

Health Insurance: Medical Treatment *vs.* Disability Payment*

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Abstract

We present arguments for treating health insurance and disability insurance in an integrated manner in economic analysis, based on a model where each individual's utility depends on both consumption and health and her income depends on her earnings ability. When purchasing insurance, she may choose a contract that offer less than full medical treatment. We find that high-ability individuals demand full recovery and equalize utility across states, while low-ability individuals demand partial treatment and cash compensation and suffer a loss in utility if ill. Our results carry over to the case where health states are not observable.

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1 Introduction

Random changes in health, *e.g.* due to illness, affect a person's well-being in several ways. One way is the direct effect of health on well-being. But there are also some indirect effects. First, reduced health may affect the person's utility from consumption. Secondly, medical expenses necessary to recover from illness reduce affordable consumption. Finally, illness may affect the ability to generate income in the first place. In this paper, we argue that a proper treatment of health risk and health insurance should take all these effects of an illness into account, and we offer a theoretical model in which to do it. In this model, an individual's utility depends on both consumption and health and her income depends on her earnings ability. When purchasing health insurance, she may choose to receive less than full medical treatment when ill, and support consumption from a combination of cash compensation and her remaining earnings ability.

While health insurance and disability insurance are in fact integrated in a number of European countries with public tax-financed (social) insurance systems, the economics literature has treated the two risks as separate problems, with the risk of medical expenditures to be covered by health insurance and the risk of losses in labour market productivity to be covered by disability insurance. The present work is an attempt at correcting this, putting a coordinating perspective on health and disability insurance. In particular, we expand the concept of health insurance to include not only coverage against medical costs but also against permanent loss in earning ability, arguing that these are two types of consequences of the same risk, *i.e.* the risk of suffering a loss in health.

Whereas health and disability insurance in most European countries is heavily subsidized — in effect, a cross-subsidization takes place from individuals with high earnings abilities to those with low abilities — our analysis addresses the question of what the outcome would be without any transfers. We find that individuals with low earnings abilities indeed trade off health for consumption. Letting insurance contracts offer individuals various combinations of medical treatment and cash compensation of income loss if they become ill, we find, in particular, that high-productivity individuals choose contracts providing full medical treatment while low-productivity individuals choose contracts offering partial medical treatment and partial compensation for loss in earnings. Low-productivity individuals consequently choose *not* to fully recuperate from an illness but rather receive cash payment that partly off-

sets the income loss due to partial impairment.¹ Moreover, even in this setting where there is symmetric information about health risks and health states, such low-productivity individuals end up being less than fully insured, in the sense that they have lower utility when ill than when healthy.

These results have interesting policy implications. Whereas there is much focus among many policy makers on the issue of providing health insurance that covers all individuals in a fair and uniform manner, our analysis points to reasons for offering a menu of health insurance contracts, where cash compensation may substitute for the right to full recovery.² In the case where health insurance schemes are also used as a means of redistributing income, our analysis indicates that this issue is related to redistribution in cash, *i.e.*, through the tax system: a low-productivity individual may actually prefer to receive support from government in the form of cash rather than in the form of improved health, since better health has a smaller effect on consumption for low-skilled people than for high-skilled ones.³

Like the traditional literature on health insurance, we focus on illnesses for which a treatment is available that fully restores pre-illness health and ability. However, in other work, individuals' desire to restore health is taken for granted.⁴ In Marchand and Schroyen (2005), for example, there is no loss of health for an individual who falls ill, only a loss of time caused by illness. In their model, high-productivity individuals get well immediately at a private practice, while low-productivity ones suffer a time loss while waiting in the public health-care system. This time loss constitutes an inefficiency, whereas the outcome in our model is efficient, with low-productivity individuals getting compensation in cash instead of full treatment.

In other work where non-monetary consequences of illness are taken into account,

¹Our findings are in accordance with the empirical observation that individuals with less schooling are more likely to be disabled than those with more schooling [*e.g.*, Haveman and Wolfe (2000)] and may provide an explanation for this correlation in addition to those traditionally put forward.

²Of course, there are normative arguments for giving all individuals the right to full recovery whenever feasible; such issues are not discussed here.

³This theme has been picked up by Fleurbaey (2006), who notes its consequences for discussions of health and equity: the poor being less healthy than the rich may in part be a result of individual preferences.

⁴One exception is Byrne and Thompson (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 the treatment. We shall assume that full treatment, if chosen, provides full restoration of health with certainty.

it is assumed that utility is state dependent and that health is either irreplaceable or not restorable.⁵ In this paper, we allow for both monetary and non-monetary consequences of illness without imposing assumptions either that health will always be fully restored or that it is irreplaceable. Thus, we provide a bridge between the health-insurance literature, which typically takes only monetary consequences of illness into account, and the disability-insurance literature postulating that health is irreplaceable or non-restorable.

