The Economic and Social Review, Vol. 29, No. 3, July, 1998, pp. 285-300

Medical Insurance, Community Rating, and Adverse Selection: An Overlapping Generations Perspective

R.A. SOMERVILLE
Trinity College, Dublin

Abstract: This paper analyses the demand for medical insurance using an overlapping generations model. It is shown that the rate of interest and the age structure of the insured population jointly determine whether a typical fully-insured individual prefers a community-rated premium structure to experience rating, assuming monopoly supply with a zero-profit constraint. Conditions are derived in which community rating leads to inter-generational adverse selection, and it is found that the impact of premium changes on adverse selection depends on the values of the coefficient of absolute risk aversion over the entire life cycle. Finally, it is suggested that the conclusions on adverse selection are currently relevent to the market for medical insurance in Ireland.

I INTRODUCTION

The Voluntary Health Insurance Board (VHI) was established in 1957 under the VHI Act[1] as a state-sponsored and non-profit body whose board is appointed by the Minister for Health, and until 1996 the VHI was a monopoly supplier of private medical insurance in Ireland. Its insurance contracts have always involved "community rating", whereby premiums are based on average levels both of risk and of costs of claims, within the insured community. Thus, premiums for a given type of contract are the same for all clients, regardless of age, health status, and health history. Moreover, the VHI's policy has been to accept new applicants of any age below an upper

1 Amended in 1996 by the Voluntary Health Insurance (Amendment) Act, section 5 of which preserves the non-profit status of the VHI.

limit of 65 years. The VHI's monopoly has recently been breached, with the entry to the market of BUPA (The British United Provident Association) on 1 January 1997. However, both companies continue to apply community rating, as required by section 7 of the Health Insurance Act, 1994. In accordance with section 8 of the 1994 act, both companies offer lifetime cover and open enrolment, subject to an age limit of 65 for the acceptance of new contracts with previously uninsured applicants.

Ageing is an inevitable process, which causes a rise in medical risks and costs over individuals' lifetimes. Consequently, compared with most other forms of insurance, decisions concerning medical insurance have an inherent time-dimension. However, the standard approach to modelling medical insurance uses a single-period framework: for example, see Zweifel and Breyer (1997). In particular, when premiums are not experience rated, adverse selection may occur, and the single-period model has been the usual framework for research on this matter, from the pioneering papers of Pauly (1974) and Rothschild and Stiglitz (1976) up to the recent work of Cutler and Zeckhauser (1997).

In Section II, this paper presents an overlapping generations model of the demand for medical insurance under monopoly supply where the insurer is required to earn zero profits, i.e., the conditions that prevailed in the market for medical insurance in Ireland until very recently. Section III analyses adverse selection under community rating, and the results are discussed in Section IV.

The principal findings are: first, that under certain conditions, the typical individual may prefer community rating to experience rating; second, given the intergenerational differences in the expected cost of claims, the pressure for intergenerational adverse selection depends on a demographic parameter and a tax parameter; third, for adverse selection, the significance of a change in the community-rated premium depends on coefficients of absolute risk aversion over the entire life cycle, not just during the "young" low-risk period.

Until now in Ireland, the pressure for adverse selection may have been contained by the deductibility of premiums at marginal tax rates, by statutory restrictions on medical insurance contracts, and by the absence of competition until recently. At the time of writing, the Department of Health is preparing a white paper on private medical insurance, which, according to the press advertisement inviting submissions, "will consider the existing private health insurance regulatory framework ... in the context of consolidating a competitive market based on the core principles of community rating, open enrolment and lifetime cover". Clearly, community rating still deserves attention.

II OPTIMAL INSURANCE

2.1 *Assumptions and Definitions*

It is assumed that individuals live for two periods, labelled 1 and 2, and that successive generations overlap. The typical individual receives a constant pre-tax income y in the first period of his lifetime, from which savings, with accrued interest at the after-tax rate $r > 0$ per period, yield the resources for consumption in period 2. There are no inheritances or bequests. Period 2 utility is discounted at the rate of time-preference $\theta > 0$. Earnings capacity may be a function of state of health, but in this paper, earnings are confined to the early part of the life cycle where the relationship may, for simplicity, be ignored.

In each period i of his life, the individual has a probability π_i of falling sick, in which event he undergoes a fixed amount of medical treatment, at a cost to him or to an insurance company of m_i. The values of π_i and m_i are assumed to be smaller in period 1 than in period 2, and for each i, $\pi_i \in (0,1)$. The central concern of this paper is with the intertemporal dimension of the insurance decision, and not with interpersonal differences other than age, and therefore π_i and m_i are assumed to be the same for all individuals within a given generation.

Although medical treatment exhibits considerable indivisibility, consumption of medical services in a given state of health is in practice likely to have some degree of price-elasticity, a larger quantity being demanded when insurance is in place. For simplicity, and given that moral hazard is not a central concern here, this consideration is ignored.

Individual utility u in each period i is assumed to be a state-uniform function of consumption c_i, with $u' > 0$ everywhere. The individual is assumed to be risk-averse, so that the utility function is strictly concave, i.e. $u'' < 0$.

There is available a single type of insurance contract giving full cover at a premium p_i in each period i of the individual's life. Premiums are set to equate total premium-income to the insurer's expected costs, and are deductible for income tax purposes at the tax-rate $\tau \in [0,1)$.[2] Initially, it is assumed that the individual may choose the proportions t_1 and t_2 of health risk to be insured in each period i of the life-cycle, with $t_i \in [0,1]$, at corresponding proportions of the full premiums. For simplicity, it is assumed that claims carry no excess.

