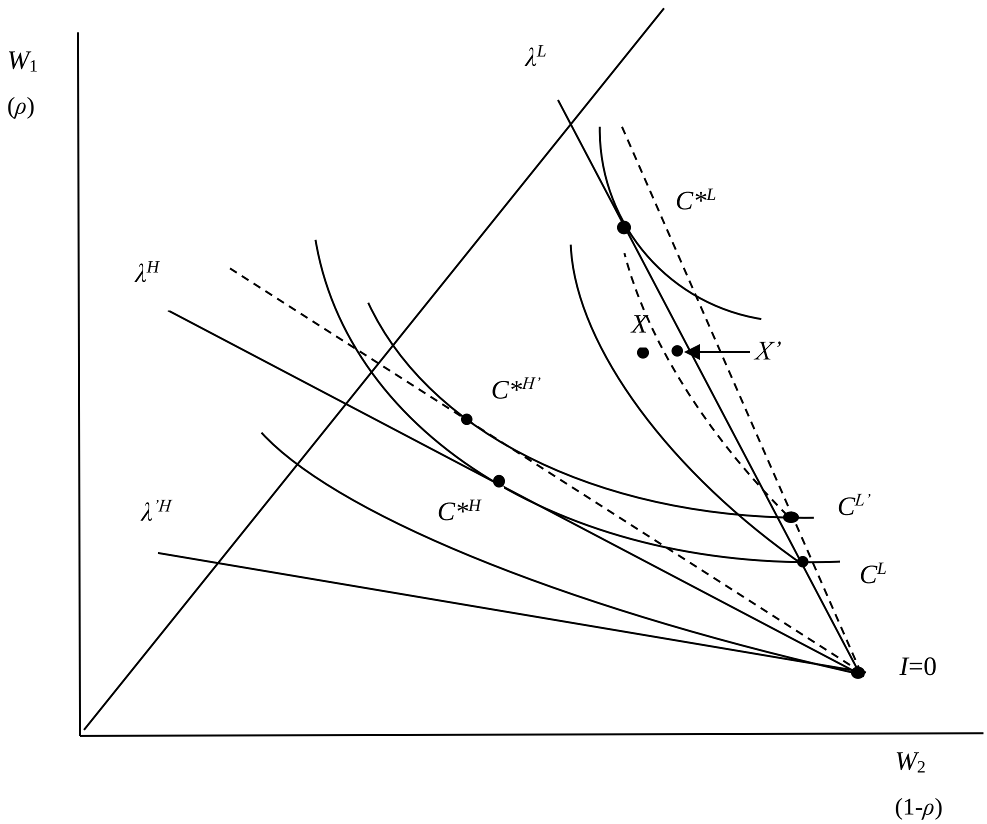
Prediction 3. Regulation designed to reduce the difference between premiums such as community rating is predicted to reduce search on the part of consumers especially among high risks, but increase selection effort on the part of insurers especially with regard to low risks.

Note that the equilibria move towards the pooling equilibrium E^p, which therefore could potentially come about without regulation.

Again, this prediction can be projected into (W_1, W_2)-space as follows (see Figure 3´). High-risk consumers are predicted to greatly scale back their search effort *c*. This lowers the IC's loading; at the same time however, the IC is predicted to step up its selection effort somewhat. The net effect on the loading depends on the relative marginal effectiveness of these efforts. Assuming them to be of comparable magnitude, one is lead to conclude that the loading contained in the premium paid by high risks decreases slightly. They therefore shift to $C^{*H\prime}$, where they enjoy an increased degree of coverage [see eq. (8) above, which establishes a negative relationship between the degree of coverage and a proportional loading].

As to the low-risk consumers, they are predicted to decrease their search effort too (but to a lesser extent than the high-risk ones), combined with a greater effort on the part of IC to attract them. The net result likely is again a slight decrease in their loading. The combined effect is a movement from point C^L to $C^{L\prime}$. Note that the challenging IC is also confronted with increasing search effort by low-risk consumers and will engage in more selection effort as well. Therefore, it has to charge a higher loading as well, causing its contract to move from point *X* to *X´*, with the possible consequence of not being attractive to low risks anymore.