Our model has the following crucial features. First, we make the reasonable assumption that an individual's productivity is affected by her health: If she suffers an illness and health is not fully restored, then her productivity will be negatively affected by the illness. The effect is that individuals with low full productivity have lower incentives for restoring health and therefore will tend to prefer contracts with cash compensation for illness.⁶ Second, we use a bivariate formulation of utility that allows for interactions between consumption and health. In particular, we make the assumption that the two are complements, *i.e.*, that an individual's marginal utility of consumption is increasing in health.⁷

Our main analysis takes place in a world of symmetric information about health risks and health states, while the individuals' ability may be private information. However, we show that our findings hold also in a situation where an individual's health is non-verifiable, *i.e.*, when insurers face problems of *ex-post* moral hazard. In fact, if *ex-post* moral hazard is a problem, then integrating medical insurance (with in-kind provision of medical treatment) and disability insurance (with cash compensation) reduces the insured individual's incentive to falsely claim to be ill when in good health; in other words, integration induces self-selection.⁸

⁵Analyses based on health being non-restorable include Zeckhauser (1970), Arrow (1974), Viscusi and Evans (1990), Evans and Viscusi (1991), and Frech (1994). Health is irreplaceable if individuals value restored health lower than pre-illness health; see Cook and Graham (1977) and Schlesinger (1984).

⁶In related work by Jack and Sheiner (1997) and Koç (2004), the demand for health insurance is discussed in a situation where, like in our model, the consumption of health care is endogenous. An important difference, however, is that these authors disregard the effect of illness on an individual's earnings ability.

⁷Such interaction is standard in analyses of disability insurance where it is called state-dependent utility; see references in footnote 5. Our assumption of complementarity between consumption and health is in line with the results from the empirical study by Finkelstein, *et al.* (2008).

⁸Asheim *et al.* (2003) analyse a version of our model with asymmetric information about an individual's probability of illness, *i.e.*, a situation where insurers face problems of adverse selection.

The outline of this paper is as follows. The model is presented in Section 2 while our main findings are derived in Section 3. We discuss the case of *ex-post* moral hazard in Section 4. Our results are discussed in a concluding Section 5. Proofs are relegated to an Appendix.

2 The model

Consider an individual who has preferences over consumption, c , and health, h . The individual faces exogenous uncertainty with respect to her state of health. She may either be healthy, which corresponds to state 1, or she may fall ill, which corresponds to state 2. The two states are mutually exclusive, jointly exhaustive, and verifiable. In state 1, the level of health is normalized to 1: $h_1 = 1$. In state 2, the individual is ill and, without any medical treatment, suffers a complete loss in health: $h_2 = 0$. Health if ill may, however, be partially or fully restored (instantly and with certainty) if the individual receives medical treatment: $t \in [0, 1]$, *i.e.*, treatment is assumed to be a continuous variable. Medical treatment leading to full recovery is available at cost C , while treatment at cost tC leads to partial recovery. Health in state 2 is henceforth measured by the fraction of C spent on treatment, that is, $h_2 = t$. Consumption in the two states is denoted c_1 and c_2 , respectively.

The probability of falling ill is known to the individual and given by $\pi \in (0, 1)$. The individual seeks to maximize the von Neumann-Morgenstern expected utility

$$(1 - \pi)u(c_1, 1) + \pi u(c_2, t),$$

where $u(c, h)$ is a Bernoulli utility function. We assume that $u : \mathbb{R}_+^2 \rightarrow \mathbb{R}$ is twice continuously differentiable, strictly concave, and satisfies: $\forall (c, h) \in \mathbb{R}_{++}^2$, $u_c > 0$ and $u_h > 0$, where partial derivatives are denoted by subscripts. In particular, a strictly concave u implies that the individual is risk averse. Moreover, health and consumption are assumed to be complements in utility: $u_{ch} > 0$. This assumption is in accordance with the empirical results of Finkelstein, *et al.* (2008) and implies that individuals take more pleasure in consumption when health is good than when health is poor. We also assume that $u_c(c, h) \rightarrow \infty$ as $c \downarrow 0$ whenever $h > 0$, $u_h(c, h) \rightarrow \infty$ as $h \downarrow 0$ whenever $c > 0$, and $u_c(c, h) \rightarrow \infty$ or $u_h(c, h) \rightarrow \infty$ as $c \downarrow 0$ and $h \downarrow 0$. Note that our assumptions on u imply normality.

Strict concavity implies that marginal utility from treatment is higher at a low treatment ratio than at a high one, and that an intermediate level of treatment

is preferred to an uncertain prospect of either complete or zero treatment with the same expected cost. Since leisure is not included in the utility function, we implicitly assume that leisure is constant (and thus, labour supply is fixed) across states.

There exists a competitive insurance market in which profit maximizing insurers offer insurance at an actuarially fair premium. Information about the individual's probability π of falling ill, which disease she is suffering from and, consequently, the associated costs of treatment, is symmetrically distributed among the market participants. Moreover, health state is verifiable, so that insurance can be offered contingent on it. (A situation where health state is non-verifiable is discussed in Section 4.)

The individual's ability, *i.e.*, her inherent capacity to generate earnings, is denoted A (> 0). By normalization, A also denotes the individual's labour earnings when well, *i.e.*, in state 1. Labour earnings in state 2 are proportional to the amount spent on medical treatment: By spending tC , the individual obtains an ability equal to tA in state 2. The analysis does not require insurance companies to know the individual's ability; hence A may be private information.