The contract specifies that medical expenses will be reimbursed if they are incurred in period i: just as happens in practice, it is the event of liability for medical expenses that is covered, rather than the event and extent of

2. Initially, τ is assumed to be the same in each period. With no loss of generality, deductions other than medical insurance premiums are ignored.

sickness. This paper does not explore the moral hazard to which this may give rise.

The size of the insured population is assumed to remain constant over time, with constant fractions $1-\varphi$ and φ respectively in the "young" and "old" cohorts at each date.

Among possible premium-structures, a "community-rated" premium is the same (*ceteris paribus*) in each period of the life cycle and is based on average claims experience. Alternatively, under "experience rating" the premium in period i reflects π_i and m_i only, and in the case of zero profits and zero administration costs, it satisfies $p_i = \pi_i m_i$, each i. The significance of experience rating is that it would probably be the basis of the premium-structure in an unregulated market.

2.2 *Individual Optimization with Insurance*

The individual chooses consumption c and saving S at each date and state so as to maximize the present value of expected utility subject to state-contingent budget constraints for each period, and the Lagrangean is:

$$\begin{aligned}
L_1 = {} & \pi_1 u(c_{s1}) + (1-\pi_1)u(c_{h1}) \\
& + \frac{1}{1+\theta}[\pi_1\pi_2 u(c^*_{s2}) + \pi_1(1-\pi_2)u(c^*_{h2}) + (1-\pi_1)\pi_2 u(c_{s2}) + (1-\pi_1)(1-\pi_2)u(c_{h2})] \\
& + \lambda_1[(1-\tau)y - S_s - (1-t_1)m_1 - t_1(1-\tau)p_1 - c_{s1}] \quad + \lambda_2[(1-\tau)y - S_h - t_1(1-\tau)p_1 - c_{h1}] \\
& + \lambda_3[(1+r)S_s - (1-t^*_2)m_2 - t^*_2(1-\tau)p_2 - c^*_{s2}] \quad + \lambda_4[(1+r)S_s - t^*_2(1-\tau)p_2 - c^*_{h2}] \\
& + \lambda_5[(1+r)S_h - (1-t_2)m_2 - t_2(1-\tau)p_2 - c_{s2}] \quad + \lambda_6[(1+r)S_h - t_2(1-\tau)p_2 - c_{h2}]
\end{aligned} \tag{1}$$

Subscripts s and h indicate sick and healthy, and an asterisk indicates a decision variable at date 2 following sickness at date 1.[3]

The Lagrange multipliers λ_1 to λ_6 are all assumed to be positive at the optimum, so the corresponding constraints bind. Also, the optimal values of c_{s1}, c_{h1}, c^*_{s2}, c^*_{h2}, c_{s2}, c_{h2}, S_s and S_h are assumed to be positive, so that the corresponding partial derivatives of L_1 all vanish. However $\frac{\partial L_1}{\partial t_1} \leq 0$, $\frac{\partial L_1}{\partial t^*_2} \leq 0$ and $\frac{\partial L_1}{\partial t_2} \leq 0$ at the optimum, allowing for the possibility of zero values for t_1, t^*_2 and t_2.

The first order conditions for the consumption and savings variables may be combined to obtain:

3. Consumption at date 2 depends not only on the state at date 2, but also on the state at date 1: this latter dependency arises because of date 2 consumption's dependence on (state-contingent) saving at date 1.

$$u'(c_{s1}) = \frac{1+r}{1+\theta}[\pi_2 u'(c^*_{s2}) + (1-\pi_2)\, u'(c^*_{h2})] \tag{2}$$

$$u'(c_{h1}) = \frac{1+r}{1+\theta}[\pi_2 u'(c_{s2}) + (1-\pi_2)\, u'(c_{h2})] \tag{3}$$

and furthermore, after eliminating the Lagrange multipliers,

$$\frac{\partial L_1}{\partial t_1} = \pi_1 u'(c_{s1})m_1 - (1-\tau)[\pi_1 u'(c_{s1}) + (1-\pi_1)u'(c_{h1})]p_1 \qquad \leq 0 \tag{4}$$

$$\frac{\partial L_1}{\partial t_2^*} = \frac{1}{1+\theta}\pi_1\{\pi_2 u'(c^*_{s2})\, m_2 - (1-\tau)[\pi_2 u'(c^*_{s2}) + (1-\pi_2)u'(c^*_{h2})]p_2\} \qquad \leq 0 \tag{5}$$

$$\frac{\partial L_1}{\partial t_2} = \frac{1}{1+\theta}(1-\pi_1)\, \{\pi_2 u'(c_{s2})m_2 - (1-\tau)[\pi_2 u'(c_{s2}) + (1-\pi_2)u'(c_{h2})]p_2\} \quad \leq 0 \tag{6}$$

Together with the constraints, these are necessary and sufficient for an optimum given any premium structure.

