International Journal of Health Care Finance and Economics, 3, 253–266, 2003

Deductibles in Health Insurance: Pay or Pain?

GEIR B. ASHEIM g.b.asheim@econ.uio.no

University of Oslo

ANNE WENCHE EMBLEM* anne.w.emblem@hia.no

Agder University College

TORE NILSSEN tore.nilssen@econ.uio.no

University of Oslo

We study a health-insurance market where individuals are offered coverage against both medical expenditures and losses in income due to illness. Individuals vary in their level of innate ability and their probability of falling ill. If there is private information about the probability of illness and an individual's innate ability is sufficiently low, we find that competitive insurance contracts yield screening partly in the form of co-payment, i.e., a deductible in pay, and partly in the form of reduced medical treatment, i.e., a deductible in pain.

Keywords: health insurance, adverse selection, deductibles

JEL classification: I11, D82

Individuals face an inevitable risk of falling ill. Illness causes individuals to suffer a loss in income earnings and to entail expenditures on medical treatment, moreover, it causes a loss in utility *per se*. Illness thus encompasses both monetary and non-monetary losses. Traditionally, individuals are thought to hedge against potential loss in income due to permanently impaired health by holding a disability insurance, and to hedge against potential medical expenditures by holding a medical insurance. We argue, however, that disability insurance and medical insurance offer different types of coverage against the same fundamental risk, namely the *risk of falling ill*. Hence, the concept of health insurance should be expanded so as to include both types of coverage, i.e., coverage against medical expenditures and coverage against loss in earnings due to impaired health. One consequence of taking this wider view of health insurance is that insurees may prefer insurance contracts offering cash compensation in part, rather than full restoration of health, if ill.[1] In this

*Address correspondence to: Anne Wenche Emblem, Agder University College, School of Management, Servicebox 422, N-4604 Kristiansand, Norway. Fax: +47 38 14 10 27.

paper, we discuss how this expanded concept of health insurance affects the performance of a private health-insurance market with *asymmetric information*. In particular: if information about the probability of falling ill is private to the individuals, will low-risk individuals get both less medical treatment and less cash compensation (i.e., disability payment) than they would in a world of symmetric information?

In the literature on health insurance, focus is mainly placed on insurance against medical expenditures, assuming that illness entails only monetary losses (e.g., medical expenditures and temporary loss in earnings). The desire to restore health is, by and large, taken for granted.[2] When non-monetary consequences of illness are taken into account, it is assumed that utility is state dependent and that health is either not restorable or irreplaceable.[3] In this paper, we allow for both monetary and non-monetary consequences of illness without imposing the assumption that health is irreplaceable. Rather, we assume that health if ill is endogenous: poor health is improved with certainty if individuals receive medical treatment, and treatment is assumed to be divisible. Health is thus insurable, and the non-monetary consequences of illness endogenous. Our model may thus provide a bridge between models taking only monetary consequences of illness into account, and models postulating that health is irreplaceable. Flochel and Rey (2002) supplement our analysis in that they, too, study individuals' demand for health insurance when utility is a function of both consumption and health. However, they do not allow labour earnings to depend on health state, hence their analysis does not include disability insurance. Moreover, their analysis takes place in a world of symmetric information about the probability of illness.

Our study is motivated by the empirical fact that health insurance and disability insurance are integrated in a number of real-life health care systems. This is particularly prevalent in European countries where health insurance with in-kind compensation and disability insurance with cash compensation typically form parts of a public tax-financed insurance system. It seems, moreover, to be a fact that high-income individuals hold insurance contracts entitling them to more extensive and higher quality health care services than do low-income individuals. Also, disability insurance seems to be of greater importance for low-income individuals than for high-income individuals. We do not aspire to provide a definite answer to why this is so, but hope to shed some light on the question by studying how individuals with different levels of earning capabilities and different probabilities of falling ill will choose to be compensated if ill. Our analysis takes place under the assumption that insurance is supplied in a private insurance market. However, if individuals' entitlements are commensurate with their contributions, i.e., no redistribution, then our findings would apply also to the design of information-constrained Pareto efficient social-insurance contracts.

In our model, individuals differ along two dimensions: ability and risk. Information about ability is assumed to be symmetrically distributed, while information about risk (i.e., the probability of falling ill) is private to the individual. Some individuals are robust: they have a low probability of falling ill. Others are frail: they have a high such probability. They have identical preferences over consumption and health. Individuals can recover partially or completely from an illness if they receive partial or complete medical treatment, respectively. Their problem is to decide *ex ante* how much income to transfer between the two possible states of the world, healthy or ill, and if ill, how to allocate income between consumption and health (i.e., medical treatment). The insurance contracts are thus allowed to be specified along *three dimensions*: (i) consumption if healthy, (ii) consumption if ill, and (iii) treatment if ill. A proper analysis of the market for health insurance will have to take this feature of the contracts involved into account. Our analysis thus contrasts with the text-book setting where insurance usually covers medical expenditures only and individuals differ with respect to their risk of falling ill only.

