J Risk Uncertain (2011) 43:127–139
DOI 10.1007/s11166-011-9124-2

Guaranteed renewability uniquely prevents adverse selection in individual health insurance

Mark V. Pauly · Kai Menzel · Howard Kunreuther · Richard A. Hirth

Published online: 2 August 2011

Abstract New models of multi-period insurance show that health insurance buyers can be protected against changes in premiums from health shocks associated with chronic conditions by the addition of "guaranteed renewability" provisions. These models assume that a buyer's risk level in every time period is observed by all insurers. They also require a premium sequence that is "front-loaded," which may be costly to buyers if capital markets are imperfect. We relax the common knowledge feature of the model by assuming that a person's risk in any time period is known only by that individual and the current insurer. One might suspect that a premium sequence with higher later period premiums would be incentive compatible because low risks will have less desirable offerings from alternative insurers. However, we show that generally, only the original premium schedule is incentive compatible, and attempts to alter front-loading will not be an equilibrium.

Keywords Health insurance · Adverse selection · Guaranteed renewability · Equilibrium

M. V. Pauly (✉)
Health Care Management Department, The Wharton School, University of Pennsylvania, 3641 Locust Walk, 208 Colonial Penn Center, Philadelphia, PA 19104, USA
e-mail: Pauly@wharton.upenn.edu

K. Menzel
Diplom-Volkswirt, MA, University of Cologne, Institute for Economic Policy, Pohligstraße 1, 50969 Köln (Cologne), Germany

H. Kunreuther
James G. Dinan Professor, Professor of Decision Sciences and Business and Public Policy, Co-Director, Risk Management and Decision Processes Center, The Wharton School, University of Pennsylvania, 3730 Walnut Street, 563 Jon M. Huntsman Hall, Philadelphia, PA 19104, USA

R. A. Hirth
Professor and Associate Chair of Health Management and Policy, University of Michigan School of Public Health, 1415 Washington Heights, Ann Arbor, MI 48109-2029, USA

JEL Classification I11

Insurance with a longer time perspective can improve efficiency by avoiding the problem of reclassification risk—the risk to the policyholder of many periods of above average future premiums for someone who unexpectedly becomes a high risk. Existing models of this process (Pauly et al. 1995; Cochrane 1995), all applied to individual health insurance, assume that a buyer's risk level in each period is common knowledge, known to the buyer, the buyer's insurer in the current period, and all other insurers. In the initial period all buyers are known to be of equal risk; risks change in future periods if a person contracts a chronic illness that persists, and all insurers now have full information on who has become a higher risk.

Such "optimal guaranteed renewability" (OGR) models describe insurance that provides protection against the risk of future reclassification by insurers when they learn who has become a higher risk. OGR contracts specify a unique time path for premiums as a function of the insured's age that minimizes the premium paid in each time period while at the same time meeting the incentive compatibility condition needed to keep policyholders at all risk levels continuing to participate in the contract. This is the policy that is optimal from a multi-period welfare economics perspective and sustainable in a world of free entry by competitive insurers.

In this paper, we modify the assumption about information to embody adverse selection with information asymmetry between insurance buyers and potential sellers in periods after the first period. For explicit reclassification risk to be an issue, at least one insurer must be able to observe that someone has become a high risk in order to reclassify that person. We plausibly assume that the initial insurer, who is in a position to observe claims and medical data, obtains this information. But we assume that this information is not common knowledge for other insurers.[1] We then ask if this change in the information structure—limiting the data available to other insurers—makes a difference. More specifically we address the following two questions:

- What kind of multi-period insurance policies might be sustainable when adverse selection is thus present?
- How might these multi-period policies compare, in terms of efficiency or equilibrium, to the optimal "guaranteed renewable" policy in the common knowledge model?

One might anticipate a difference if one does not assume common knowledge by all insurers. The OGR policy "front-loads" additional premiums in the early years of a policy to collect funds that are then used to just offset the later difference between the low risk premium and the expected expense of those who have become higher insured risks until the person goes on Medicare. Ignoring loading, the OGR premium sequence in every period exactly equals the expected cost of a low risk insured from that period forward.