In the special case of experience rating with zero administration costs and a zero profit condition, $p_i = \pi_i m_i$, each i, and from (6),

$$\begin{aligned}\frac{\partial L_1}{\partial t_2} &= \frac{1}{1+\theta}(1-\pi_1)p_2[u'(c_{s2}) - (1-\tau)(\pi_2 u'(c_{s2}) + (1-\pi_2)u'(c_{h2}))] \\ &= \frac{1}{1+\theta}(1-\pi_1)p_2 u'_{s2}\, [1-(1-\tau)\pi_2(1 + \frac{1-\pi_2}{\pi_2}\frac{u'_{h2}}{u'_{s2}})] \text{ in an obvious notation.}\end{aligned}$$

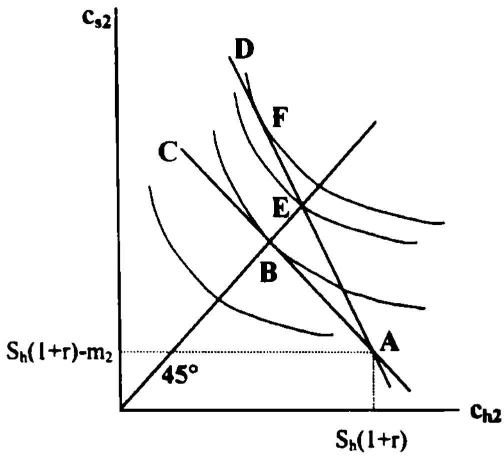
If $t_2 > 0, \frac{\partial L_1}{\partial t_2} = 0$, and $\frac{1-\pi_2}{\pi_2}\frac{u'_{h2}}{u'_{s2}} = \frac{1-(1-\tau)\pi_2}{(1-\tau)\pi_2}$, so $\frac{u'_{h2}}{u'_{s2}} > 1$ unless $\tau = 0$.[4] If $\tau = 0$, $\frac{u'_{h2}}{u'_{s2}} = 1$ and the optimum has $c_{s2} = c_{h2}$: i.e., the consumer buys full insurance at a tangency point on the 45° line in Figure 1 where the marginal rate of substitution between consumption in each state equals the tradeoff offered by insurance. In the alternative case $\tau \in (0,1)$, the consumer would like to choose $c_{s2} > c_{h2}$, but assuming that t_2 may not exceed unity, the tangency solution is not possible, and again full insurance is demanded.[5] Condition (5) has similar

4. $\frac{\partial L_1}{\partial t_2} < 0$ is not possible under experience rating, because it implies (a) $t_2=0$, i.e., a point such as A in Figure 1; (b) the slope (in absolute value) of the indifference curve $\frac{1-\pi_2}{\pi_2}\frac{u'_{h2}}{u'_{s2}} > \frac{1-(1-\tau)\pi_2}{(1-\tau)\pi_2}$, so $\frac{u'_{h2}}{u'_{s2}} > 1$ and the indifference curve is steeper than at the intersection with the 45° line. Together, (a) and (b) are inconsistent with strict concavity of u.

5. This may be shown formally by adding a term $\lambda_7(1-t_2)$ to the Lagrangean.

implications for period 2 following a sick state in period 1, and we may write $c_{s2}=c_{h2}=c_2$ and $c^*_{s2}=c^*_{h2}=c^*_2$.

Figure 1: *The Insurance Decision in Period 2 with Experience Rating.*



Indifference curves: for expected utility.

Opportunities:
A: state-contingent consumption, no insurance.
AC: consumption opportunities for experience-rated insurance, premiums non-deductible.

At the tangency optimum **B**, the the slope of AC, $-\frac{1-\pi_2}{\pi_2}$, equals the MRS: $-\frac{1-\pi_2}{\pi_2}\frac{u'_{h2}}{u'_{s2}}$ between consumption in each state.

With premiums deductible, opportunities are **AD**, whose slope is $-\frac{1-(1-\tau)\pi_2}{(1-\tau)\pi_2}$. The optimum is the tangency **F**, if permitted. The restriction $0 \leq t_2 \leq 1$ puts the optimum at **E**, with full insurance.

It follows from a similar analysis of condition (4) with $\pi_1 m_1 = p_1$, using (2) and (3) together with the results for c_2 and c^*_2, that $c_{s1} = c_{h1}$, and full insurance is demanded in the first period under experience rating, just as it is in the second.

2.3 *The Optimal Premium-Structure*

How would the individual prefer his premium payments to be structured? This may be answered by constrained maximization of the individual maximizer's indirect expected utility function[6] $V(\bullet, p_1, p_2)$, where $\bullet$ indicates a vector of parameters other than premium-rates. Properties of V follow from applying the envelope theorem to the Lagrangean (1) in the individual's optimization problem, from which:

$$\frac{\partial V}{\partial p_1} = -t_1(1-\tau)(\lambda_1 + \lambda_2) \text{ and } \frac{\partial V}{\partial p_2} = -(1-\tau)\{(\lambda_3 + \lambda_4)t^*_2 + (\lambda_5 + \lambda_6)t_2\}$$

6. I.e., the maximum value function, expressing maximized expected utility as a function of the parameters of the problem.

where the λs are evaluated at the individual optimum. The first-order conditions in the individual's optimization problem include:

$$\frac{\partial L_1}{\partial S_s} = -\lambda_1 + (\lambda_3+\lambda_4)(1+r) = 0 \text{ and } \frac{\partial L_1}{\partial S_h} = -\lambda_2 + (\lambda_5+\lambda_6)(1+r) = 0$$

so that:

$$\frac{\partial V}{\partial p_2} = \frac{-(1-\tau)(\lambda_1 t_2^* + \lambda_2 t_2)}{1+r}.$$

For the problem of finding the optimal premium structure, the Lagrangean is:

$$L_2 = V + \mu[(1-\phi)t_1(p_1 - \pi_1 m_1) + \phi\{\pi_1 t_2^* + (1-\pi_1)t_2\}\{p_2 - \pi_2 m_2\} - \alpha] \tag{7}$$

where α is average per-client administration cost, μ is a Lagrange multiplier, and the constraint is the insurance company's no-profit condition taking account of the two generations who are alive at a given time. It is assumed that $\mu > 0$ always, to ensure zero profits. The representative individual has a two-period horizon for utility maximization, but when setting premiums the insurer is only concerned with covering costs in the current period. Optimality is viewed from an individualistic perspective, and the solution is the premium-stucture that maximizes the individual's maximized utility.

