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Abstract

This paper theoretically and empirically explores the effects of insurance parameters and a complementary information environment on patient´s primary prevention activity in the context of a managed care organisation. The theoretical model is based on a principal-agent setting in which the patient is acting as an agent in deciding about his preventive effort. Both for the patient and for the insurer the information distribution about prevention efforts is diluted. Hence, the theoretical results reflect the impact of insurance parameters as well as complementary information settings.

The empirical investigation sheds the light on the patient´s prevention decision in the case of smoking. This depends on age effects, education, working time and health status. The research also stresses the relationship between monetary incentive schemes and individual behaviour as well as the influence of additional information schemes. In addition to the theoretical results, there is an evidence that changes in health behaviour depend on education and individual health assessment, too.

Keywords: Incentives in Prevention; Information distribution;

JEL classification: I12, D82, C23

1 Introduction and motivation

The problems of health care sector in the most industrialised countries, especially of the Statutory Health Insurances (SHI) in Germany, are the starting point of our paper. On the one hand there are the well-known problems of rising expenditures driven by the double aging process and its interdependence with the medical-technological progress.[1] On the other side, there are inappropriate incentives structures that help fostering the altered challenges in health care. Especially the discussion about the basic factors for demand in health care offer many aspects for outstanding research. Beside the models in the tradition of Grossman illustrating the productivity impact upon health one central element for outstanding research is still the individual behaviour. Here, especially patient´s health related behaviour and his efforts in illness prevention are worth mentioning. It is interesting to observe that people often fail in providing the 'optimal' amount of prevention.

Patient's role in the health production process is one of a productive input factor. Besides his therapeutic compliance also the preventive efforts are important for future health care.[2] Primary prevention is concerned with the avoidance of undesirable outcomes whereas secondary prevention aims at an early detection of a disease. Each prevention activity sheds the light on the relationship between investments in a changed health behaviour or detection activity in the present opposed to gains in health in the future[3]. It is not proven that most preventive care, while improving health, actually saves money in the long run. For example Garber and Phelps (1997) show that preventive care can provide an improvement in health at relatively low costs but does not necessarily lead to a reduction of health care costs. Therefore, prevention is similar to each investment decision that has to consider the expected benefits against the current costs. Hence, the interconnection between activity in the present and the prospective outcome in the future becomes more relevant. A strand of literature has expressed concern about a lack of individual compliance with prevention recommendations (cf. Kenkel 2000, Hayes 1978 or Hayes et. al. 2002). The obvious inconsistency of prevention efforts has been noted in several surveys concentrating on secondary prevention activities (e. g. Giveon and Kahan 2000). Here, we are interested in the relation between primary prevention, the effects of asymmetric

[1] The impact of double aging with respect to German Health Care system are discussed by Breyer and Felder (2006) or Zweifel et al. (2004)

[2] We abstain from problems of concomitant compliance that is the influence of physician's advice and well practice on patient's effort activities (cf. e. g. Oberender and Zerth 2007).

[3] It is very important to distinguish between primary and secondary prevention concerning the role of patient and physician. Whereas the latter needs the concomitant performance of patient and physician in a form of screening vaccine, primary prevention disintegrates the uno-actu-principle of production of prevention goods (cf. similar Evans 1988).

information and uncertainty, and how it is possible for governments and insurers to encourage prevention.

A classical form of discussing primary prevention problems is related with problems of discussing decisions for quitting smoking or discussing alcohol abuses. But these models regularly refer to ideas of rational addiction in the sense of Becker and Murphy (1988). Recent literature has often added ideas of time-inconsistencies (cf. e. g. Kan 2005) to the explanation of addiction which helps to interpret intertemporal investment ideas in a more appropriate way. But all these attempts do not consider the expanding role of health care strategies in prevention especially of insurers that focus on different values of private or public information.