[1] There is another possible model in which only the insured person, and not even the current insurer, knows when and if the risk changes, but in which insurance is sold as a multi-period contract. We do not develop that model here.

With literally perfect capital markets, OGR would not be superior to payment of a lifetime premium, but some transactions costs of borrowing or financing a very large lifetime lump sum would make the periodic payment possible in OGR superior. If capital markets are even more imperfect, so that there would be significant costs even to funding these payments, such front-loading may be undesirable (Frick 1998). But the OGR front-loading is unavoidable in the full information model with a single level of coverage sold at uniform premiums in each time period. If not enough is collected in the earlier periods to fully fund those who become high risks, an insurer that tries to collect it later from those who remained as low risks would cause those low risks to defect to other insurers. If low risks are not charged more than the OGR premium (reflecting risk for the specified coverage in at least some future period), the insurer would be unable to cover the cost of its commitment to those who become high risks.

Consider a model where outside insurers cannot identify low risks directly but do know the details of the offerings by the inside insurer. An important question is whether more of the premium for high risks could feasibly be collected later in the period, thus reducing the early capital burden relative to the benchmark OGR policy.

The relaxation of the possibility that low risks will defect to outside insurers, caused by the inability of those insurers to identify specific individuals as low risks, might lead to a lower feasible premium in the very early years of the GR contract and thus provide some benefit to offset capital market imperfections. This paper will not model the general problem of insurance purchasing under imperfect consumer capital markets, but will use that imperfection as a motivation for insurers to consider alternatives to OGR. (For further extensions of the "guaranteed renewability" (GR) model, see Pauly (2006).)

We first show that, not surprisingly, the benchmark OGR policy that is incentive compatible in a model with common knowledge is also immune to adverse selection in the asymmetric information model. But is there a less demanding policy still offering protection against reclassification risk that can also survive in the adverse selection scenario? We next show that, surprisingly, no such improvement is possible: only the OGR policy is a feasible policy, even with asymmetric information, as long as potential insurers offering a single level of coverage at a single premium make the traditional assumptions of the Rothschild-Stiglitz model. That is, the OGR premium schedule is surprisingly robust, and would prevail in competitive insurance markets regardless of what insurers know about differences across individuals in risk levels. We then consider informally some modifications of this story in order to see what needs to be assumed to reduce the front-loading "burden" in GR markets. We find that either outside insurers must behave differently or protection against reclassification risk must be sacrificed.

Following prior literature, we describe the model in terms of health insurance. However, it could apply more broadly to other lines of insurance where exogenous current period shocks change the risk of claims in future periods. Most obviously, this could be the case in long-term care and life insurance. However, the model could apply to property insurance where individuals may have their premiums changed due to a reclassification of the risk. For example, if levees that were presumed to be well constructed are now shown to be unsafe, the premiums for flood coverage would have to be increased—a situation that is currently under consideration by the Federal

Emergency Management Agency (FEMA) following the failures of the levees in New Orleans from Hurricane Katrina.[2]

1 Assumptions

We adopt the set of assumptions used by Rothschild and Stiglitz in their classic treatment of adverse selection (1976). There are two levels of risk: high risks with loss probabilities p_H for a loss of $X, and low risks with a probability of p_L. Individual consumers know their own risk level. Insurers newly enrolling a consumer know the proportion of high and low risks in a population of potential insureds at any point in time and/or at any age, but they cannot distinguish between high risks and low risks. Competitive insurers offer a variety of policies for sale; policies differ in terms of the number of covered dollars C they will pay if a loss occurs ($X \geq C > 0$). All insurers know the total amount of coverage an individual has obtained.