Illness entails two types of loss: financial and non-financial. The financial loss includes reduced earnings due to lower ability (productivity) and medical expenditures. The non-financial loss is in the form of reduced utility due to poorer health. Health if ill is however endogenous, and so the size of the non-financial loss is also endogenous. Indeed, if the individual chooses treatment leading to full recovery ($t = 1$), then she suffers a financial loss only, *viz.*, the costs of treatment, while if she chooses partial treatment ($0 < t < 1$), then she suffers both a financial and a non-financial loss.

The individual's insurance decision takes place *prior* to her knowing which state has occurred. Her budget constraints in states 1 and 2 are respectively given by:

$$c_1 + \pi I = A,$$

and

$$c_2 + \pi I + tC = tA + I,$$

where πI is the insurance premium to be paid in both states of the world in order to receive compensation equal to I if ill. It follows that

$$I = tC + c_2 - tA + A - c_1,$$

that is, the insurance provides for both medical expenditures, tC , and a cash compensation, $c_2 - tA + A - c_1$.⁹ By eliminating I from the two budget constraints, it follows that the individual is constrained by:

$$A - c_1 = \pi[tC + (c_2 - tA + A - c_1)] \quad (1)$$

when *ex ante* making her choice of c_1 , c_2 , and t .

In the following, we characterize the individual's demand for insurance with respect to both level and type of coverage. In particular, we analyze how the individual's ability A influences her choice of compensation: whether to be compensated in the form of health restoration, *i.e.*, medical treatment, and/or in the form of cash, *i.e.*, compensation for loss in income due to incomplete recovery.

3 Analysis

Treatment leading to a health level t is available at a cost tC when ill. For the purpose of our analysis, however, we ask more generally what is the maximum utility achievable if the individual has to pay P (≥ 0) for treatment t :

$$\begin{aligned} U(t, P; A) &:= \max_{(c_1, c_2)} \{(1 - \pi)u(c_1, 1) + \pi u(c_2, t)\} \\ \text{s.t. } &(1 - \pi)c_1 + \pi(c_2 + P) = (1 - \pi)A + \pi tA, \end{aligned}$$

where, for the purpose of defining and analyzing the U function, we allow $t > 1$, so that $U : \mathbb{R}_{++} \times [0, (1/\pi - (1 - t))A] \times \mathbb{R}_{++} \rightarrow \mathbb{R}$. Solving this problem, we find the consumption function in each state:

$$(\mathbf{c}_1(t, P; A), \mathbf{c}_2(t, P; A)) \in \mathbb{R}_{++}^2,$$

satisfying

$$u_c(\mathbf{c}_1(t, P; A), 1) = u_c(\mathbf{c}_2(t, P; A), t) \quad (2)$$

and the budget constraint in (1). Consumption in each state is a function of treatment t (*i.e.*, the degree of recovery in state 2), the price of treatment P , and ability A . In optimum, the individual's marginal utility of consumption is equal across states.

⁹Since the premium $\pi I = A - c_1$ must be paid in both states, disposable income net of the premium equals $tA - (A - c_1)$ if no cash compensation is received. Hence, the cash compensation is $c_2 - [tA - (A - c_1)]$.

We write the utility function U as:

$$U(t, P; A) = (1 - \pi)u(\mathbf{c}_1(t, P; A), 1) + \pi u(\mathbf{c}_2(t, P; A), t),$$

and have that U is strictly increasing in t , strictly decreasing in P , and strictly increasing in A .

The marginal rate of substitution between t and P , given A , is:

$$MRS(t, P; A) = -\frac{\frac{\partial U}{\partial t}}{\frac{\partial U}{\partial P}} = \frac{u_h(c_2, t)}{u_c(c_2, t)} + A, \quad (3)$$

where the second equality follows from the envelope theorem and equation (2). As shown in the Appendix, the utility function U has the single-crossing property, i.e., MRS is increasing in A , and features diminishing willingness to pay for treatment, i.e., it is quasi-concave. These two properties of U are illustrated in Figure 1: diminishing willingness to pay for treatment implies that indifference curves are strictly concave, and the single-crossing property implies that the slopes of indifference curves are steeper, the higher is A .

< FIGURE 1 about here >

Due to the diminishing willingness to pay for treatment, an individual being faced with the possibility of purchasing treatment t at cost $P = tC$, constrained by $t \leq 1$, will have a unique level of treatment $\mathbf{t}(A)$ maximizing $U(t, tC, A)$. Furthermore, due to the single-crossing property, $\mathbf{t}(A)$ is (weakly) increasing in A . In fact, whenever $0 < \mathbf{t}(A) < 1$, $\mathbf{t}(A)$ is determined by

$$MRS(t, P; A) = C, \quad (4)$$

i.e., marginal willingness to pay for treatment equals marginal cost of treatment. It follows that $\mathbf{t}(A)$ is strictly increasing in A when $0 < \mathbf{t}(A) < 1$.

We have that $\mathbf{t}(A) = 1$ for all $A \geq A^*$, where A^* is that level of ability, unique by the single-crossing property, for which the indifference curve through $(1, C)$ has slope C , so that unconstrained maximization of $U(t, tC, A^*)$ leads to $t = 1$. We define A^* by

$$MRS(1, C; A^*) = C. \quad (5)$$

We have that $A^* < C$, since $MRS(1, C; A) > A$. Moreover, it follows from (1) and (2) that $c_1 = c_2 = A - \pi C$ when $t = 1$ and $P = C$, implying that $t = 1$ is not feasible

when $A < \pi C$. Finally, since $u_c(c, h) \rightarrow \infty$ as $c \downarrow 0$ whenever $h > 0$, it follows that $\partial MRS(1, C; A)/\partial t \rightarrow 0$ as $A \downarrow \pi C$. Now, at $A = \pi C$, full treatment will not be chosen. It follows that $A^* > \pi C$.