When there is asymmetric information on risk, it follows from the analysis of Rothschild and Stiglitz (1976) that contracts can be differentiated in terms of the premium paid by the insured and the level of coverage provided; see, e.g., Zweifel and Breyer (1997, chs. 5 and 6) for a health-insurance exposition. Rothschild and Stiglitz show that, under certain conditions, a separating equilibrium exists in which each insurer offers a menu of insurance contracts. Frail individuals (i.e., those with a high probability of falling ill) are offered full insurance coverage, while robust individuals (with a low such probability) are offered partial coverage only. In this standard set-up, partial coverage means a reduction in the compensation paid for medical expenditures, i.e., a monetary deductible. As argued above, health insurance involves three-dimensional contracts and it is, therefore, necessary to extend the Rothschild-Stiglitz analysis to such a three-dimensional case. This is what we set out to do in the subsequent analysis.

The paper is organized as follows. In Section 1, we outline the model and characterize insurance contracts satisfying the self-selection constraints. Individuals' choice between consumption and medical treatment if ill is shown not to change relative to a situation with symmetric information. Insurers consequently do not have to place any restrictions on how individuals allocate the insurance indemnity if ill. Our three-dimensional problem therefore reduces to one of only two dimensions: (i) consumption if healthy, and (ii) consumption if ill. In Section 2, analogously to Rothschild and Stiglitz (1976), we find separating contracts in which frail individuals obtain their first-best level of coverage, while robust individuals are constrained in order for insurers to induce self-selection. In Section 3, we study the comparative statics with respect to individuals' level of innate ability and investigate what level of medical treatment and consumption these separating contracts lead to if illness occurs. Insurers screen individuals through deductibles, and we show that robust individuals face a deductible in their level of insurance coverage. In particular, robust individuals with a sufficiently high level of innate ability will have a deductible in the form of co-payment only, i.e., deductible in pay. Robust individuals with a sufficiently low level of innate ability, on the other hand, will have part of the deductible in the form of reduced treatment, i.e., deductible in pain. In contrast, frail individuals are offered their first-best optimal level of insurance coverage. In particular, frail individuals with a sufficiently high level of ability obtain complete treatment if ill, while those with a sufficiently low ability obtain their optimal level of (partial) treatment and their optimal level of disability payment if ill. Our findings and their implications are discussed in Section 4.

1. The Model

We model a setting where individuals have preferences over consumption (c) and health (h). Each individual faces uncertainty with respect to her state of health. There are two such (jointly exhaustive and verifiable) states. In state 1, the individual is healthy and has a level of health normalized to 1: $h_1 = 1$. In state 2, she is ill and suffers a complete loss in health: $h_2 = 0$. Health if ill may, however, be partly or fully restored with certainty through medical treatment $t \in [0, 1]$, and health improves instantly. Medical treatment leading to full recovery (i.e., $t = 1$) costs C, while treatment at rate t costs tC. Treatment is thus measured as the fraction of total cost (C) spent on treatment.[4] Consequently, if the individual receives complete medical treatment, i.e., $t = 1$, health if ill is fully restored: $h_2 = 1$. If no treatment is received, i.e., $t = 0$, then health equals zero: $h_2 = 0$. Health if ill is thus given by $h_2 = t$. Consumption in the two states are denoted c_1 and c_2, respectively.

The individuals know their objective probability of falling ill, which is either high or low: The probability of falling ill is π_j for type-j individuals, where $j = F, R$ denotes frail (high-risk) and robust (low-risk) individuals, respectively, and $0 < \pi_R < \pi_F < 1$. Individuals maximize the von Neumann-Morgenstern expected utility function:

$$(1 - \pi_j)u(c_1, 1) + \pi_j u(c_2, t), \tag{1}$$

where $u(c, h)$ is a Bernoulli utility function. We assume that $u : \mathcal{R}^2_+ \to \mathcal{R}$ is twice continuously differentiable and strictly concave, and satisfies: $\forall (c, h) \in \mathcal{R}^2_{++}$, $u_c > 0$, and $u_h > 0$, where partial derivatives are denoted by subscripts. A strictly concave utility function implies that individuals are risk averse. We also assume that $u_{ch} > 0$. Hence, in addition to being an important factor of well-being in its own right, health affects an individual's ability to enjoy consumption. Moreover, $u_c(c, h) \to \infty$ as $c \downarrow 0$ whenever $h > 0$, and $u_h(c, h) \to \infty$ as $h \downarrow 0$ whenever $c > 0$, and $u_c(c, h) \to \infty$ or $u_h(c, h) \to \infty$ as $c \downarrow 0$ and $h \downarrow 0$. Note that our assumptions on u imply normality.[5]