We invoke the assumptions of the simple three-period model we used in our treatment of guaranteed renewability. A population begins in period 1 with all potential consumers as low risks facing the uniform loss probability p_L. The proportion of buyers who actually suffer a loss of $X in period 1 become high risks in periods 2 and 3, while the proportion of remaining low risks who suffer a loss in period 2 become high risks only for period 3. A time path of premiums Π and policies C is a competitive equilibrium if no insurer can enter with a new policy and attract a set of buyers who allow it to have a positive expected profit.

We have previously shown that there is an optimal GR contract for a given amount of coverage purchased C^*. The quantity C^* is the expected utility maximizing amount of coverage purchased by a low risk facing a premium for that policy that reflected only the loss probability p_L. If the only change from period to period is the risk level, the optimal quantity will remain at C^*as long as income effects from changes in the magnitude of current-period premiums are absent.[3] For simplicity, we assume the administrative cost loading is zero, so the low risk premium $\prod_L$ equals $p_L^* C$ and the amount of insurance C equals X, the cost of treatment. As noted, we also assume that a high risk facing a fair premium rate p_H would also demand $C = X = C^*$.

We assumed in Pauly et al. (1995) that all insurers knew each person's value of p at every point in time. In this modification, we continue to assume that the insurer that sold insurance to a consumer in one period knows perfectly that person's risk in subsequent periods. After all, risk reclassification is an issue only if the initial insurer can know any change in risk level and therefore base premiums on the new level. However, other insurers that might attract the consumer away from the initial insurer and contract now are assumed to be ignorant of changes in each person's risk level and not constrained in what they might offer. Outside insurers know the proportion

[2] For more details on actions taken by FEMA see http://www.floods.org/ace-files/Levee_Information/map_changes_and_insurance_savings.pdf (accessed 7 June 2011).

[3] Ehrlich and Becker (1972) show that, for a given level of risk aversion and a loading percentage that is independent of the probability of loss, the amount of insurance purchased will not depend on the loss probability.

who have become high risk in each future period, but not which persons experienced such changes.

2 OGR is adverse-selection proof

It is easy to see that the policy with $C = X = C^*$ and the OGR premium schedule is not vulnerable to adverse selection. That is, in a market where all sellers offer this policy in every time period, no insurer can enter and offer a policy with different values of C other than C^* and a set of premiums that would allow it to earn profits. While this point is fairly obvious, we present the argument here as a template for further analysis in this paper.

Let us begin with the last period, before the person exits the market (for Medicare). The OGR premium in this period is the low risk premium (for that age cohort); it is clear that no outside insurer that might expect to attract at least some people who have become high risks could profitably offer a lower premium for the C^* policy or for any other policy since C^* is the optimal policy and the low risk premium is the lowest feasible price. To be more specific: any outside insurer will offer either a policy that will attract both high and low risks, or a policy that potentially attracts only low risks. To break even while attracting all risks, the premium will have to be the average (community-rated) premium, which is higher than the OGR low risk premium. To attract only low risks, an insurer will have to offer a policy with lower coverage than C^*, coverage so low that higher risks will not prefer it to C^*. But then all buyers will prefer the policy offering C^* to that policy, since the C^* policy maximizes expected utility at the low risk premium rate.

What about the second-last period? In this case, the OGR premium is the low risk premium for that period plus the difference between the last period low risk premium and the high risk premium for those who become high risks in the second-last period, again for the C^*-policy. Since the OGR policy is optimal for those who are low risk in the second-last period, there is no policy-premium combination an outside insurer could feasibly offer that would attract them. Here again, an insurer expecting to attract all risks will have to charge more than the OGR policy, while an insurer attracting only the low risks in the second-last period will have to offer suboptimal coverage (and somehow protect against risk reclassification for the next period). By backwards induction using the same argument, OGR is preferred to any outside premium in any earlier period. More generally, the plan to lower premiums relative to OGR in early periods and offset by raising them in some future period will not work.

3 Imperfect information and any GR contract

But might there be some premium schedule other than the GR schedule that could be sustained in a world of asymmetric information? If the answer is yes, and if this alternative has lower capital market costs than the benchmark policy, we might expect such an alternative policy to be chosen if capital markets are less than perfect. However, we conclude that no policy offering a single premium and a single level of coverage could displace OGR.