A particularly tractable case arises when t_1, t_2 and t_2^* are fixed by the insurer at the value 1, and this in fact characterises the type of contracts available in Ireland from VHI or BUPA: each insurer sells a range of plans or schemes, but each of these is offered on an all-or-nothing basis. Generally, claims carry a fixed excess, but this does not affect the analysis at this point.

Assuming that $t_1 = t_2 = t_2^* = 1$ always, then from (7) and the properties of V, the Kuhn-Tucker conditions include:

$$\frac{\partial L_2}{\partial p_1} = -(1-\tau)(\lambda_1 + \lambda_2) + \mu(1-\varphi) \leq 0 \tag{8}$$

$$\frac{\partial L_2}{\partial p_2} = \frac{-(1-\tau)(\lambda_1+\lambda_2)}{1+r} + \mu\varphi \leq 0 \tag{9}$$

From (8) and (9), it is only possible for $p_i > 0$ at the optimum for both i if $1-\varphi = \varphi(1+r)$ so that $\varphi = 1/(2+r) = \varphi(r)$ say. Moreover:

	— if $\varphi > \varphi(r)$,	$p_1 = 0$ and $p_2 > 0$	— case I;
while	— if $\varphi < \varphi(r)$,	$p_1 > 0$ and $p_2 = 0$	— case II.

By inspection, $\varphi(r)$ is quite insensitive to the after-tax real interest rate r: $\varphi(-0.05) = 0.513$; $\varphi(0) = 0.5$; $\varphi(0.01) = 0.498$; $\varphi(0.05) = 0.488$; $\varphi(0.1) = 0.476$.

A corner-optimum is almost certain, with a positive premium preferred in one period of the life cycle only. With a positive interest rate, this is certainly the second period if the fraction φ of the insured population in the "old" cohort is at least 0.5, and the first period if φ is below about 0.475. For consumers buying an "all-or-nothing" insurance contract, where $t_1 = t_2 = t_2^* = 1$ always, the optimal premium structure involves sharing all the burden among the larger age-cohort, adjusted by the interest rate, at each date.[7]

The argument may be modified by assuming that the relevant rate of income tax varies over the life cycle: plausibly, for example, it might be lower later in life under a progressive tax system, after the peak years for earnings have been passed. In this case, it may be shown that the critical value $\varphi(r)$ exceeds $1/(2+r)$,[8] increasing the possibility that $\varphi < \varphi(r)$, i.e., case II.

Unless by chance φ equals the critical value $\varphi(r)$, the optimal solution invites moral hazard. Under the case II premium structure, $p_2 = 0$, and at each date the "old" cohort would pay nothing for medical care, and have no incentive to economise in its use. Alternatively, this would be the circumstance of the "young" cohort at each date in case I, where $p_1 = 0$, but the matter would be even more serious in that the young would have an incentive to take free cover and then exit after one period, unless they were inescapably locked into a two-period contract.

The question then arises: if the first-best optima must be ruled out because of their potential for moral hazard, would the consumer prefer experience rating to community rating, as second-best? This depends on the nature of the first-best optimum. In case I, experience rating is preferred to community rating, being closer to the first-best optimum.[9] In case II, community rating is preferred, and moreover the higher the tax-rate in the first period relative to the second, the more likely is this case to occur.

In the case II first-best optimum, from the constraint in (7) with $p_2 = 0$, $p_1 = \pi_1 m_1 + \pi_2 m_2 \varphi/(1-\varphi) + \alpha/(1-\varphi) = \pi_1 m_1 + \alpha + (\pi_2 m_2 + \alpha)\varphi/(1-\varphi)$.

7. An alternative approach to this is to notice that the individual's MRS ($\frac{dp_2}{dp_1}$) between £1 of current and future premium is given by $-\frac{\partial V}{\partial p_2} / \frac{\partial V}{\partial p_1} = -(1+r)$, which is unlikely to equal the corresponding MRS for the insurer, $-(1-\varphi)/\varphi$.

8. With differential tax rates τ_1 and τ_2, $\varphi(r)$ is $1/[1+(1+r)T]$, where $T = (1-\tau_1)/(1-\tau_2)$. $T \in (0,1)$ when $\tau_2 < \tau_1$.

9. Formally, the impact on V of changing premiums is: $dV = \frac{\partial V}{\partial p_1}dp_1 + \frac{\partial V}{\partial p_2}dp_2 = -(1-\tau)(\lambda_1 + \lambda_2)[dp_1 + \frac{1}{1+r}dp_2]$, and using $dp_2 = -dp_1(1-\varphi)/\varphi$ for constant premium income, $dV = Xdp_1$ say. In case I, $\varphi > \varphi(r)$, $X<0$, and the optimal solution has $p_1=0$. Moving from community rating to experience rating involves $dp_1<0$, so $dV>0$. In case II, such a move yields $dV<0$ because $X>0$.