The theoretical literature about prevention in insurance based models is still small. Miceli and Heffley (2002) analyse in how far alternative health care financing plans affect the choice of preventive care by the consumers and the providers' choice of capacity. They find that pure fee-for-service plans lead to a Pareto-optimal choice of both preventive care and capacity. The same result applies to a mixed plan which includes a lump-sum fee and a fee for service. In contrast to this a pure prepaid plan may lead to under- or overconsumption of prevention. In addition Barigozzi (2004) shows in how far secondary prevention, such as diagnostic screening, medical examinations and checks-up can be viewed as self-insurance activities. She analyses the influence of reimbursement schemes on prevention and treatment. The main finding is that the optimal reimbursement scheme encourages treatment and prevention whereas for the latter it is required that prevention reduces the cost of treatment. Considering these papers there is an open question of the effects of appropriate incentives schemes set by an insurer given different levels of information shared by both the patient and the insurer.

Within this context of patient's behaviour there arise several important questions. First, it seems plausible that the preventive activities depend on the level of insurance as well as on the distribution of information between the insurer and the insurant. This raises the question of how to deal with this ex ante moral hazard in providing the optimal amount of prevention. Second it is interesting to explore the connection between monetary influence parameters e. g. co-payments and the impact of intangible costs in consequence of doing prevention. The paper is organised as follows. First we refer to the standard literature concerning a patient-physician-relationship within a managed-care-environment. After that we develop a model of the health care process which resembles screening models in the traditional principal-agent-literature. The results of our theoretical analysis are tested within an empirical approach using data of the SOEP, a representative longitudinal study of private households in Germany.

2 Theoretical model

In our investigation, we make use of a principal-agent setting in which the patient is acting as an agent in deciding about his preventive effort. For the sake of simplification, the principal in our model is an insurer comparable to an HMO that offers health insurance and decides about the necessary treatment in the case of an illness.[4]

For the patient's von Neumann-Morgenstern utility function *U*, it is assumed that he owns an initial wealth *W* and is risk averse in disposable income (*U* is concave). The probability of getting sick is *p*, with $p \in [0,1]$. In the case of illness, the patient suffers a health shock in monetary units *L*. This shock depends negatively on the amount of consumed medical services in monetary terms *x*. Moreover, *L* is a convex function of *x*, i.e. $L'<0$ and $L''>0$. This formulation implies diminishing marginal benefits of health care.

The patient can purchase insurance for which he has to pay a premium π. Moreover, in the case of treatment, he has to pay a fixed share β of the expenditures for medical treatment (co-payment: $0 \leq \beta < 1$)). To avoid an illness, the patient engages in preventive activities *e* that lowers the probability of getting sick *p*(*e*). These activities are set after the insurance contract has been established. Here, we assume that the relation between the probability of an illness and prevention is convex, i.e. an additional unit of prevention the patient exceeds lowers the probability less than the unit before[5]:

$$\frac{\partial p(e)}{\partial e} < 0; \frac{\partial^2 p(e)}{\partial^2 e} > 0$$

The patient‘s prevention *e* is associated with disutility *C*(*e*) which is a convex function of the compliance *e* so the expected utility is additive-separable in income and disutility[6]. The expected utility is then:

$$EU = p(e)U[W - \pi - L(x) - \beta x] + (1 - p(e))U[W - \pi] - C(e) \quad (2.1)$$

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[4] Therefore, we differ in the representation of the patient. In other approaches, the patient has the role of the principal and the physician is acting as agent (see Zweifel 1994 with an application of the work of Holmström 1979 to the field of health economics).

[5] This idea is very similar to the attempt used by Miceli and Heffley 2002. It is very important to distinguish between the basic probability of getting ill and the effort dependent probability for a better or a worse level of given illness. Especially when considering forms of chronic illness the patient has to live with the illness the rest of their life after getting ill. Therefore, there will other aspects that may influence the probability of getting ill.

[6] An additive-separable utility function states that the degree of risk-aversion of the income-dependent utility (*U*(.)) does not vary with the effort-level (*e*) (cf. Macho-Stadler and Pérez-Castrillo 2001, 19).

In the subsequent analysis the following notation is used as a simplification to express the patient‘s utility:

$$U_S = U[W - \pi - L(x) - \beta x]$$
$$U_H = U[W - \pi]$$

If the patient is sick, his income-related utility is U_S, if he is healthy, he only has to pay the insurance premium and his utility is denoted U_H, with $U_S < U_H$.