We first give the technical explanation, and then illustrate it diagrammatically. In this model, a policy which charged more than $\prod_L p_L$ in the last period would not automatically lose the low risks, because outside insurers cannot identify them directly. However, if the policy did offer C^* at a premium rate above p_L, for example $p_L + d$ and is intended to be sold to all risks (as OGR is), that cannot be an equilibrium. We know some other single period policy exists with $C < C^*$ and $p = p_L + d - p = p_L$ that would attract only the low risks; the high risks would prefer to remain with the old coverage at the old premium. The logic of this conclusion follows that of the classic Rothschild-Stiglitz model which shows that any pools of low and high risk consumers at a premium above the low risk premium will not be an equilibrium because an outside insurer will be able to craft a policy attractive only to low risks (the application of this logic to the current model is further explained graphically below). Hence the hypothesized "shallower" premium schedule could not profitably be maintained. That is, any premium which tried to move away from the OGR benchmark low risk premium and toward a pooled premium for the C^*-policy could be undercut by an outside insurer offering less generous coverage than C^* that would attract only the lower risks. This is because the quantity C^* is larger than the amount low risks would ideally want to purchase if they could buy varying amounts of coverage at the higher premium rate $p_L + d$; the lower risks are not in equilibrium at the quantity C^* at any premium other than the low risk premium. The only way for them to be in equilibrium at C^* is for the premium rate to remain at p_L and hence the premium at $\prod_L$.

What about the second-last period in this new model? The same argument applies. The premium here needs to be high enough (ignoring interest) to collect sufficient funds to cover the costs in excess of $\prod_L p_L$ for the people who became high risks in period 2 and will be retaining coverage in period 3. Would there be a higher premium for the C^*-policy that the original insurer could collect? The answer is "no" because any such higher premium would trigger an offer by an outside insurer with a lower level of coverage and a low risk two-period premium that would attract the low risks and not the high risks.

A low risk individual maximizes her expected utility by having full coverage in both periods 2 and 3 and paying an actuarially fair cumulative premium over both periods. A prospective low risk customer in period 2 might prefer to pay the single-period low risk premium in period 2 and then pay the low risk premium in period 3, whether she is a high or low risk at that time, but access to the GR premium in period 3 is limited to those who paid extra for it in period 2, so this choice is not feasible.

4 Understanding the problem

This conclusion is counterintuitive. Shouldn't restricting the information available to outside insurers cause there to be a higher price that the inside insurer could charge in the later years (with concomitant lower burden in the earlier years) that would be sustainable? One would expect that the outside insurers would be able to pick off only low risks if they offered them something better than their option in the initial insurance; and now their ability to identify those who could be offered something better has been reduced. But this expectation is not correct.

To see why the inside insurer cannot charge more than the OGR premium when there is not common knowledge, consider the last period, in which the OGR policy charges all the insured individuals the low risk premium. Is there a way to charge more than that amount (in order to offset earlier lower-than-OGR charges) and still keep the low risks in the OGR policy so that the insurer can cover its costs?

The ordinate of Fig. 1 shows a person's wealth level and the abscissa shows the level of insurance coverage C. The line p_L shows the actuarially fair budget line facing a low risk, while p_H shows the line facing an otherwise-similar high risk:

$$p_L : W - p_L^* C$$

$$p_H : W - p_H^* C$$

with W = initial wealth level.

The slopes are $-p_L$ and $-p_H$ respectively. Without administrative loading, p_L is also the zero profit line for insurers offering insurance to low risks in the final period.[4] South-East of p_L, low risks would be overcharged. The vertical distance between any point underneath p_L and p_L equals the absolute amount of overcharging of low risks for the respective amount of coverage. North-West of p_L, insurers would "undercharge" low risks and thus make a loss even with this group alone. Hence p_L also limits the scope of feasible insurance policies.