The optimum level of treatment is illustrated in Figure 2 for two different values of ability: $A_l < A_h = A^*$. In that figure, a high-ability individual's indifference curve in (t, P) -space is tangent to the marginal-cost line for $t = 1$, while that of a low-ability individual is tangent to the marginal-cost line for some $t \in (0, 1)$.

< FIGURE 2 about here >

In the proposition below, we make use of the following assumption on u :

$$\frac{u_h(c, 1)}{u_c(c, 1)} \geq \frac{u_h(c', t)}{u_c(c', t)}, \text{ if } 0 < c' < tc \text{ and } 0 < t < 1. \quad (6)$$

Any concave homothetic function of c and h satisfies this, but the assumption is also satisfied by other demand systems.¹⁰ The proposition states that the individual's utility is constant across states if she chooses full treatment. Her utility if ill is lower than that if well if she chooses less than full treatment. Moreover, with full treatment, she will not receive any cash payment in addition to what is required to pay for treatment, while in the case of partial treatment, her compensation will exceed the amount spent on medical treatment. The observations in the text above partially prove the proposition; the proof is completed in the Appendix.

Proposition 1 *Assume that the condition in (6) holds. Then there exists a level of ability, A^* , where $\pi C < A^* < C$, such that:*

1. *If the individual's ability A is high, in particular, if $A \geq A^*$, then her optimum level of treatment is the maximum one and does not vary with A : $\mathbf{t}(A) = 1$. Moreover, her level of consumption is identical in the two states: $\mathbf{c}_1(1, C, A) = \mathbf{c}_2(1, C, A) = A - \pi C$, as is her utility: $u(c_1, h_1) = u(c_2, h_2) = u(A - \pi C, 1)$. Her insurance coverage is in the form of medical treatment only.*

¹⁰The multiplicatively separable specification $u(c, h) = v(c)w(h)$, where $v', w' > 0$ and $v'', w'' < 0$, which is a one-period version of the utility function proposed by Bleichrodt and Quiggin (1999), satisfies all our assumptions. The specification $u(c, h) = f(c + ah) + bh$, where $f', a, b > 0$ and $f'' < 0$, used by Ma and Riordan (2002), satisfies all our assumptions (including (6)), except that it has $u_{ch} < 0$. See Rey and Rochet (2004) for a discussion of various bivariate utility functions used in health economics.

2. If, however, the individual's ability A is low, in particular, if $0 < A < A^*$, then her optimal level of treatment is positive but less than one, $0 < \mathbf{t}(A) < 1$, and increasing in A : $\partial \mathbf{t}(A)/\partial A > 0$. Moreover, her level of consumption if ill is lower than if healthy: $\mathbf{c}_2(\mathbf{t}(A), \mathbf{t}(A)C, A) < \mathbf{c}_1(\mathbf{t}(A), \mathbf{t}(A)C, A)$, and her utility if ill is lower than if healthy: $u(c_2, h_2) < u(c_1, h_1)$. Her insurance coverage is partly in the form of medical treatment and partly in the form of cash.

Proposition 1 can be illustrated by the following Bernoulli utility function:

$$u(c, h) = c^r h^s, \text{ with } r > 0, s > 0 \text{ and } r + s < 1,$$

satisfying all our assumptions; see the Appendix for detailed calculations. In this case,

$$A^* = \frac{r + \pi s}{r + s} C,$$

and if $A < A^*$, then the following expression obtains for the cash compensation:

$$c_2 - \mathbf{t}(A)A + A - c_1 = \frac{r + s}{(1 - \pi)s} \mathbf{t}(A)(A^* - A). \quad (7)$$

This means that the critical level A^* increases with both a greater probability π of falling ill and a greater cost of treatment, C . Furthermore, for given values of π and C (and hence, for a given A^*), the individual's level of ability, A , has an ambiguous effect on the size of the cash compensation. On the one hand, provided that $A < A^*$, a smaller A leads to a greater relative importance of the cash compensation through the term $A^* - A$. On the other hand, an individual with a smaller A has a smaller initial endowment and will choose an insurance contract with a lower level of total compensation. This moderating effect on the size of the cash compensation is reflected by the term $\mathbf{t}(A)$, which decreases with a reduction in A when $A < A^*$.

4 *Ex-post* moral hazard

We have, in Proposition 1, shown that an ill individual with ability A lower than the critical level A^* receives partial treatment, $\mathbf{t}(A) < 1$, and, in addition, a positive cash compensation:

$$\mathbf{c}_2(A) - \mathbf{t}(A)A + A - \mathbf{c}_1(A),$$

where we from now on write $\mathbf{c}_1(A) = \mathbf{c}_1(\mathbf{t}(A), \mathbf{t}(A)C, A)$ and $\mathbf{c}_2(A) = \mathbf{c}_2(\mathbf{t}(A), \mathbf{t}(A)C, A)$. If, contrary to what we assumed above, the two states (healthy/ill) are

not observable, the availability of such a disability payment may tempt the individual to claim that she has fallen ill, although she is in fact in good health. In this section, we show that our analysis goes through even if we allow for such *ex-post* moral hazard,¹¹ provided that (i) the cash compensation is paid only in combination with treatment; and (ii) the disutility of receiving treatment while healthy is sufficiently great. Consequently, in order to prevent the individual from falsely claiming to be ill, she should suffer a loss in expected utility from undergoing redundant medical treatment. Moreover, the disutility should at least balance the gains in expected utility from masquerading as ill.