Figure 3´. Projecting the effect of community rating into (W_1, W_2)-space



In sum, the conclusion suggested by Figure 3 that the separating equilibria move closer together is not necessarily vindicated in Figure 3´ in that the distance between $C^{*H´}$ and $C^{L´}$ may actually increase. Moreover, the challenger may benefit from the reduction in loading as much as (or even more than) the incumbent IC, rendering its offer more attractive than before (see point *X´*).

Prediction 3´. Community rating is predicted to be associated with higher amounts of coverage for both high and low risks caused by reduced consumer search combined with increased selection effort on the part of the insurer. The ability of a challenger to siphon off low risks may increase or decrease.

4.2 Free provision of information to consumers

Recent regulation has aimed at providing consumers with information concerning insurance policies. Denoting this as a change $di > 0$, this amounts to an increase in the marginal effectiveness of search, $d/di[\partial I^H/\partial c > 0$. In analogy to eqs. (4a) and (4b), one obtains

$$\frac{dc^H}{di} \approx \frac{\partial^2 EU^H}{\partial c \partial i} = \rho^H \left[\upsilon^{H''} \frac{\partial I^H}{\partial c} + \upsilon^{H'} \frac{\partial^2 I^H}{\partial c \partial i} \right] \gtrless 0 \tag{10a}$$

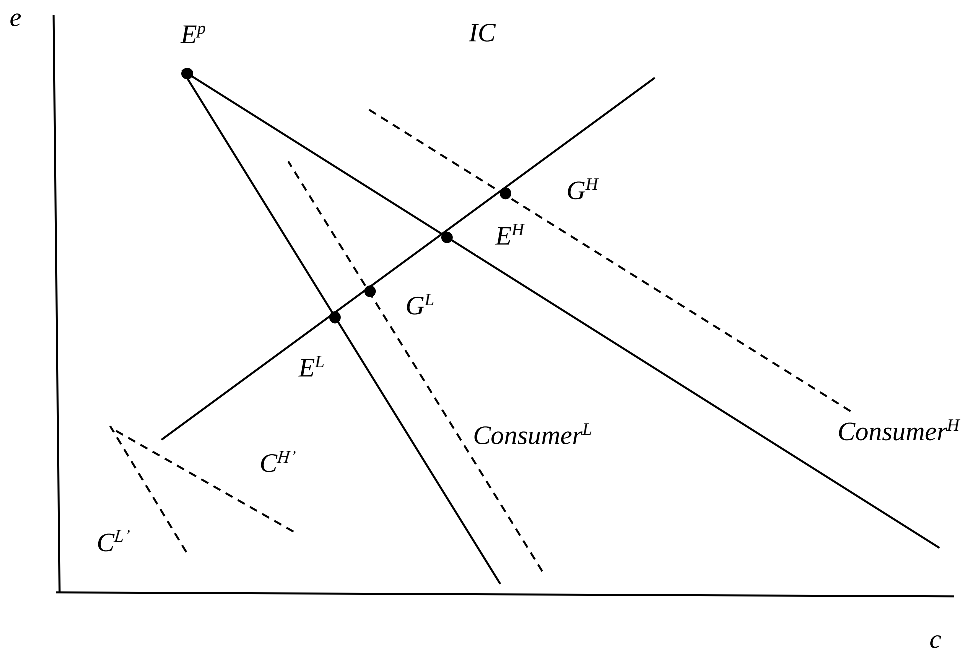
$$\frac{dc^L}{di} \approx \frac{\partial^2 EU^L}{\partial c \partial i} = \rho^L \left[\upsilon^{L''} \frac{\partial I^H}{\partial c} + \upsilon^{L'} \frac{\partial^2 I^L}{\partial c \partial i} \right] \gtrless 0 \tag{10b}$$