Both risk types are assumed to have the same optimal OGR insurance level C^* (which under the assumptions of actuarial fairness and no moral hazard will be full coverage). Under OGR, both high and low risks face the low risk premium $\prod_L p_L$ in the final period, so point E^* would represent the equilibrium with associated indifference curves I_L^0 and I_H^0 that buyers would achieve under OGR. The functional forms of the indifference curves are:

$$I_L : p_L^* U(W - X + C - \Pi_L) + (1 - p_L)^* U(W - \Pi_L) = U_L$$

$$I_L : p_H^* U(W - X + C - \Pi_H) + (1 - p_H)^* U(W - \Pi_H) = U_H$$

with U being a von Neumann/Morgenstern utility function.

Since points South-West of p_L imply overcharging of low risks, we can represent a reduction in early-period front-loading and a shift in cost to the last period as a shift of the final-period GR budget line downwards and to the left from p_L for the people in the GR policy. The limiting case of this shift is a budget line that would represent a weighted average of the two risk levels; if premiums were set along this budget line and everyone still purchased, the insurer would collect enough to cover its full benefits costs for all risks in the final period, so there would be zero front-loading in the previous period; this is shown in Fig. 1 as p_B (for "both"):

$$p_B : W - \left\{ p_L(1 - p_L)^{n-1} + p_H^* \left[1 - (1 - p_L)^{n-1} \right] \right\}^* C$$

[4] Assuming that customers have not been overcharged in previous periods. Overcharging in early periods would even increase front-loading and hence capital costs.

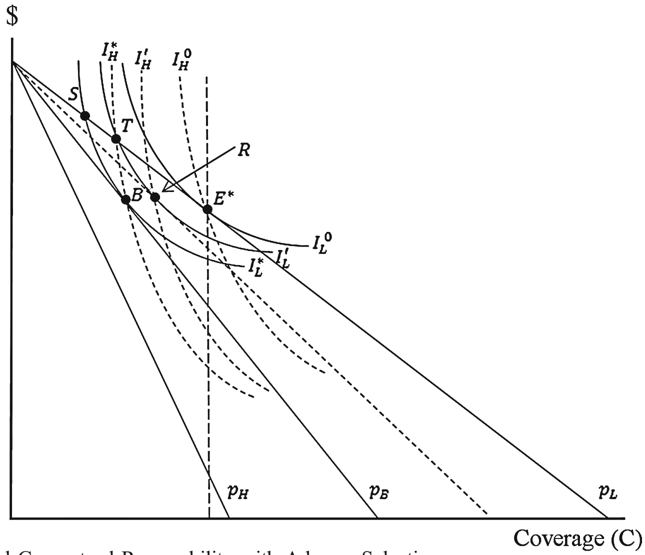

Fig. 1 Optimal Guaranteed Renewability with Adverse Selection

with n = number of periods passed since everyone was low risk. Obviously, the slope is a weighted average between p_L and p_H so that p_B is situated between those two lines. In a two-period model, the expression boils down to:

$$p_B : W - [p_L(1 - p_L) + p_L p_H]^* C.$$

The p_B-policy is very similar to the Rothschild-Stiglitz single period pooled policy (which in their model is not an equilibrium). It is the budget line a new insurer would expect if it offered coverage without knowledge of buyer risk levels but expected to attract both types of buyers. It would expect to break even at any point along p_B. The key determinant of the quantity of coverage such an insurer could offer and still attract both risk levels is the amount of coverage a low risk would prefer along that budget line; high risks would always prefer more generous coverage at the same premium rates. That potential pooling equilibrium quantity is at the tangency at B^*, with associated indifference curves I_H^* and I_L^*. However, in the Rothschild-Stiglitz model this pooling equilibrium is not stable since an outside insurer could offer another policy with less coverage that low risks would prefer to the pooled policy but high risks would not; policies along the low risk line from S to T would satisfy this condition. Thus the best outcome for a low risk that could be offered by an outside insurer is the policy at T. This policy maximizes the low risk person's utility conditional on high risks remaining out of the pool and the outside insurer breaking even.