Since $\varphi(r)/(1-\varphi(r))=1/(1+r)$ and $\varphi<\varphi(r)$, then $p_1 < \pi_1 m_1 + \alpha + P.V.(\pi_2 m_2 + \alpha)$: the markup over the experience-rated value of p_1 is smaller than the present value of expected medical costs in period 2 (or equivalently, the present value of the period 2 experience-rated premium). Community rating is second-best in this case, and compared with experience rating, it follows from $\varphi<\varphi(r)$ that the two-period flow of community-rated premiums has a lower present value.

III COMMUNITY RATING AND ADVERSE SELECTION

If the premium is community-rated and administration costs are ignored,[10] and if also the consumer is allowed free choice within [0,1] over t_1, t_2 and t_2^*, then

$$p_1 = p_2 = p = \frac{(1-\varphi)t_1\pi_1 m_1 + \varphi(\pi_1 t_2^* + (1-\pi_1)t_2)\pi_2 m_2}{(1-\varphi)t_1 + \varphi(\pi_1 t_2^* + (1-\pi_1)t_2)}.$$

From $\pi_1 < \pi_2$ and $m_1 < m_2$ it follows that in the second period p is less than the actuarially fair value $\pi_2 m_2$ and the consumer will wish to buy full insurance, i.e., $t_2^* = t_2 = 1$ always; the analysis is similar to that of the effect of deductibility on experience-rated insurance. In this case, $c_{s2}^* = c_{h2}^* = c_2^*$ and $c_{s2} = c_{h2} = c_2$.[11]

Given the expression for p, it is clear that it cannot be computed by the insurance company independently of the "young" cohort's reaction to it, i.e., of the value of t_1. However, it is assumed from this point that only full insurance is allowed. Thus, $t_1=1$ and $t_1=0$ are the only *ex post* possibilities, no matter what the young cohort's preference may be as regards t_1 (see below). In this case, the previous expression simplifies to $p_1 = p_2 = p = (1-\varphi)\pi_1 m_1 + \varphi\pi_2 m_2$, which is now taken to define the community-rated premium.

10. Administration costs are ignored for simplicity. Their inclusion would make adverse selection more likely. The community-rated premium defined here in effect gives different amounts of treatment to young and old at a standard premium. For example, this is the position in Ireland where a given VHI plan is offered to everyone at the same premium, and the amount that may be claimed is to a great extent open-ended. Thus, the price of £1 of cover is in effect lower for the old, whose claims are higher. This definition of community rating differs from the "pooling contracts" that appear in the literature, for example Zweifel and Breyer (1997, p. 141), wherein the price of a unit of cover is constant between different risk-groups.

11. An implication of conditions (2) and (3) along with strict concavity is that if $c_{s1} > c_{h1}$ (which, arguably, could occur through some combination of insurance with different levels of savings in each state), then $c_2^* > c_2$ and therefore $S_s > S_h$. However, this violates the period-1 income constraints and therefore $c_{s1} \leq c_{h1}$ and $c_2^* \leq c_2$ must hold. It is easy to show that both are satisfied as equalities if and only if $t_1=1$, and as strict inequalities otherwise. This finding is used below.

From (4), the first-order condition for t_1 is

$$\frac{1-\pi_1}{\pi_1}\frac{u'_{h1}}{u'_{s1}} \geq \frac{1-(1-\tau)p/m_1}{(1-\tau)p/m_1} \tag{10}$$

Here, adverse selection may occur in period 1. Noting that $\pi_1 < p/m_1$, it is clear that without deductibility, full insurance is not chosen in period 1. The optimum in (c_{h1}, c_{s1}) space lies below the 45° line, so that $t_1 < 1$ (see footnote 11), either at a tangency where $t_1 \in (0,1)$, or at a corner where $t_1 = 0$. In the latter case adverse selection occurs. It may also occur in the former, where the consumer would prefer a fractional value of t_1, but is only permitted full insurance or none: then, the outcome cannot be determined *a priori*. Deductibility pushes the solution towards full insurance, and reaches it for certain if $(1-\tau)p/m_1 \leq \pi_1$.

Let $\pi_2 m_2 = (1+\delta)\pi_1 m_1$, where $\delta > 0$. Then $p = (1-\varphi)\pi_1 m_1 + \varphi\pi_2 m_2 = \pi_1 m_1(1+\varphi\delta)$, and using (10), the condition $\frac{\partial L_1}{\partial t_1} < 0$ is equivalent to $\frac{1-\pi_1}{\pi_1}\frac{u'_{h1}}{u'_{s1}} > \frac{1-(1-\tau)\pi_1(1+\varphi\delta)}{(1-\tau)\pi_1(1+\varphi\delta)}$. If this holds at the optimum, then *ex ante* $t_1 = 0$ and adverse selection is certain. Since $\frac{u'_{h1}}{u'_{s1}} = 1$ on the 45° line in (c_{h1}, c_{s1}) space and is less than 1 below it, this condition cannot hold if $(1-\tau)(1+\varphi\delta) \leq 1$, and the condition $\frac{\partial L_1}{\partial t_1} < 0$ is equivalent to $(1-\tau)(1+\varphi\delta) > \frac{1}{(1-\pi_1)\frac{u'_{h1}}{u'_{s1}} + \pi_1} > 1$: i.e., the potential for adverse selection is positively related to the share φ of the "old" cohort in the insured population and to the excess expected cost per head δ of that cohort's medical treatment. However, the higher the permitted rate τ at which premiums may be deducted for tax purposes, the lower the potential for adverse selection.