It is noteworthy that the provision of free information to consumers need not induce more search on their part. However, since this is the objective of a policy designed to enhance consumer empowerment, the second positive term is assumed to prevail. Therefore, in Figure 4 both consumer reaction functions shift up, with the amount of shift larger for the high risks than the low ones. Comparison of equilibria G^H with E^H and G^L with E^L, respectively leads to

Prediction 4. The provision of information to consumers free of charge is predicted to result in more search on their part combined with more selection effort by insurers, with both effects especially marked for high risks.

Again, these predictions can be projected into (W_1, W_2)-space. Since high-risk consumers exert more search effort while the IC steps up its selection effort, the loading increases substantially. Therefore, high risks will reduce their coverage to an amount as indicated by $C^{*H\prime}$ in Figure 4´ (or even refrain from purchasing coverage at all). Accordingly, the low risks must be more strongly rationed, down to $C^{L\prime}$. Whether the challenger's offer becomes more or less attractive to them depends on how strongly its loading is affected (it remains attractive according to point $X\prime$).

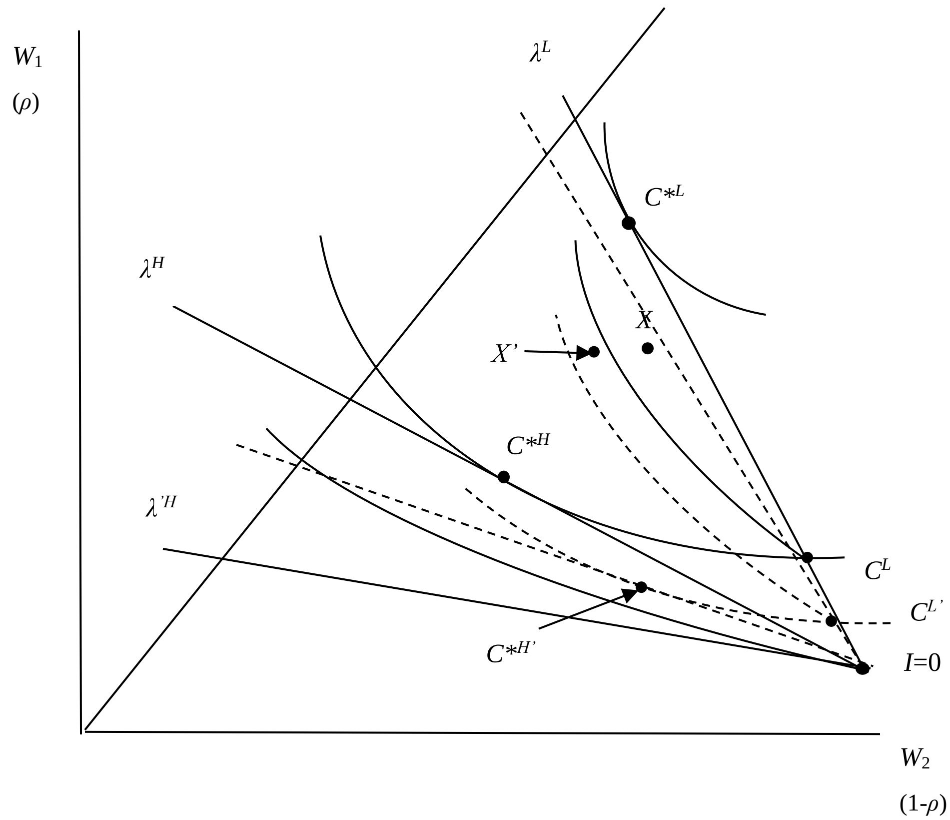
Figure 4. Displacements of equilibria due to provision of information to consumers



Prediction 4´. The provision of information to consumers is predicted to result in a reduced amount of coverage for both risk types, caused by an increase both in consumer search and selection effort by insurers.