It therefore follows that a GR plan that shifted the budget line downwards might still be selection-proof as long as it kept low risks on a higher indifference curve than the one through T; such a plan would make low risks as well off as they would be if they selected the separating policy. The policy with the lowest front-loading that meets these constraints is the policy at R in the diagram. This policy still has full coverage (I^*) even though, at the implied unit premium through R, low risks would prefer less coverage—because movement away from R would increase low risk utility by less than it reduced high risk utility—so R maximizes expected utility.

For example, the policy with the highest premium rate on the indifference curve $I_L^{'}$ is at point R. Here the dotted budget line is tangential to the low risk indifference curve. Hence it is the steepest budget line for which low risks can maintain the utility level they would have at T.

However, even this policy would not be able to be sustained, because there is another policy along the fair odds line for low risks that is better than R for low risks but not for high risks. The two indifference curves through R, $I_H^{'}$ and $I_L^{'}$, allow for a policy on the fair odds line for low risks that low risks will prefer to the "overpriced" GR policy at R but the high risks will not. Hence the pooled policy will not be an equilibrium.

For any policy with $C > 0$, there exists another policy with lower coverage which low risks would prefer but high risks would not. This is the case because for any policy with uniform values of C and $\prod$ for both risk types,[5] i.e., at any intersection point, high risk indifference curves are strictly steeper than low risk indifference curves. This can be easily shown by comparing the respective slopes for identical values of C and $\prod$. For I_L we get:

$$\frac{\partial(W-\Pi)}{\partial C} = -\frac{\frac{\partial U_A}{\partial C}}{\frac{\partial U_A}{\partial(W-\Pi)} + \frac{1-p_L}{p_L} * \frac{\partial U_N}{\partial(W-\Pi)}}$$

with $p_L > 0$ and U_A indicating utility in the accident state whereas U_N represents utility in the no-accident state. The slope of the high risk indifference curves is:

$$\frac{\partial(W-\Pi)}{\partial C} = -\frac{\frac{\partial U_A}{\partial C}}{\frac{\partial U_A}{\partial(W-\Pi)} + \frac{1-p_H}{p_H} * \frac{\partial U_N}{\partial(W-\Pi)}}.$$

In absolute terms, the slope of the high risk indifference curves is larger since the denominator is smaller. That implies that the negative slope of high risk indifference curves is steeper at any intersection, as depicted in Fig. 1. This is also intuitively clear: all other things being equal, high risks would be willing to pay more for additional coverage than low risks since their loss probability is higher. Hence if coverage is marginally increased, high risks would accept a larger reduction in wealth to remain at the same utility level (i.e. on the same indifference curve) than low risks, which implies steeper high risk indifference curves.

The consequence of this steeper slope is that North-East of any intersection of low and high risk indifference curves, a wedge opens up in which low risk utility is higher, and high risk utility is lower than at the intersection. Low risks can self-select into any policy which is offered within this wedge. The limiting case is obviously the p_L-line beyond which contracts could only be offered at a loss. It follows that self-selection can only be avoided on the p_L-line at a premium rate which is actuarially fair for low risks. Hence any equilibrium must be on that line. The corner-solution at point E with full coverage obviously provides the highest utility along this line of selection-proof policies and is therefore the only equilibrium for low risks

[5] This is an assumption we have made, but at the same time a precondition for maintaining the informational advantage of the current insurer if outside insurers can observe premia.

in a competitive market—otherwise a competing insurer would offer a contract with higher coverage on that line which would be preferred by low risks until full coverage is reached. At all other points, insurers either make a loss or self-selection takes place or people are underinsured.