Introducing health as an argument in the utility function bears resemblance to the literature on insurance with state-dependent utility; see, e.g., Zeckhauser (1970), Arrow (1974), Cook and Graham (1977), Viscusi and Evans (1990), Evans and Viscusi (1991), and Frech (1994). In these discussions, health is an unalterable characteristic of the state and they therefore fit well with the insurance being purely a disability insurance. Our formulation can be seen as filling the gap between a pure disability insurance, where the reduced health following illness is inevitable and irreversible (and thus a formulation where a state-dependent utility is appropriate), and a pure medical insurance, where the insurance coverage is used to its full extent on medical treatment in order to restore health as much as possible to its pre-illness level.[6]

Individuals' innate capacity to generate income is henceforth referred to as 'ability' and denoted by A. We choose our monetary unity so that total earnings are equal to A when in good health. Since leisure is not included in the utility function (cf. equation (1)), we implicitly assume that leisure (and thus labour supply) is constant across individuals and states. In addition, we assume that individuals, by spending tC on treatment, will generate earnings equal to tA when ill. Hence, labour earnings in state 2 are proportional to treatment t. Information about an individual's A is *symmetrically distributed*.

Individuals are risk averse and, consequently, willing to insure against the uncertainty they face. Buying insurance is the only way that an individual can transfer income across the two states. Her budget constraints in states 1 and 2 are respectively given by:

$$c_1 + P = A \tag{2}$$

and

$$c_2 + P + tC = tA + I, \tag{3}$$

where P is the total insurance premium and I the insurance benefit.

The insurance market is competitive, with risk-neutral, profit-maximizing insurers earning zero expected profits. Insurance is thus offered at an actuarially fair premium:

$$P = \pi_j I, \quad j = F,\ R. \tag{4}$$

As is standard in the insurance literature, we assume that individuals cannot buy more than one insurance contract.[7] We assume that information about which disease an individual suffers from and, consequently, the associated costs of treatment, is known by both insurer and insuree. The insurers know the proportions of frail and robust individuals, while information about each individual's risk type is *asymmetric*. To simplify, we assume that individuals can influence neither the probability of falling ill nor the costs associated with the illness, i.e., there is no moral hazard.

Combining equations (2)–(4), we get:

$$(1 - \pi_j)(A - c_1) + \pi_j(tA - tC - c_2) = 0, \quad j = F,\ R, \tag{5}$$

which gives the insurers' zero-profit condition.

2. Separating Equilibrium

For reasons similar to those in Rothschild and Stiglitz (1976), a (pure-strategy) Nash equilibrium, if it exists, is separating.[8] The insurers face informational constraints in the design of insurance contracts. Indeed, they face a self-selection constraint in that frail individuals may masquerade as robust individuals in order to get insurance at a lower premium. In order to induce individuals to reveal their probabilities of falling ill, insurers offer a menu of insurance contracts from which individuals can choose. Each contract is designed with a particular type of individual in mind and, since there are two risk types, only two types of contracts are offered. Individuals can be characterized by their *ex-ante* choices of consumption in the two states, as well as their levels of medical treatment if ill. Insurers thus have to design contracts in three dimensions, i.e., a contract for type j is: $\{c_{1j}, c_{2j}, t_j\}$, $j = F,\ R$. In order to ensure that a pure-strategy equilibrium exists, we assume that there are relatively few robust individuals.

We first characterize the contract intended for *frail* individuals. As shown in the appendix, robust individuals do not wish to masquerade as frail individuals and we can, therefore, ignore the self-selection constraint on robust individuals. The contract offered frail individuals constitutes the solution to the following program:

$$\max_{c_1, c_2, t} (1 - \pi_F)u(c_1, 1) + \pi_F u(c_2, t)$$

subject to:

$$(1-\pi_F)(A-c_1)+\pi_F(tA-tC-c_2)=0,$$
$$t \leq 1.$$

The first constraint is the insurers' zero-profit condition. The second constraint reflects that individuals cannot more than fully restore health. (In addition, there is a non-negativity constraint on t that never binds because of the assumptions we have made on u.) Let the multipliers associated with the constraints be respectively μ_F and ϕ_F, and write the Lagrangian as follows:

$$\begin{aligned}\mathcal{L} &= (1-\pi_F)u(c_1,1)+\pi_F u(c_2,t)\\ &\quad +\mu_F((1-\pi_F)A+\pi_F tA-(1-\pi_F)c_1-\pi_F(c_2+tC))+\phi_F(1-t).\end{aligned}$$