It may be noteworthy that this prediction contradicts expectations derived from the view that additional information provided to consumers serves to lower their transaction cost and should therefore result in an increased market volume. However, this view neglects the fact that easier consumer search may burden producers with increased cost of advice and documentation which is reflected in a higher loading in the case of insurance.

Figure 4´. Projecting the effect of providing information to consumers into (W_1, W_2)-space



4.3 Learning from loss experience by insurers

While modeling the learning process of ICs is beyond the confines of this paper, its result can be analyzed in a simple way. For instance, an IC who has implemented experience rating in the past is likely to see the effectiveness of its selection effort enhanced. Symbolizing a change of this type by $dx > 0$, an increase in the marginal effectiveness of selection effort is equivalent to $d/dx[\partial\pi/\partial e] < 0$, recalling that $\partial\pi/\partial e < 0$. In analogy to eq. (3), one obtains

$$\frac{de}{dx} \approx \frac{\partial^2 E\Pi}{\partial e \partial x} = \partial^2\pi / \partial e \partial x \cdot \left\{ \left[P^H - C^H(c) \right] - \left[P^L - C^L(c) \right] \right\} > 0 \qquad (11)$$

since the margin on high risks is smaller than on low risks by assumption. The displacement of equilibria therefore is the same as in Figure 3; its amount is reduced however by premium regulation such as community rating designed to lower the difference in margins [see eq. (9) again]. Therefore, one has

Prediction 5. Learning from loss experience by insurers is predicted to decrease search on the part of consumers especially among low risks but increase selection effort on the part of insurers especially with regard to high risks. These effects are reduced by premium regulation such as community rating.

Since Figure 3´ (derived from Figure 3) applies as before, one also has

Prediction 5´. Learning from loss experience by insurers is predicted to be associated with higher amounts of coverage for both high and low risks caused by a decrease in consumer search combined with an increase of selection effort by insurers, with an ambiguous effect of a challenger to siphon off low risks. These effects are reduced by premium regulation such as community rating.

Again, the RS model turns out to be a special case because it neglects insurers' learning from loss experience. The analysis performed here suggests that such learning results in an ever more perfect separation of equilibria, as found by Doherty and Dionne (1994). Conversely, separation of equilibria can be undermined by premium regulation, without necessarily resulting in a pooled equilibrium, however.

5 Comparison of predictions and concluding remarks

This section is devoted to an overview of predictions designed to guide future empirical research (see Table 1). Already in the absence of exogenous shocks, both the present model and the RS model generate testable predictions. Concerning effort levels, high risks are predicted to exert more search effort, which is countered by higher selection effort by ICs in the separating equilibrium (the improbable pooling equilibrium is neglected at this point; see Figures 1 to 4). In terms of coverage levels, the present model predicts more (partial) coverage for the high risks than for the low risks as long as proportional loadings do not differ strongly. For a separating equilibrium, the RS model calls for full coverage being offered to high risks in the absence of a proportional loading (with a proportional loading, partial coverage would have to be high enough to prevent them from applying for the contract designed for the low risks, a condition that is difficult to test empirically). Low risks are rationed to a degree of coverage below the amount of loss. In addition, an indicator of high-risk status not excessively contaminated by measurement error is negatively correlated with the coverage obtained by the high risks while an indicator of low-risk status is positively correlated with coverage obtained by the low risks.

However, discriminating evidence comes from displacements of Nash equilibria caused by exogenous changes. First, the imposition of community rating is predicted to lower search effort on the part of consumers, but more so among high risks than low risks. In their turn, ICs step up their risk selection effort, but more so directed at high risks than at low risks if the present model is correct (again, focus is on separating rather than improbable pooling equilibria). Nevertheless, both risk types obtain a higher (partial) degree of coverage. Second, the provision of information to consumers free of charge has the predicted effect of increasing search effort on the part of consumers, particularly for the high risk types. Selection effort by the ICs is predicted to increase as well, but more so directed to attracting low-risk types rather than staving off high-risk ones. In terms of coverage levels, both types end up obtaining less coverage, particularly the high risks provided the risk-specific loadings do not differ much. The third change considered is learning from loss experience by the IC. Its predicted effect is a reduced amount of search on the part of consumers, in particular the low-risk types. This is matched by more selection effort on the part of ICs, again in particular devoted to attracting low risks. To the best knowledge of the authors, the RS paradigm does not generate testable predictions in these three cases.