Result: Even with adverse selection, only the OGR premia characterize a stable multi-period equilibrium.[6]

The fundamental problem is that any policy with a premium in any time period which moves away from the OGR schedule is, in effect, a pooled policy (or at least a partially pooled policy) in the Rothschild-Stiglitz sense, and we know that no pooled policy can be a competitive equilibrium. In effect, the ability of outside insurers to attract away low risks does not depend on the utility level of low risks in the original plan but on whether they can get the low risks to self-select. This happens in the breakeven Rothschild-Stiglitz policy, but it also happens in any plan where the premium that the high risk individuals are charged is actuarially fair and above the low risk premium. The reason is that some point on the low risk fair odds line is always available to outside insurers as long as they can get low risks to self-select. But since high risks prefer more coverage on the low risk fair odds line to a policy with less coverage but on the same line that is at least as good for low risks as the inside policy, the inside policy can be self-selected against, and so cannot be an equilibrium. The ability to initiate self-selection has ultimately the same effect as if outside insurers had no informational disadvantage. And if there is no equilibrium in which the low risks remain in the plan, there is no way for the insurer to collect more (than OGR) in later periods to offset charging less (than OGR) in the early periods.

Of course, selection of this type by outside insurers requires that they know the quantity of insurance and premium being charged by the original insurer. They need this information to determine what alternative policy with lower premia and lower coverage will attract only the low risks.

To sum up: the OGR contract provides subsidized premiums to high risks from premiums collected *before* individual health statuses are revealed, and so prevents adverse selection; it makes transfers across periods as well as within periods. Therefore, in the OGR contract the low and high risks can remain together in a "pseudo-pooled" contract. If the insurer were to attempt to lower the front-loading of the premium, it would effectively be trying to implement the pooled-within-period-only Rothschild-Stiglitz policy, and that would create incentives for outside insurers to offer a policy that attracts only low risks.

5 Alternative assumptions and alternative models

This somewhat surprising result obviously depends on modeling decision making about insurance as the step-by-step myopic process envisioned by the Rothschild-

[6] This result is true for uniform premia for high and low risks as assumed thus far. It is always true for low risks. With positive capital costs, high risk premia can deviate in the same way as under complete information, see below.

Stiglitz model. Given the conceptual advantages to reducing front-loading when we move from full information to only the inside insurer knowing the risk level, can the GR insurer compress this process so as to make a less demanding but preferred policy feasible?

There are two ways to think about alternatives. One is to retain the single-premium, single-coverage model but modify the story about competitive strategy. The other is to imagine that, at least in some future periods, the insurer might propose different policies or different premiums.

Consider the first approach. In Fig. 1, the policy offered to low risks that picks them off from the overcharged GR policy is itself not sustainable in the long run, since the exit of low risks means that the pooled policy will no longer survive, and the high risks will then move into the "pickoff" policy; in the diagram, there is no equilibrium.[7] Perhaps insureds and insurers will have enough foresight to see this, and there are alternative concepts of insurer beliefs (Miyazaki 1977; Wilson 1977) that could be employed (though few of them allow a pooled policy to be an equilibrium). Potential insurer entrants would note that the pooled policy which retains the high risks will not be able to be offered once the low risks depart; as Wilson hypothesizes, this foresight would then discourage them from offering the policy that attracts the low risk in the previous round. That is, this policy that attracts the low risks does not remain profitable once the policy offered by the initial insurer becomes unprofitable and disappears. The fact that there are few "next periods" as people approach age 65 might also contribute to stability of the "overpriced" GR solution.

What about the second approach? The simplest alternative is to assume that the inside insurer proposes to charge a higher premium to those who become high risks, but offers a sufficient reduction in front-loading to make a modest exposure to reclassification risk acceptable. It therefore selectively raises premiums for high risks above that for low risks in those future periods when the high risk buyer can best "afford" (or most prefers) to pay more than the low risk premium. One problem here is that only the inside insurer knows who is low risk, and so may be motivated to take advantage of them as well, along the lines suggested by Kunreuther and Pauly (1985) in their analysis of insurance market equilibrium with private knowledge.

This second outcome might also be what would ensue regardless of explicit insurer behavior if the premium in later periods is raised above the OGR level and low risks depart, leaving the insurer only with the high risks. To break even, the insurer would then have to charge the high risks more than the low risk premium that would have prevailed under OGR; they would pay exactly the same premium as would have prevailed under the explicit risk rating discussed in the preceding paragraph.