An obvious question is whether a rise in p, or equivalently in φ,[12] raises the likelihood of adverse selection. The answer follows from partially differentiating the first-order conditions from Section 2.2 with respect to p, to obtain an expression of the form: $Q_1 \frac{\partial t_1}{\partial p} = [Q_2][Q_3] - Q_4$ (see Appendix). The terms Q_1, Q_2, and Q_4 are all positive, so that $Q_3 \leq 0$ is sufficient for $\frac{\partial t_1}{\partial p} < 0$. It may be shown that Q_3 has the same sign as the expression

12. $\frac{dp}{d\varphi} = \pi_2 m_2 - \pi_1 m_1$, a positive constant under *ceteris paribus* assumptions.

$$u'_{s1} u'_{h1} \frac{1}{A_{h1}} [A_2^* A_2(A_{s1}-A_{h1}) + \frac{1}{1+r} A_{s1}A_{h1}(A_2^* - A_2)]$$

where A_{s1} and A_{h1} are the coefficients of absolute risk aversion in period 1 in each state, and A_2^* and A_2 are the coefficients in period 2.

All the coefficients of risk aversion are positive, and in the case of non-decreasing absolute risk aversion $Q_3 \leq 0$, given $c_{s1} \leq c_{h1}$ and $c_2^* \leq c_2$ under community rating (see footnote 11). In this case $\frac{\partial t_1}{\partial p} < 0$: a rise in p or φ certainly increases the pressure for adverse selection. If absolute risk aversion is decreasing and $t_1 < 1$, then $A_{s1} > A_{h1}$, $A_2^* > A_2$ and $Q_3 > 0$, and when the premium p rises and real wealth falls, the substitution effect, in favour of increased consumption by the young in the healthy state and away from insurance, is partially offset by the wealth effect. In this case, which corresponds to the usual assumption about attitudes to risk,[13] the overall impact on t_1 of a change in p (or φ) is indeterminate. However, where $t_1=1$, which is the *ex post* position for purchasers of the type of contracts that are sold by VHI or BUPA, footnote 11 implies that, disregarding any excess charged, $A_{s1}-A_{h1} = A_2^* - A_2 = 0 = Q_3$, and $\frac{\partial t_1}{\partial p} < 0$ regardless of attitudes to risk (see Appendix).

These qualitative conclusions generalise standard single-period results (for example, Gravelle and Rees, 1992, p. 593), but the reactions to premium changes are not separable between the two periods: the outcome depends on the size of the risk aversion coefficients in all periods and states, and c_2^* and c_2 enter the equation as arguments of A_2^* and A_2 respectively.

So far it has been assumed that the choice lies between insuring in both periods, versus the second only. What if the latter choice is unavailable, so that insurance is available at date 2 only to persons who were insured at date 1? Then, the choice is between 2-period insurance and none. With community-rated premiums and no taxes, this is not a fair gamble. After health-related costs and without insurance, the expected present value of wealth is $y - \pi_1 m_1 - \frac{\pi_2 m_2}{1+r}$, versus a certain value if insured of $y - p_1 - \frac{p_2}{1+r}$, ignoring taxes. These are equal with experience-rated premiums, but under community rating, and continuing to assume that $t_1 = t_2^* = t_2 = 1$ *ex post,* then the certain value becomes $y - [(1-\varphi)\pi_1 m_1 + \varphi\pi_2 m_2] - \frac{(1-\varphi)\pi_1 m_1 + \varphi\pi_2 m_2}{1+r}$. If $\varphi < \varphi(r)$, this exceeds the expected value, and a risk averter certainly insures at

13. "Since we must assume that absolute risk aversion decreases with wealth to obtain results that accord with both intuition and observations of rational behaviour ... we can infer that agents must satisfy this assumption in general." (Laffont, 1989, p. 24.)

a community-rated premium. If $\varphi > \varphi(r)$, the certain value is below the expected value, in which case the acceptability of the community-rated contract depends on the parameters of the problem. Adverse selection may thus apply to both periods, rather than the first alone, and this is also true if premiums are tax-deductible.

Adverse selection gives rise to efficiency costs, and causes a problem for the insurer in that if significant numbers of young individuals reject insurance, then community-rated premiums will generate inadequate premium income. Actuarially, for each young person who rejects insurance, the insurer loses more premium income than it saves in claims avoided. Inter-generational adverse selection is the possibility investigated here. Other possibilities arise from the fact that age-differences are not the only source of variation in the probability and cost of sickness, but this issue is not pursued.

IV DISCUSSION OF RESULTS

4.1 *Summary of Conclusions*

This paper analyses non-profit medical insurance from the perspective of individual utility-maximization. It is shown that when medical insurance is only supplied on a fully-insured basis, then unless $\varphi=\varphi(r)$, the optimal premium-structure involves a zero premium in one of the two periods. Assuming that considerations of moral hazard rule this out, the second-best optimum depends on the structure of the insured population and, not very sensitively, on the net-of-tax real rate of interest, and may involve either experience rating or community rating. Community rating is second-best if the "old" cohort accounts for significantly less than half the population; moreover a differentially higher tax rate on the "young" cohort would tip the balance, not necessarily decisively, towards community rating when premiums are deductible at marginal tax rates.