The Lagrangian first-order necessary conditions are:

$$\frac{\partial\mathcal{L}}{\partial c_1} = (1-\pi_F)u_c(c_{1F},1)-\mu_F(1-\pi_F)\leq 0 \tag{6}$$
$$\frac{\partial\mathcal{L}}{\partial c_2} = \pi_F u_c(c_{2F},t_F)-\mu_F\pi_F \leq 0 \tag{7}$$
$$\frac{\partial\mathcal{L}}{\partial t} = \pi_F u_h(c_{2F},t_F)+\mu_F\pi_F(A-C)-\phi_F \leq 0. \tag{8}$$

Since c_1, c_2, and t are positive (by the properties of u), it follows from the complementary-slackness conditions that the marginal conditions will hold as equalities. From equations (6) and (7), we get:

$$u_c(c_{1F},1)=u_c(c_{2F},t_F), \tag{9}$$

i.e., frail individuals' marginal utility from consumption is equal across states. Combining equations (7) and (8), we find:

$$\frac{u_h(c_2,t_F)}{u_c(c_2,t_F)}+A = C+\frac{\phi_F}{\mu_F}\frac{1}{\pi_F}. \tag{10}$$

The left-hand side here is the *marginal willingness to pay for treatment* and is given by the sum of the marginal rate of substitution of consumption for health, $u_h(c_2,t_F)/u_c(c_2,t_F)$, and the additional earnings capacity generated by a marginal increase in treatment, A. Hence, frail individuals choose consumption and treatment if ill such that marginal willingness to pay for treatment equals the marginal cost of treatment plus the marginal imputed costs associated with the treatment constraint. The insurers' zero-profit condition obviously binds, hence $\mu_F > 0$. The marginal imputed costs incurred by restraining the individuals' level of treatment, t_F, is given by ϕ_F. According to the complementary-slackness condition, this

Lagrange multiplier may take a positive or zero value. If $t_F < 1$, then $\phi_F = 0$, and it follows that:

$$\frac{u_h(c_{2F}, t_F)}{u_c(c_{2F}, t_F)} + A = C \quad \text{if } t_F < 1.$$

Note that there are no distortions in the contract designed for frail individuals, since self-selection constraints have no effect. The equilibrium insurance contract offered to frail individuals is, therefore, *first-best efficient*.[9]

Next, we identify the contract intended for *robust* individuals. In this case, the introduction of a self-selection constraint on frail individuals is necessary since they have an incentive to masquerade as robust individuals in order to obtain lower premium. The equilibrium contract for robust individuals solves the following program:

$$\max_{c_1, c_2, t} (1 - \pi_R) u(c_1, 1) + \pi_R u(c_2, t)$$

subject to:

$$\begin{aligned}
(1 - \pi_R)(A - c_1) + \pi_R(tA - tC - c_2) &= 0, \\
(1 - \pi_F)u(c_1, 1) + \pi_F u(c_2, t) &\leq (1 - \pi_F)u(c_{1F}, 1) + \pi_F u(c_{2F}, t_F) \\
t &\leq 1.
\end{aligned}$$

The first and third constraint are as above. The second one is the self-selection constraint: Frail individuals should not wish to pretend being robust. Thus, the contract intended for robust individuals must ensure that frail individuals do not derive higher utility from choosing this contract rather than the contract intended for them. The self-selection constraint will always bind.

With Lagrangian multipliers for the three constraints being denoted μ_R, λ_R, and ϕ_R, the Lagrangian is:

$$\begin{aligned}
\mathcal{L} = {} & (1 - \pi_R)u(c_1, 1) + \pi_R u(c_2, t) \\
& + \mu_R((1 - \pi_R)A + \pi_R tA - (1 - \pi_R)c_1 - \pi_R(c_2 + tC)) \\
& + \lambda_R((1 - \pi_F)u(c_{1F}, 1) + \pi_F u(c_{2F}, t_F) - (1 - \pi_F)u(c_1, 1) - \pi_F u(c_2, t)) \\
& + \phi_R(1 - t).
\end{aligned}$$

Again, since c_1, c_2, and t are positive, it follows from the complementary-slackness conditions that the marginal conditions will hold as equalities. Thus, the first-order necessary conditions are:

$$\frac{\partial \mathcal{L}}{\partial c_1} = (1 - \pi_R)u_c(c_{1R}, 1) - \mu_R(1 - \pi_R) - \lambda_R(1 - \pi_F)u_c(c_{1R}, 1) = 0 \tag{11}$$

$$\frac{\partial \mathcal{L}}{\partial c_2} = \pi_R u_c(c_{2R}, t_R) - \mu_R \pi_R - \lambda_R \pi_F u_c(c_{2R}, t_R) = 0 \tag{12}$$

$$\frac{\partial \mathcal{L}}{\partial t} = \pi_R u_h(c_{2R}, t_R) + \mu_R (\pi_R A - \pi_R C) - \lambda_R \pi_F u_h(c_{2R}, t_R) - \phi_R = 0. \tag{13}$$