In the face of high capital costs to pay the early period front-loaded OGR premiums, buyers might prefer to accept a modest amount of reclassification risk as a second-best optimum. As discussed above this risk could either be made explicit or naturally result from the breakdown of the insurance pool when premiums rise

[7] Withdrawing a GR policy should not be a realistic option, because consumers would not be attractive in the market if buyers had full foresight. But we allow that possibility here since markets may be imperfect and stability is important.

enough to drive out low risks. While some deviation from the OGR schedule can be second-best efficient for high risks, only OGR is a feasible and efficient premium schedule for low risks.

6 Conclusion

Introducing the possibility of adverse selection required introducing the possibility that the amount of coverage per contract could be varied, a contrast to the benchmark GR models. So long as we maintain the RS assumption that all insurers know the total amount of coverage a person has purchased, we have shown that the OGR schedule is also the only equilibrium schedule that protects against reclassification risk even when outside insurers cannot distinguish among risks.

This conclusion will not hold if any of the following three actions occur:

(1) Buyers can purchase coverage from more than one firm without other insurers being aware of this fact (Pauly and Kunreuther 1983) because a potential pickoff policy could no longer be certain to attract only the low risks.
(2) The insurer that sold GR coverage is able to use the information it has acquired on each insured's risk to modify the contract quoted to that person on an individual basis, or if it can reduce service or in other ways lower the quality of the product for the high risks once those who have become higher risks are locked in.
(3) The potentially new insurer notes that the high risks will not remain with the OGR policy once the lower risks have been attracted away.

The first action would violate the explicit promise inherent in GR, the second should be able to be detected by prospective new purchasers who would punish such "skimping" firms by refusing to buy, and the third violates the single period expectational structure of the Rothschild-Stiglitz model and the explicit promise inherent in GR.

Essentially, any attempt to rely on low risk individuals to pay more than their expected costs in later periods in order to relax the need to front-load premiums in early periods cannot be sustained in equilibrium. This will be the case even if other insurers cannot identify low risks and even if, as is the case in the OGR policy, the pooling contract would not be withdrawn after the defection of low risks. So it seems that the optimal GR premium schedule has a strong claim to being the unique best solution to the problem of risk reclassification.

References

Cochrane, J. (1995). Time consistent health insurance. *Journal of Political Economy, 103*(3), 445–473.

Ehrlich, I., & Becker, G. S. (1972). Market insurance, self-insurance, and self-protection. *Journal of Political Economy, 80*(4), 623–648.

Frick, K. (1998). Consumer capital market constraints and guaranteed renewable insurance. *Journal of Risk and Uncertainty, 16*(3), 271–278.

Kunreuther, H., & Pauly, M. V. (1985). Market equilibrium with private knowledge: An insurance example. *Journal of Public Economics, 26*(3), 269–288.

Miyazaki, H. (1977). The rat race and internal labor markets. *Bell Journal of Economics, 8*(2), 394–418.
Pauly, M. V. (2006). Time, risk, precommitment and adverse selection in competitive insurance markets. In P.-A. Chiappori & C. Gollier (Eds.), *Competitive failures in insurance markets* (pp. 11–31). Cambridge: MIT.
Pauly, M. V., & Kunreuther, H. (1983). Equilibrium in insurance markets with experience rating. In J. Finsinger (Ed.), *Economic analysis of regulated markets* (pp. 91–110). London: Macmillan.
Pauly, M. V., Kunreuther, H., & Hirth, R. A. (1995). Guaranteed renewability in insurance. *Journal of Risk and Uncertainty, 10*(2), 143–156.
Rothschild, M., & Stiglitz, J. E. (1976). Equilibrium in competitive insurance markets: An essay on the economics of imperfect information. *Quarterly Journal of Economics, 90*(4), 630–649.
Wilson, C. (1977). A model of insurance markets with incomplete information. *Journal of Economic Theory, 16*(2), 167–207.