Table 1. Predictions derived from the RS model and the present model

	Present model				RS model	
Exogenous change	**Effort levels**		**Coverage levels**		**Coverage levels**	
	High risk	Low risk	High risk	Low risk	High risk	Low risk
None, initial Equilibrium	$c^H > c^L$ $e^H > e^L$	$c^L < c^H$ $e^L < e^H$	$I^H > I^L < L$ if $\lambda^H \approx \lambda^L$	$I^L < I^H < L$ if $\lambda^H \approx \lambda^L$	$I^H = L$ if $\lambda^H = 0$ $corr(i^H, I^H) < 0$	$I^L < L$ $corr(i^L, I^L) > 0$
Community rating	$dc^H < 0$ $\lvert dc^H \rvert > \lvert dc^L \rvert$ $de^H > 0$ $de^H < de^L$	$dc^L < 0$ $de^L > 0$	$dI^H > 0$	$dI^L > 0$	n.a.	n.a.
Free provision of information to consumers	$dc^H > 0$ $\lvert dc^H \rvert > \lvert dc^L \rvert$ $de^H > 0$ $\lvert de^H \rvert < \lvert de^L \rvert$	$dc^L > 0$ $de^L > 0$	$dI^H < 0$ $\lvert dI^H \rvert < \lvert dI^L \rvert$ if $\lambda^H \approx \lambda^L$	$dI^L < 0$	n.a.	n.a.
Learn from loss experience	$dc^H < 0$ $\lvert dc^H \rvert < \lvert dc^L \rvert$ $de^H > 0$ $de^H > de^L$	$dc^L < 0$ $de^L > 0$	$dI^H > 0$	$dI^L > 0$	n.a.	n.a.

Note. i^H (i^L) is an indicator of high (low) risk status; L is loss.

In conclusion, taking into account two types of effort in insurance markets holds the promise of substantially expanding the set of testable predictions. Consumers are modeled as searching for maximum coverage given the premium they have to pay; ICs, as trying to decrease the share of high risks (and increasing the share of low risks) they enroll. Nash equilibria in efforts space turn out to be of the separating type under very general conditions; moreover, their displacement can be traced in a number of circumstances. Given consumer survey data and information about risk selection policy of ICs, the associated predictions can be tested. Moreover, Nash equilibria and their displacements can be projected into wealth levels space as in the RS model in order to derive predictions concerning coverage levels, extending the set of testable predictions once again.

Although promising, the model proposed in this paper is subject to several limitations. First, consumers are modeled as expected utility maximizers, which may serve as long as one is willing to concede that their decision-making may be beset by error (Hey, 2002). Second, a one-period model of insurer behavior likely fails to fully depict the complexity of controlling the insured population. In particular, when discarding a consumer categorized as a high risk, the IC has no guarantee to find a low-risk replacement, contrary to the simplified model. In the same vein, the amount of loading may well be another decision variable, to be employed in combination with risk selection effort. Finally, the three exogenous changes might not be correctly represented by the model parameters.

In spite of these limitations, pursuing the extension of the RS model put forward here may be worthwhile. Specifically, data routinely collected by Australian auto insurers could be combined with a consumer survey commissioned by them and with information about their effort at risk selection (e.g. in the guise of a steep experience rating) to test at least some of the predictions collected in Table 1. This will pave the way to a more in-depth exploration of the RS paradigm than has hitherto been undertaken.

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