Rearranging equations (11)–(13), we get:

$$1 - \frac{\mu_R}{u_c(c_{1R}, 1)} - \frac{(1-\pi_F)}{(1-\pi_R)}\lambda_R = 0 \tag{14}$$

$$1 - \frac{\mu_R}{u_c(c_{2R}, t_R)} - \frac{\pi_F}{\pi_R}\lambda_R = 0 \tag{15}$$

$$1 + \frac{\mu_R(A-C)}{u_h(c_{2R}, t_R)} - \frac{\pi_F}{\pi_R}\lambda_R - \frac{\phi_R}{\pi_R u_h(c_{2R}, t_R)} = 0. \tag{16}$$

From equations (14) and (15), we have:

$$\frac{1}{u_c(c_{1R}, 1)} - \frac{1}{u_c(c_{2R}, t_R)} = \frac{\lambda_R}{\mu_R}\frac{\pi_F - \pi_R}{\pi_R(1-\pi_R)}, \tag{17}$$

which implies that marginal utility of consumption differs across states for robust individuals. In particular,

$$u_c(c_{2R}, t_R) > u_c(c_{1R}, 1). \tag{18}$$

In addition, from equations (15) and (16), we get:

$$\frac{u_h(c_2, t_R)}{u_c(c_2, t_R)} + A = C + \frac{\phi_R}{\mu_R}\frac{1}{\pi_R}. \tag{19}$$

Thus, marginal willingness to pay for treatment equals marginal costs of treatment plus marginal imputed costs associated with the treatment constraint. The insurers' zero-profit condition binds, hence $\mu_R > 0$. The marginal imputed costs incurred from restraining the individuals' level of treatment, t_R, is ϕ_R. Again, according to the complementary-slackness condition, this Lagrange multiplier may take a positive or zero value. If $t_R < 1$, then $\phi_R = 0$:

$$\frac{u_h(c_2, t_R)}{u_c(c_2, t_R)} + A = C \quad \text{if } t_R < 1, \tag{20}$$

We note that the allocation of income between consumption and health if ill is *first-best efficient*. The allocation of income between consumption if well and consumption if ill is, however, *not first-best efficient* (cf. equation (18)) and, subsequently, nor is the allocation of income on consumption if healthy and treatment if ill. Thus, robust individuals are restrained in their level of insurance coverage in order to induce self-selection by the frail ones.

It follows from the above discussion that neither frail nor robust individuals' choice between consumption and treatment if ill is changed compared to the case of symmetric information. Consequently, our three-dimensional problem, i.e., (i) consumption if healthy, (ii) consumption if ill, and (iii) treatment if ill, *reduces to one of only two dimensions*, namely that of (i) and (ii): how to allocate consumption across states. This implies that the level of medical treatment if ill does not have to be specified in the insurance contract.

Rationing of robust (low-risk) individuals as a way of separating risk-groups is, of course, in line with Rothschild and Stiglitz (1976). Frail individuals obtain their first-best allocation of consumption between the two states of the world. Robust individuals, on the other hand, are restrained in their level of insurance coverage compared to a situation with symmetric information and will have to accept a strictly positive deductible. The intriguing question is *whether this deductible is in pay or in pain*, i.e., does the self-selection constraint restrict robust individuals' consumption if ill, their treatment if ill, or a bit of both? This is the topic of the next section.

3. Pay or Pain?

Individuals' decisions regarding the appropriate level of insurance coverage and the allocation of insurance indemnity if ill depend on their levels of innate ability. In a world of symmetric information, Asheim, Emblem and Nilssen (2003) show that individuals may *ex ante* prefer not to equalize utility across states so that $u(c_1, 1) > u(c_2, t)$. In particular, individuals with a sufficiently low level of innate ability prefer to not fully recover from an illness, but rather spend some of the indemnity on consumption. The implications of an individual's level of innate ability on her choice of insurance contract, in the present context of asymmetric information about the probability of falling ill, is discussed more closely in the following.

Proposition 1.

(i) *If individuals have a high level of innate ability, in particular, if $A \geq C$, then, for a given positive level of insurance coverage, both robust and frail individuals choose complete treatment if ill*: $t_R = t_F = 1$.

(ii) *If individuals have a low level of innate ability, in particular, if $A \leq \pi_R C$, then, for a given positive level of insurance coverage, both robust and frail individuals choose less than complete treatment if ill*: $0 < t_R, t_F < 1$.

Proof: (i) It follows from our assumptions on u that $u_h(c_2, h_2)/u_c(c_2, h_2) > 0$. Hence, equations (10) and (19) can hold in the case when $A \geq C$ only if $\phi > 0$, which implies $t = 1$.