To ensure that a healthy individual with ability A does not falsely claim to be ill, we must consider the possibility that she not only misrepresents her health state but also her ability, in order to receive the higher cash compensation designed to be paid to an individual with a different ability A' . Using the observation that an individual has no incentive to lie about her ability unless she intends also to misrepresent her health state, we provide, in the Appendix, a proof of the following result.

Proposition 2 *The ex-post moral hazard of a healthy individual masquerading as ill in order to obtain cash compensation does not constitute an incentive problem if, for any true ability A and claimed ability A' , the additional utility that A obtains from the cash compensation, $\mathbf{c}_2(A') - \mathbf{t}(A')A' + A' - \mathbf{c}_1(A')$, to be paid to A' in case of illness, does not exceed the disutility that A suffers from undergoing, when healthy, redundant treatment at the level $\mathbf{t}(A')$ that A' is entitled to.*

It is clear from this result that a healthy individual falsely claims to be ill only after having purchased the optimal insurance contract of some ability A' smaller than A^* . The reason is that, according to Proposition 1, for any ability $A' \geq A^*$, the optimal insurance contract includes no cash compensation, implying that the disutility from undergoing redundant treatment will dominate. On the other hand, if $A' < A^*$, then there is a positive cash compensation. What can be said about how this cash compensation varies with A' for $0 < A' < A^*$?

To investigate this question, it might be instructive to look at the special Cobb-Douglas case considered at the end of Section 3. It follows from the expression for

¹¹*Ex-post* moral hazard refers to the effect of insurance on the insured individual's incentives to reveal her true health state (*i.e.*, the insured individual knows the state of the world, while the insurer does not, or verification of health state is too costly for the insurer). The analysis of *ex-post* moral hazard was pioneered by Spence and Zeckhauser (1971). The idea that in-kind transfers, such as medical treatment, can alleviate *ex-post* moral hazard is due to Nichols and Zeckhauser (1982).

the cash compensation in (7) that the level of claimed ability, A' , has an ambiguous effect on the size of the cash compensation. While, with $A' < A^*$, a smaller A' leads to a greater relative importance of the cash compensation through the term $A^* - A'$, there is a moderating effect through the term $\mathbf{t}(A')$, which reflects that a smaller A' leads to an insurance contract with a lower level of total compensation. Hence, provided that the disutility of receiving treatment while healthy does not decrease significantly with a smaller t , and thus with a smaller A' , this disutility exceeds, for any true ability A and claimed ability A' , the additional utility obtained from the cash compensation paid to A' in case of illness.

When health state is not verifiable, *i.e.*, when *ex-post* moral hazard is a problem, the individual will have an incentive to masquerade as ill in order to acquire a cash compensation. However, when cash compensation is made conditional on medical treatment, we have shown that the individual's incentive to masquerade is reduced since she will suffer a disutility from receiving redundant treatment. The *ex-post* moral hazard problem associated with cash compensation is hence solved in our model through the *integration of treatment for illness and payments for disability*. The lack of such integration can help explain why private markets for disability insurance are of little empirical significance. Naturally, one may argue that even if treatment and cash compensation were *not* integrated, then information about whether an individual is ill could be obtained if the insurer offering disability insurance could require information from the insurer offering medical insurance. In this case, information on the (contractually) adequate level of treatment as well as the level of treatment actually undertaken is required. It follows that the informational costs would be higher relative to a situation in which the two types of insurance are integrated.

5 Discussion

Our focus has been on how an individual's inherent ability at full functionality (*i.e.*, when healthy) influences her *ex-ante* choice of insurance contract. Insurance allows the individual to allocate income between the two health states *prior* to knowing which state occurs and, if falling ill, between consumption and health.

It is of no importance, in a world of symmetric information, whether the coverage for medical costs is paid in cash intended to cover medical bills, or directly in the form of medical treatment. The individual's *ex-ante* decision concerning what level

of treatment to choose is unaffected by the way she is compensated; the fundamental decision concerns to what extent health is to be restored.¹² However, as discussed in Section 4, if health state is not easily verifiable, then it becomes essential whether medical expenditures are compensated in cash or in kind. When information about health state is asymmetric, integration of a cash compensation of income loss and an in-kind compensation of medical expenditures reduces the individual's incentive to falsely claim to be ill.

Our findings are driven by the fact that the potential loss in income is larger, the higher the ability. This implies that the prices of the two types of contracts differ depending on the individual's ability. The higher the potential income loss due to reduced ability, the cheaper is the contract offering indemnity in kind (*i.e.*, treatment), compared to a contract offering cash compensation of income loss. Thus, the cost-benefit ratio on medical treatment is lower the higher the level of ability at full functionality.