The insurance company is risk neutral and finances the health care expenditures in the case of an illness (p) against a premium π. The insurance pays for all treatment costs except the co-payment share β. The insurance supplies this service at actuarial fair premiums on a competitive insurance market:

$$\pi = p(e)(1-\beta)x \tag{2.2}$$

2.1 The first-best case: full information

Under full information the preventive activities of the patient are known to the insurance company. Therefore, it is possible to contract contingent on these activities. Moreover, the insurer decides about the necessary medical services for treating the illness and the contract parameters π and β. As proposed in Stewart (1994) the insurance company maximises patient’s expected utility subject to its zero profit condition:[7]

$$\begin{aligned} \max_{e,\beta,\pi,x} \quad & EU = p(e)U[W - \pi - L(x) - \beta x] + (1 - p(e))U[W - \pi] - C(e) \\ & s.t. \quad \pi = p(e)(1-\beta)x \end{aligned} \tag{2.3}$$

Inserting the zero-profit condition into the objective function reduces the problem to one seeking the optimal coinsurance rate, the optimal level of medical services and preventive activities:

$$\begin{aligned} \max_{e,\beta,x} \quad & EU = p(e)U[W - p(e)(1-\beta)x - L(x) - \beta x] + \\ & (1 - p(e))U[W - p(e)(1-\beta)x] - C(e) \end{aligned} \tag{2.4}$$

[7] We do deliberately refrain from aspects of insurer´s self-interest concerning risk selection or rationing.

The first-order condition for the preventive activity after rearranging is:

$$\frac{\partial EU}{\partial e} \Rightarrow p'(e)(U_S - U_H) - p'(e)(1-\beta)x\left[p(e)U'_S - (1-p(e))U'_H\right] = C'(e). \tag{2.5}$$

In optimum, the insurance company chooses that level of prevention that equals marginal benefits and marginal costs. Here, the marginal costs of prevention (or marginal effort) on the right-hand side is rising with an increase in *e*. On the left-hand side, the first term is the direct gain in utility from a decrease of the probability of getting sick. The second term is the indirect effect of a higher prevention level due to the insurance premium of the patient.

Partial derivation of equation (2.4) with respect to medical services needed *x* leads to:[8]

$$\frac{\partial EU}{\partial x} \Rightarrow \frac{U'_H}{U'_S} = -\frac{p(e)\left[p(e)(1-\beta) + \frac{\partial L}{\partial x} + \beta\right]}{(1-p(e))p(e)(1-\beta)} \tag{2.6}$$

Generally, the level of medical services depends on the probability of getting ill as well as on the co-payments. The last partial derivative is that with respect to the co-payment parameter β. After rearranging, it follows that

$$\frac{\partial EU}{\partial \beta} \Rightarrow \frac{U'_H}{U'_S} = 1, \tag{2.7}$$

This means that, given that the patient is fully cured, there is no co-payment necessary for the use of medical services and the individual has full coverage. This result depends on the fact that the insurer can observe and directly control the patient's preventive activities so that there exist no ex ante moral hazard (within the managed-care environment).[9]

With this result which implies that the utilities in both states of nature are equal, it is possible to write equation (2.5) as

$$-p'(e)xU' = C' \tag{2.8}$$

[8] The relation in equation (2.6) requires that the numerator is positive, $\partial L/\partial x < -\beta - p(1-\beta)$.

[9] At first, this result seems counterintuitive because the co-payment is directly combined with preventive activities. In the case of asymmetric information where the patient decides about the level of prevention, it is clear that there is a relation between preventive activities and coinsurance for medical services.

Here, U' is the marginal utility with $U'_S=U'_H=U'$. Using this together with $\beta = 0$ simplifies the first-order condition for the level of medical services to

$$-L'(x) = 1, \tag{2.9}$$

which describes the first-best marginal productivity of medical services x^*.

2.2 Asymmetric information: the patient's sight

In the case of asymmetric information, it is not longer possible for the insurance company to contract upon the optimal level of prevention. The literature traditionally distinguishes between two types of asymmetric informational problems; hidden action and hidden information (cf. Macho-Stadler and Pérez-Castrillo 2001). Although in many cases both forms simultaneously exist, we take the contract as set and only concentrate on the informational schemes which go along with forms of co-payment and monitoring after the contract parameters are known to the patient.[10] Hence, the exact problem of our investigation is related to patient's motivation after a definite contract is set and resembles traditional moral hazard schemes.