(ii) Note that $A \leq \pi_R C$ implies $A \leq \pi_F C$. Rewriting equation (5) as:

$$(1 - \pi_j)c_1 + \pi_j c_2 = (1 - \pi_j)A + \pi_j t(A - C), \quad j = F,\ R, \tag{21}$$

we see that the right-hand side is decreasing in t when $A \leq \pi_j C$. It follows from the properties of u that c_1, c_2, and t are positive. Suppose that $t = 1$. Now, the right-hand side of (21) reduces to: $A - \pi_j C$. Thus, with $A \leq \pi_j C$, there is nothing left for consumption, and the right-hand side will have to be increased through a reduction in t, that is, $t < 1$. □

In light of this result, we assume in the subsequent analysis that individuals have one of two levels of ability: low (A_L) and high (A_H), such that $A_L \leq \pi_R C$ and $A_H \geq C$. It follows that $A_L/\pi_F < A_L/\pi_R < C \leq A_H$, since $0 \leq \pi_R < \pi_F < 1$.[10]

The implications of the ability level for the insurance contracts when there is asymmetric information on risk can be summarized as follows:

Proposition 2. *Equilibrium insurance contracts under asymmetric information are characterized as follows.*

(a) *Among high-ability individuals* ($A_H \geq C$):

 (i) *Frail individuals face no deductibles, and receive their first-best level of insurance coverage. Their level of utility is constant across states, just like in the case of symmetric information.*

 (ii) *Robust individuals are restrained in their level of insurance coverage and have to make a co-payment. Their deductible is in pay only.*

 (iii) *In particular, frail individuals' marginal utility from consumption is equal across states, while that of robust individuals is not*: $0 = u_c(c_{2F}, t_F) - u_c(c_{1F}, 1) < u_c(c_{2R}, t_R) - u_c(c_{1R}, 1)$. *Both risk types choose complete medical treatment*: t_R, $t_F = 1$. *Hence*, $0 = c_{1F} - c_{2F} < c_{1R} - c_{2R}$.

(b) *Among low-ability individuals* ($A_L \leq \pi_R C$):

 (i) *Frail individuals face no deductibles and achieve their first-best levels of consumption and medical treatment. However, even though not constrained in their level of insurance coverage, their utility is not equal across states; this corresponds to the case of symmetric information.*

 (ii) *Robust individuals are restrained in their level of insurance coverage. They have part of the deductible in pain. Consequently, the indemnity provides for lower level of consumption and medical treatment if ill relative to a situation with symmetric information. Utility is, moreover, not equal across states.*

 (iii) *In particular, both risk-types choose a lower level of consumption if ill than if healthy*, $0 < c_{1F} - c_{2F} < c_{1R} - c_{2R}$, *and choose less than complete treatment*, $0 < t_R < t_F < 1$.

Proof: We start out by establishing parts (a) and (b)(i). From the first-order conditions of the optimization problem in Section 2, we see that frail individuals' marginal utility from consumption is equal across states (cf. equation (9)), whereas robust individuals' marginal utility from consumption is not (cf. equation (17)). Frail individuals consequently receive their first-best level of insurance coverage, as stated in (a)(i) and (b)(i) of the proposition, while robust individuals do not. For high-ability individuals, $t = 1$ by Proposition 1. Thus, by equation (18), for robust high-ability individuals, $u_c(c_{1R}, 1) < u_c(c_{2R}, t_R) = u_c(c_{2R}, 1)$ and $c_{1R} > c_{2R}$. Moreover, by part (a)(i) and Proposition 1, $u_c(c_{1F}, 1) = u_c(c_{2F}, t_F) = u_c(c_{2F}, 1)$ and $c_{1F} = c_{2F}$. This completes the proof of parts (a) and (b)(i).

Parts (b)(ii) and (b)(iii) remain to be established. For low-ability individuals (both robust and frail), $t < 1$ and $c_1 > c_2$ by Proposition 1. For robust low-ability individuals, $u_c(c_1, 1) = u_c(c_2, t)$ in first best and $u_c(c_1, 1) < u_c(c_2, t)$ under asymmetric information (cf. equation (18)). Since u is strictly concave, it follows from the zero-profit condition that c_{1R} is higher and $u(c_{2R}, t_R)$ is lower than they would have been in first-best. It now follows from the normality of c and h that both c_{2R} and t_R are lower than they would have been in first best. The consumption of frail low-ability individuals, c_{1F}, is, due to their higher cost of insurance, smaller than what robust low-ability individuals would have got in first-best, which in turn is smaller than c_{1R}, i.e., $c_{1F} < c_{1R}$. It now follows from the frail low-ability individuals' self-selection constraint that $u(c_{2R}, t_R) < u(c_{2F}, t_F)$. By normality, this implies that $c_{2R} < c_{2F}$ and $t_R < t_F$. □