A Appendix

A.1 Properties of U

The single-crossing property: By differentiation in (3), we find that MRS is increasing in A :

$$\frac{\partial MRS}{\partial A} = \frac{\partial}{\partial A} \left[\frac{u_h(\mathbf{c}_2(\bar{t}, \bar{P}, A), \bar{t})}{u_c(\mathbf{c}_2(\bar{t}, \bar{P}, A), \bar{t})} + A \right] > 1,$$

since $u_{cc} < 0$, $u_{ch} > 0$, and $\partial \mathbf{c}_2 / \partial A > 0$. This is the single-crossing property.

Diminishing willingness to pay for treatment: We need to show that U is strictly quasi-concave as a function of t and P . This is done by demonstrating that, if (t', P') and (t'', P'') are different combinations yielding the same utility level given A , then any interior convex combination

$$(t, P) = (\alpha t' + (1 - \alpha)t'', \alpha P' + (1 - \alpha)P''), \quad 0 < \alpha < 1,$$

¹²Arrow (1963) mentions three different ways in which costs of medical care can be covered in an insurance contract: payment directly in medical services, a fixed cash payment, and a cash payment that covers the actual costs involved in providing the necessary medical treatment. In a perfect market, individuals wishing to receive medical treatment would be indifferent between a payment directly in the form of medical treatment and its cash equivalent.

will yield a strictly higher utility level. Accordingly, assume

$$U(t', P', A) = U(t'', P'', A),$$

and introduce some notation:

$$\begin{aligned} c'_1 &= \mathbf{c}_1(t', P', A) & c''_1 &= \mathbf{c}_1(t'', P'', A) \\ c'_2 &= \mathbf{c}_2(t', P', A) & c''_2 &= \mathbf{c}_2(t'', P'', A). \end{aligned}$$

Also, let $(c_1, c_2) = (\alpha c'_1 + (1-\alpha)c''_1, \alpha c'_2 + (1-\alpha)c''_2)$. Since (c'_1, c'_2) satisfies the *ex-ante* constraint (1) given (t', P', A) and (c''_1, c''_2) satisfies constraint (1) given (t'', P'', A) , it follows that also (c_1, c_2) satisfies constraint (1) given (t, P, A) , implying that (c_1, c_2) is feasible. Hence,

$$\begin{aligned} U(t, P, A) &\geq (1-\pi)u(c_1, 1) + \pi u(c_2, t) \\ &> (1-\pi)[\alpha u(c'_1, 1) + (1-\alpha)u(c''_1, 1)] + \pi[\alpha u(c'_2, t') + (1-\alpha)u(c''_2, t'')] \\ &= \alpha U(t', P', A) + (1-\alpha)U(t'', P'', A) \end{aligned}$$

where the first inequality follows since (c_1, c_2) is feasible, and the second inequality follows since u is strictly concave.

A.2 Proof of Proposition 1

Part (1). Given the observations in the text prior to the proposition, it remains to show that the individual's utility is constant across states, and that she has insurance coverage in the form of medical treatment only.

Constant utility across states follows since $c_1 = c_2 = A - \pi C$ and $h_1 = h_2 = 1$. Since cash payment equals $c_2 - tA + A - c_1$ (see footnote 9), it follows that cash payment is zero.

Part (2). Given the observations in the text prior to the proposition, it remains to show that the individual's utility if ill is lower than if healthy, and that she receives a positive cash compensation if ill.

By the definition of A^* , $0 \leq \mathbf{t}(A) < 1$ whenever $0 < A < A^*$. Moreover, since $u_h(c, h) \rightarrow \infty$ as $h \downarrow 0$ whenever $c > 0$, and $u_c(c, h) \rightarrow \infty$ or $u_h(c, h) \rightarrow \infty$ as $c \downarrow 0$ and $h \downarrow 0$, it follows from $A > 0$ and equation (3) that $MRS > C$ if t is sufficiently small; hence, $\mathbf{t}(A) > 0$. Now, the single-crossing property implies that $d\mathbf{t}(A)/dA > 0$. From equation (2) and the properties of u , it follows that $c_1 > c_2$, since $h_1 = 1$, and $h_2 = \mathbf{t}(A) < 1$. This in turn implies that $u(c_1, 1) > u(c_2, h_2)$. To show that cash payment is positive, *i.e.*, that $c_2 - tA + A - c_1 > 0$, we start out

with the observation that $t(A)$ is determined by $MRS = C$ whenever $0 < t(A) < 1$. Using the expression for MRS in (3), we have that the marginal willingness to pay for treatment equals the marginal cost of treatment: $u_h(c_2, t)/u_c(c_2, t) + A = C$. In the hypothetical case where treatment were available also if healthy, or inversely, where health could be sold at price $C - A$, the access to actuarially fair insurance would imply the same level of health in both states. Since this is not the case, it is a binding constraint that healthy individuals cannot sell health at price $C - A$, implying that: $u_h(c_1, 1)/u_c(c_1, 1) < C - A = u_h(c_2, t)/u_c(c_2, t)$. Hence, effectively, the relative price of health in terms of consumption is lower if healthy than if ill. It follows by assumption (6) that $tc_1 \leq c_2$. Moreover, constraint (1) entails that $c_1 \geq A - \pi tC$ if and only if $c_2 \leq tA - \pi tC$. Therefore, $c_1 \geq A - \pi tC$ leads to the following contradiction: $tc_1 \geq t(A - \pi tC) > tA - \pi tC \geq c_2$. Thus, we have that $c_1 < A - \pi tC$ and $c_2 > tA - \pi tC$. This in turn means that $c_1 - A < c_2 - tA$, or $c_2 - tA + A - c_1 > 0$.