With community rating and no restriction against insuring only in the second period, inter-generational adverse selection may arise, and for given expected excess medical costs in the second-period, the pressure for adverse selection is positively related to the share of the "old" cohort in the insured population, and negatively related to the rate at which premiums are deductible for tax purposes. A rise in the community-rated premium, or equivalently in the share of the old in the insured population, will reduce the proportion of medical risk that an individual wishes to insure in the first period if he is already fully insured, or if absolute risk aversion is increasing or constant in all states and in both periods. No firm conclusion is possible in the case of decreasing risk aversion if the individual is not fully insured. In all cases, there is an intertemporal dimension to this decision: it reflects attitudes to risk in both periods, not the first alone.

Where the insurance scheme may be joined only for two periods or none, adverse selection over both periods may arise from community-rated premiums, if $\varphi > \varphi(r)$. This is because, taking a lifetime perspective, a risk averter who chooses to bear his medical risk himself takes a gamble that is better than fair in this particular case.

Inititially, the insurer is assumed to be a monopolist, regulated to earn zero profits. In fact, the results have a wider applicability: the model of individual optimization (Section 2.2) and the analysis of adverse selection under community rating (Section III) are both valid for a price-taking consumer, in any market structure. It is only the analysis of optimal premiums (Section 2.3) that depends on market structure, via the constraint that governs premiums.

4.2 *Has the VHI Experienced Inter-Generational Adverse Selection?*

McDowell (1989, p. 9) shows that in the early 1980s the VHI's members' age profile was biased towards the under-55s. Since 1984, the VHI no longer publishes age-profile data in its annual reports, but in the 1992 report (p.5), it is stated that "The membership of VHI is over-representative of those in their middle years and under-representative of the 65-plus age category..." At the same time, the average age of the VHI's members has been rising, but very slowly — from 29.67 years in 1985-6 to 31.01 in 1988-9, and to 32.46 in early 1993 (Nolan, 1991, p. 133, and VHI, 1993,[14] p. 7). Finally, up to 1997, the VHI's membership has continued to grow, although data published from 1994-95 appear to be based on definitions that differ from those used earlier.[15]

These three pieces of evidence suggest that while the age-profile of the VHI's members may have been converging towards that of the whole population, growth in membership means that this convergence, and the rise in members' average age, have both been slower than would have occurred otherwise. Moreover, this evidence suggests that inter-generational adverse selection has not occurred to a great extent up to now. However, it is the growth in membership — presumably the acquisition of new members who are predominantly young and healthy — that has protected the VHI from the full impact of an ageing membership on the cost of claims (see Nolan, 1991, p. 133). Now that the VHI has to compete for market share, it is likely that

14. More recent annual reports have not included these data.

15. VHI's *Annual Reports* 1989 to 1993 show "membership of the main plans: *1988/9*: 1.108m.; *1989/0*: 1.130m; *1990/1*: 1.166m.; *1991/2*: 1.193m.; *1992/3*:1.222m. The *Annual Reports* 1996 & 1997 show "membership": *1994/5*: 1.378m.; *1995/6*: 1.399m.; *1996/7*: 1.424m. For data before 1989, see Nolan (1991, p. 148).

average age, and costs, will rise more rapidly. This will tend to raise the relative attractiveness of experience rating versus community rating, from a consumer's perspective, and there will be increased scope for adverse selection to become a problem.

Recent changes to the income-tax code work in the same direction. Premiums are now deductible at the standard rate only. To the extent that marginal tax-rates fall as taxpayers age, this change reduces the attractiveness of community rating to the young, who no longer get disproportionately favourable treatment during their years of peak earnings. Reduction to the standard rate raises the pressure for adverse selection among higher rate taxpayers, and recent reductions in the standard rate have this effect for all taxpayers.

4.3 *The Rationale for Community Rating*

Community rating may be seen as a substitute for a missing market. In an Arrow-Debreu world, markets exist, *inter alia*, for medical services at all dates. Under otherwise weak assumptions, every general competitive equilibrium allocation is Pareto efficient, provided that the set of markets is complete. In fact, there are no futures markets for medical treatment or medical insurance,[16] and insurance normally involves an annual contract. However, with community rating, the excess premium early in the life cycle may be seen as reflecting an implicit contract for future delivery: insured persons pay higher premiums while young and healthy, trusting the system to deliver in their old age.

The preceding argument reflects intertemporal considerations, but there is also a cross-sectional aspect that illustrates the shortcomings of the standard model of individual utility maximization in this context. As a matter of observation, individuals have a degree of concern for others. Insurance schemes such as those of the VHI may work partly because some young and healthy individuals pay premiums that exceed the actuarially fair computation. This may perhaps be explained partly through lack of competition in the past, and partly through the tax relief on premiums. Other possibilities include irrationality, or misinformation about health risks and costs of treatment, but such explanations contradict the standard assumptions of economic theory. A full explanation may include an element of altruism.