We briefly restate the main results derived in the above analysis. Robust individuals are constrained in their level of insurance coverage because of the problem of self-selection. As a consequence, their allocation of income on consumption across states is not first-best efficient. Their level of consumption if ill is, indeed, distorted downwards causing consumption if ill to be less than consumption if healthy: $c_{2R} < c_{1R}$. Since robust high-ability individuals' marginal willingness to pay for treatment always exceeds marginal cost of treatment, we have that $t = 1$ for this group, entailing that their level of treatment is not altered relative to the situation of symmetric information. Indeed, health if ill is fully restored: $h_1 = h_2 = 1$. The deductible imposed on robust high-ability individuals is consequently in the form of reduced consumption if ill, i.e., *deductible in pay*. Low-ability individuals' marginal willingness to pay for treatment, on the other hand, is shown to equal marginal cost of treatment only for levels of treatment less than one: $t < 1$. Hence, when faced with a reduction in the insurance indemnity, they will reduce both their level of consumption and their level of treatment, since both consumption and health are normal goods. The deductible imposed on robust low-ability individuals consequently takes the form of reduced consumption and reduced health, i.e., *deductible in pay and pain*.

Considering the outcome for low-ability individuals, we note a sharp contrast between the cases of symmetric and asymmetric information. When insurers know each insuree's probability of illness, robust (i.e., low-risk) individuals get higher consumption and more medical treatment than frail individuals. This is turned around when information about this probability is private: In order to obtain self-selection, insurers offer robust individuals a contract that provides for lower consumption and less treatment if ill than do the contract offered frail individuals.

Note that the contracts described are *information-constrained Pareto-efficient*. Like in the Rothschild-Stiglitz model (see Crocker and Snow, 1985), the pure-strategy separating equilibrium is efficient whenever it exists.

4. Discussion

Analyzing a competitive health-insurance market under asymmetric information, we have identified separating insurance contracts that induce individuals to reveal information by means of deductibles. Our analysis takes place in a standard adverse-selection situation in which the insuree has more information about risk than does the insurer, the insurer offers a menu of contracts, and the insuree is restricted to buy all her insurance from the same insurer. However, the analysis deviates from the standard adverse selection situation in two related ways. Firstly, we assume that consumption and health are complements in utility. This implies that individuals may choose *not* to equalize utility across states in a world of symmetric information, and thus, that their optimal level of insurance coverage is even lower in a world of asymmetric information. Secondly, the consequences of the insured-against event are made endogenous: individuals can choose their level of recovery, and thus also their loss in income (i.e., monetary loss) and utility (i.e., non-monetary loss), if ill.

The *novelty* of this paper lies in the integration of medical insurance and disability insurance in a setting where adverse selection is a problem. By integrating the two types of insurance, we show that the separating scheme may involve two types of deductibles: a deductible in the form of reduced medical treatment and a monetary deductible. In fact, we find that low-ability robust individuals will have insurance contracts with both these types of deductibles, i.e., deductibles in both pay (i.e., in cash) and pain (i.e., in kind).

Our findings may be of relevance to the practical design of health-insurance contracts. Indeed, one may observe empirically that insurance contracts specify both quantity and quality of care, rather than providing a cash compensation. Individuals will consequently have access to a pre-determined level (or quality) of treatment, rather than just a cash payment. There are obviously many reasons for this, one of which being transaction costs associated with having to search for the appropriate supplier of medical treatment when ill. Thus, it is not counter-intuitive that individuals *ex ante* may find it optimal to specify their preferred level of treatment if ill, thus restricting the allocation of income when ill between consumption and health. If so, our analysis suggests that, under asymmetric information, robust individuals with low ability will achieve less treatment and less cash compensation than they would have achieved under symmetric information.

Appendix

We show here that robust individuals do not wish to masquerade as frail individuals, i.e., that they will suffer a loss in expected utility if masquerading as frail:

$$(1-\pi_R)u(c_{1R},1)+\pi_R u(c_{2R},t_R) > (1-\pi_R)u(c_{1F},1)+\pi_R u(c_{2F},t_F). \tag{22}$$

We know from Section 2 that contracts for robust individuals are designed so that frail individuals are indifferent between masquerading or not:

$$(1-\pi_F)u(c_{1F},1)+\pi_F u(c_{2F},t_F) = (1-\pi_F)u(c_{1R},1)+\pi_F u(c_{2R},t_R). \tag{23}$$

Rewriting equation (23) such that:

$$\frac{(1-\pi_F)}{\pi_F}(u(c_{1R},1)-u(c_{1F},1)) = u(c_{2F},t_F)-u(c_{2R},t_R),$$

and observing that:

$$\frac{(1-\pi_R)}{\pi_R} > \frac{(1-\pi_F)}{\pi_F},$$

it follows that:

$$\frac{(1-\pi_R)}{\pi_R}(u(c_{1R},1)-u(c_{1F},1)) > u(c_{2F},t_F)-u(c_{2R},t_R).$$

Hence, inequality (22) holds.