A.3 Calculations for the Cobb-Douglas case

The following Cobb-Douglas function is a Bernoulli utility function that satisfies all assumptions listed in Section 2, as well as the condition in (6):

$$u(c, h) = c^r h^s, \text{ with } r > 0, s > 0 \text{ and } r + s < 1.$$

With this function, it is possible explicitly to calculate A^* . We have that

$$\begin{aligned} MRS(1, C; A) &= \frac{u_h(c_2, 1)}{u_c(c_2, 1)} + A \\ &= \frac{u_h(A - \pi C, 1)}{u_c(A - \pi C, 1)} + A = \frac{s}{r}(A - \pi C) + A, \end{aligned}$$

where the first equality follows from (3), the second equality follows since $c_2 = A - \pi C$ when $t = 1$ and $P = C$, and the third equality follows since

$$\frac{u_h(c, h)}{u_c(c, h)} = \frac{s}{r} \cdot \frac{c}{h} \tag{A1}$$

when u is given by the Cobb-Douglas function above. Since A^* is defined by $MRS(1, C; A^*) = C$, we can find A^* by solving

$$\frac{s}{r}(A^* - \pi C) + A^* = C,$$

which implies that

$$A^* = \frac{r + \pi s}{r + s} \cdot C. \tag{A2}$$

Since, for $A < A^*$, t is determined by $MRS = C$, we get, by invoking equations (3) and (A1), that

$$\frac{s}{r} \cdot \frac{c_2}{t} + A = C. \quad (\text{A3})$$

Moreover, by letting the cash compensation, $c_2 - tA + A - c_1$, be denoted by x , it follows from equation (1) that

$$x - c_2 + tA = \pi[tC + x]. \quad (\text{A4})$$

We now have that

$$\begin{aligned} (1 - \pi)x &= \pi tC + c_2 - tA \\ &= \pi tC + \frac{r}{s}t(C - A) - tA \\ &= \frac{1}{s}[(r + \pi s)C - (r + s)A]t \\ &= \frac{r+s}{s}(A^* - A)t, \end{aligned}$$

where the first equality follows from (A4), the second equality follows from (A3), and the fourth equality follows from (A2). We have thereby shown that the cash compensation can be expressed as in (7).

A.4 Proof of Proposition 2

Denote by $v(c, t)$ the (direct) disutility of receiving treatment t while healthy and consuming c ; to be precise, $v(c, t)$ is the difference between the utility derived from consumption c when healthy and *not* receiving unnecessary treatment and the utility derived from consumption c when healthy and receiving unnecessary treatment t . Assume that v satisfies, $\forall(c, t) \in \mathbb{R}_{++}^2$, $v(c, t) > 0$ and $v_t \geq 0$.

To prevent problems caused by *ex-post* moral hazard, the following inequality must hold, for any true ability A and claimed ability A' :

$$\begin{aligned} (1 - \pi)u(\mathbf{c}_1(A), 1) + \pi u(\mathbf{c}_2(A), \mathbf{t}(A)) &\geq \\ (1 - \pi)[u(c'_2, 1) - v(c'_2, \mathbf{t}(A'))] + \pi u(\mathbf{c}_2(A') + \mathbf{t}(A')(A - A'), \mathbf{t}(A')). \end{aligned} \quad (\text{A5})$$

Here, $c'_2 = \mathbf{c}_2(A') + (A - \mathbf{t}(A')A')$ represents the consumption that a healthy individual with ability A receives having purchased the optimal insurance contract of an individual with ability A' and masquerading as ill, while $\mathbf{c}_2(A') + \mathbf{t}(A')(A - A')$ is the consumption that an ill individual with ability A receives having purchased the optimal insurance contract of ability A' and truly claiming to be ill. An individual with ability $A > (<) A'$ generates higher (lower) earnings and can, therefore, sustain a higher (lower) level of consumption than can an individual with ability A' .

In condition (A5), we allow the claimed ability A' to take any value, including the real ability A . Hence, we do not require that an individual also lies about her ability when she misrepresents her health state, but we allow for this possibility. Of course, a misinterpretation of ability must, if it occurs, take place before the individual knows whether she has fallen ill or not; this is reflected by the last term on the right-hand side of condition (A5).

To find a sufficient condition for (A5) to hold for any true ability A and any claimed ability A' , the following observation is useful: $(\mathbf{c}_1(A), \mathbf{c}_2(A), \mathbf{t}(A))$ maximizes expected utility over all triples (c_1, c_2, t) satisfying (1); in particular,

$$\begin{aligned} (1 - \pi)u(\mathbf{c}_1(A), 1) + \pi u(\mathbf{c}_2(A), \mathbf{t}(A)) &\geq \\ (1 - \pi)u(c'_1, 1) + \pi u(\mathbf{c}_2(A') + \mathbf{t}(A')(A - A'), \mathbf{t}(A')), &\end{aligned} \tag{A6}$$

where $c'_1 = \mathbf{c}_1(A') + (A - A')$ is the consumption that a healthy individual with ability A receives having purchased the optimal insurance contract of ability A' and *not* masquerading as ill. This means that an individual with ability A does not lie about her ability unless she intends also to misrepresent her health state.