With experience rating, differentially high premiums would be payable by individuals subject to high risk, for example the elderly, or high cost of treatment, for example people with a history of chronic illness. Compared

16. For hedging by individuals. Trading began in health insurance futures and options contracts at the Chicago Board of Trade in 1993, but these contracts are designed for risk-hedging by insurers and reinsurers. See Hayes *et al*. (1993).

with a system of community rating, some groups might be excluded from insurance altogether, through inadequate income. Of course, this may be the outcome of community rating as well, if adverse selection becomes dominant. The imposition of a maximum age of admission to insurance schemes may be seen as a defence against this, but a defence that is weak, given the high value of the maximum at 65 years.

REFERENCES

ACTS OF THE OIREACHTAS, 1957. No.1, *Voluntary Health Insurance Act*.

ACTS OF THE OIREACHTAS, 1994. No.16, *Health Insurance Act*.

ACTS OF THE OIREACHTAS, 1996. No.4, *Voluntary Health Insurance (Amendment) Act*.

CUTLER, DAVID M., and RICHARD J. ZECKHAUSER, 1997. *Adverse Selection in Health Insurance*, Cambridge MA: National Bureau of Economic Research, Working paper 6107.

GRAVELLE, HUGH, AND RAY REES, 1992. *Microeconomics*, 2nd edition, London: Longman.

HAYES, JAMES A., JOSEPH B. COLE, and DAVID I. MEISELMAN, 1993. "Health Insurance Derivatives: The Newest Application of Modern Financial Risk Management", *Business Economics*, April, pp. 36-40.

LAFFONT, JEAN-JACQUES, 1989. *The Economics of Uncertainty and Information*, Cambridge (Mass.): The MIT Press.

McDOWELL, MOORE, 1989. *Competitive Health Insurance: The Implications of Removing the VHI Monopoly*, Dublin: University College Dublin, Centre for Economic Research, Policy Paper No. PP89/2.

NOLAN, BRIAN, 1991. *The Utilisation and Financing of Health Services in Ireland*, Dublin: The Economic and Social Research Institute, General Research Series, Paper no. 155.

PAULY, MARK V., 1974. "Overinsurance and Public Provision of Insurance: The Roles of Moral Hazard and Adverse Selection", *Quarterly Journal of Economics* LXXXVIII, pp. 44-62.

ROTHSCHILD, MICHAEL, and JOSEPH STIGLITZ, 1976. "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information", *Quarterly Journal of Economics* XC, pp. 629-649.

VHI — THE VOLUNTARY HEALTH INSURANCE BOARD, 1989 to 1997. *Report and Accounts* (32nd to 40th), Dublin: VHI.

ZWEIFEL, PETER, and FRIEDRICH BREYER, 1997. *Health Economics*, Oxford: Oxford University Press.

APPENDIX

COMPARATIVE STATIC ANALYSIS OF THE RELATIONSHIP BETWEEN t_1 AND p.

From the first-order conditions for the Lagrangean L_1 after partially differentiating with respect to p,

$$\left[\frac{A(m_1-(1-\tau)p)}{A+\frac{u''_{s1}}{1+r}}+\frac{B(1-\tau)p}{(B+\frac{u''_{h1}}{1+r})\frac{A_{s1}}{A_{h1}}}\right]\frac{\partial t_1}{\partial p}=$$

$$\left[(1-\tau)(\frac{1}{1+r}+t_1)\right]\left[\frac{A}{A+\frac{u''_{s1}}{1+r}}-\frac{B}{(B+\frac{u''_{h1}}{1+r})\frac{A_{s1}}{A_{h1}}}\right]-\frac{m_1}{A_{s1}p(m_1-(1-\tau)p)}$$

or $Q_1\frac{\partial t_1}{\partial p}=[Q_2][Q_3]-Q_4$, where $A=\frac{1+r}{1+\theta}u''(c_2^*)$, $B=\frac{1+r}{1+\theta}u''(c_2)$, and A_{s1} and A_{h1} are the coefficients of absolute risk aversion in period 1 in each state. From strict concavity, $A<0$, $B<0$, $A_{s1}>0$, $A_{h1}>0$, $u''_{s1}<0$ and $u''_{h1}<0$. Also, it is assumed that $m_1-(1-\tau)p>0$. This seems reasonable: otherwise the *only* point of insurance in period 1 would be to guarantee access to insurance in period 2, in the case of a prohibition against joining for the second period only. Clearly, Q_1, Q_2 and Q_4 are all positive, so that a sufficient but not necessary condition for $\frac{\partial t_1}{\partial p}<0$ is $Q_3\leq 0$. After combining the two ratios that define Q_3, the numerator is:

$$A(B+\frac{u''_{h1}}{1+r})\frac{A_{s1}}{A_{h1}}-B(A+\frac{u''_{s1}}{1+r}),$$ or after rearrangement,

$$u'_{s1}u'_{h1}\frac{1}{A_{h1}}[A_2^*A_2(A_{s1}-A_{h1})+\frac{1}{1+r}A_{s1}A_{h1}(A_2^*-A_2)]$$ as displayed in the text,

while the denominator is positive.

In the case where $t_1=1$, $c_{s1}=c_{h1}$ and $c_2^*=c_2$ (see footnote 11) so $A=B$, $A_{s1}=A_{h1}=A_1$ and $A_2^*=A_2$, and $Q_3=0$.

Q_1 simplifies so that $$\frac{A_2}{A_2+\frac{1}{1+r}A_1}\frac{\partial t_1}{\partial p}=-\frac{1}{A_1p(m_1-(1-\tau)p)},$$

and clearly $\frac{\partial t_1}{\partial p}<0$.