Acknowledgments

We are grateful to Vidar Christiansen and two anonymous referees of this journal for their valuable comments. We are also grateful for helpful comments from participants at the Nordic Health Economists' Study Group Meeting in Helsinki, and from seminar participants at Erasmus University in Rotterdam. Asheim and Nilssen gratefully acknowledge financial support for their research from the Research Council of Norway through HERO—the Health Economics Research Programme at the University of Oslo. Emblem gratefully acknowledges financial support from the SiS Programme at Agder University College.

Notes

1. See our companion paper, Asheim, Emblem and Nilssen (2003).
2. This view has been contested by authors like Byrne and Thompson (2000) and Graboyes (2000) who argue that, when the probability of successful treatment is small, the insured may be better off with cash compensation if ill, rather than going through with the treatment.
3. For more on irreplaceable commodities, see Cook and Graham (1977) and Schlesinger (1984).
4. We assume that cost of curing an illness depends on characteristics of the illness, rather than characteristics of the individuals suffering from it.
5. What is more, if we were to measure treatment in terms of utility, then it follows from the properties of u (i.e., $u_h > 0$ and $u_{hh} < 0$) that the cost of treatment would be strictly convex.
6. See also the above-mentioned contribution by Flochel and Rey (2002).
7. For a discussion of an asymmetric-information market where consumers are allowed to have transactions with more than one firm, see Beaudry and Poitevin (1995).
8. Rothschild and Stiglitz (1976) show that, if a Nash equilibrium exists, it is never a pooling equilibrium since pooling contracts are not robust to competition.
9. For more on first-best contracts, see Asheim, Emblem and Nilssen (2003), where the probability of falling ill is assumed to be public information.
10. At intermediate levels of ability, i.e., where $A \in (\pi_R C, C)$, there is a possibility for cases where the constraint on treatment ($t \leq 1$) is binding for one of the risk types only. No extra insight would be gained from incorporating such hybrid situations into the analysis.

References

Arrow, K. J. (1974). "Optimal Insurance and Generalized Deductibles." *Scandinavian Actuarial Journal* 1–42; reprinted in: *Collected Papers of Kenneth J. Arrow, vol 3: Individual Choice under Certainty and Uncertainty.* Oxford: Blackwell (1984), pp. 212–260.

Asheim, G. B., A. W. Emblem and T. Nilssen. (2003). "Health Insurance: Treatment vs. Compensation." Unpublished manuscript. University of Oslo and Agder University College. Available at: http://home.hia.no∼annewe/Treatment-Compensation.pdf.

Beaudry, P. and M. Poitevin. (1995). "Competitive Screening in Financial Markets When Borrowers Can Recontract." *Review of Economic Studies* 62, 401–423.

Byrne, M. M. and P. Thompson. (2000). "Death and Dignity: Terminal Illness and the Market for Non-Treatment." *Journal of Public Economics* 76, 263–294.

Cook, P. J. and D. A. Graham. (1977). "The Demand for Insurance and Protection: The Case of Irreplaceable Commodities." *The Quarterly Journal of Economics* 91, 143–156.

Crocker, K. J. and A. Snow. (1985). "The Efficiency of Competitive Equilibria in Insurance Markets with Asymmetric Information." *Journal of Public Economics* 26, 207–219.

Evans, W. N and W. K. Viscusi. (1991). "Utility-Based Measures of Health." *American Journal of Agricultural Economics* 73, 1422–1427.

Flochel, L. and B. Rey. (2002). "Health Care Demand and Health Insurance." Unpublished manuscript. Groupe d'Analyse et de Théorie Economique (GATE), Université Lumière Lyon II.

Frech, H. E. III. (1994). "State-Dependent Utility and the Tort System as Insurance: Strict Liability versus Negligence." *International Review of Law and Economics* 14, 261–271.

Graboyes, R. F. (2000). "Our Money or Your Life: Indemnities vs. Deductibles in Health Insurance." Working Paper 00-4, Federal Reserve Bank of Richmond. Available at: http://www.rich.frb.org/pubs/wpapers/pdfs/wp00-4.pdf.

Rothschild, M. and J. E. Stiglitz. (1976). "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information." *Quarterly Journal of Economics* 90, 629–649.

Schlesinger, H. (1984). "Optimal Insurance for Irreplaceable Commodities." *The Journal of Risk and Insurance* 51, 131–137.

Viscusi, W. K. and W. N. Evans. (1990). "Utility Functions That Depend on Health Status: Estimates and Economic Implications." *American Economic Review* 80(3), 353–374.

Zeckhauser, R. (1970). "Medical Insurance: A Case Study of the Tradeoff between Risk Spreading and Appropriate Incentives." *Journal of Economic Theory* 2, 10–26.

Zweifel, P. and F. Breyer. (1997). *Health Economics*. Oxford University Press.