The increase in consumption that an individual with ability A , having purchased the insurance contract of ability A' , obtains by masquerading as ill, $c'_2 - c'_1$, is equal to the cash compensation designed to be paid to an individual with ability A' :

$$c'_2 - c'_1 = \mathbf{c}_2(A') - \mathbf{t}(A')A' + A' - \mathbf{c}_1(A').$$

Moreover, by (A6), it is a sufficient condition for (A5) to be satisfied, for any true ability A and claimed ability A' , that

$$u(c'_2, 1) - u(c'_1, 1) \leq v(c'_2, \mathbf{t}(A')) \tag{A7}$$

holds for any true ability A and any claimed ability A' . This completes the proof of Proposition 2.

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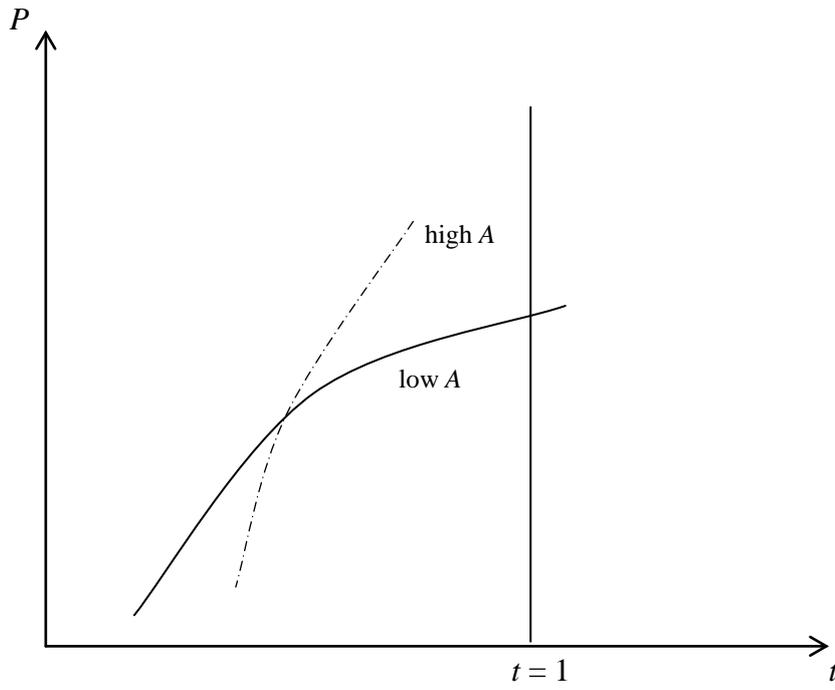


Figure 1. The single-crossing property

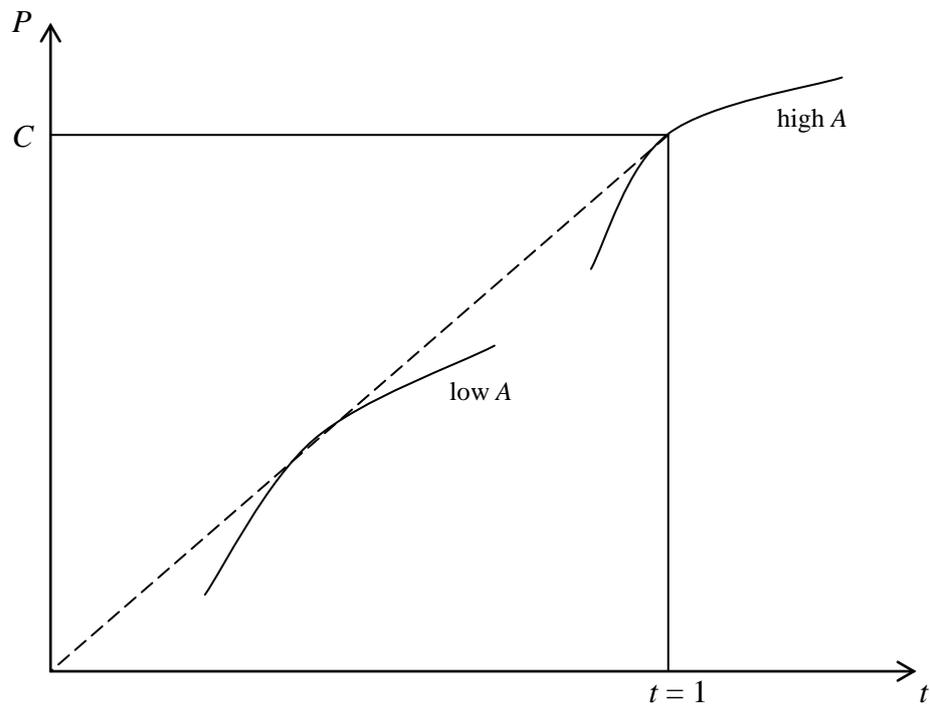


Figure 2. The optimal level of treatment