In addition, we include a form of monitoring that completes normal incentive constraint used in moral hazard approachesOur monitoring scheme describing the typical form of managed care environment as a kind of a screening game that differs from the typical approach used in the institutional economics literature.[11] Opposite to traditional screening models (cf. Macho-Stadler and Pérez-Castrillo 2001) we do not focus on different forms of contracts set by the uninformed side to detect the different type of a patient. But similar to a traditional screening model, we assume that the uniformed agent is playing first. This is very plausible for a managed care organisation because there are standard contracts set by the insurer. Hence, the patient is fully informed, so his beliefs are not affected by what he can observe (cf. Rasmusen

[10] Hence, patient's preventive action encompasses both aspects, hidden action and hidden information.
[11] Considering the findings of Shavell (1979), we can conclude that in special forms of principal-agent-problems and opposite to the "normal findings", approaches of ex post detection in form of monitoring could be cheaper than alternative ex ante signalling and screening activities. These results especially hold for insurance contracts when risk-reducing activities are able to vary to some extent within the insured period of time.

1989)[12]. To sum up, we only concentrate on the patient's effort activity given an insurance contract which has been set before the prevention efforts start.[13]

As we have seen in the first-best model, the organisation of an appropriate incentive scheme influences the probability of the common investment activities of the patient and an idealistic health plan. Similar results are presented in the model of Miceli and Heffley (2002) who present the concern of a HMO organisation promoting prevention efforts. Like in typical moral hazard models (cf. Zweifel and Manning 2000), one problem for the insurer to fix stable contract condition is the assessment of the patient's effort behaviour. Therefore, our model has to consider two separable problems with hidden information. The first one is the result of a typical form of lack in patient's control because opposite to the first-best-case the insurer and the patient do not concomitantly maximise their utility function. The second problem is related to disturbance in information perception, which is relevant for the insurer as well as the patient.[14] Hence, we face a lack of patient´s control as well as the problem of mutual information dilution.

The first assumption results in using a form of sequential stages that describe the managed care environment sufficiently. In the first stage the uninformed insurer sets her contract parameter. At the second stage of the game, the patient chooses an amount of prevention efforts e in the set of available actions $e \in [0,1]$, which combines a high or a low level of prevention. Our model focuses at the second stage of the principal-agent-model and discusses the relationship of different contract parameters with different levels of information. A traditional model of asymmetric information would only concentrate on the tangible effect of sequential decisions made by the insurer and patient. What is problematic is that we have only implicit ideas of the relationship between co-payment and effective effort and when combining the control problem with the complementary information problem.

As a consequence, the insurer itself has to consider the effectiveness of a higher co-payment-scheme compared to his monitoring activities. In other words, the insurance company has to anticipate the patient's behaviour but is only able to use a signal of the patient's prevention

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[12] We discuss a special form of moral hazard with hidden action that belongs to different types of asymmetric information. A good review of asymmetric information into pre- and post-contractual cases was introduced by Hart and Holmström (1987).

[13] Mas-Colell et. al. (1995) show the different aspects of signalling and screening in order to reveal the type of a agent, an aspect which we can only use in a weak form because of the usual conditions of a managed care environment.

[14] An instructive and comprehensive overview about different forms of asymmetric cases in context of incentives problems describes Mas-Colell et al. (1995).

activity. The insurance company could only interpret the type of the patient which depends on the signal which is given by the parameter $\lambda \in [0,1]$.[15] A value of λ close to one means that the value of information is low whereas λ approaching zero goes along with better information which can be perceived by the patients as well as the insurer.

The information signal λ itself depends on the effort level (e) and could be enhanced by additional monitoring activities (m) done by the insurer. The influence of these two variables cannot be measured by both parties involved. Due to the inverse relation between a high effort level and the value of information of patient's activity we can set ($\lambda(e); \lambda'(e) < 0, \lambda''(e) > 0$). The impact of additional monitoring investments shall be contingent on the hidden level of prevention effort, e. g. $\partial\lambda/\partial m|e \to 0 < 0 \cup \partial\lambda/\partial m|e \to 1 = 0$ .This means that with perfect prevention there is no need to monitor the patient's activities.

For that reason we denote the "effectiveness" of monitoring activities by the adaptation of the individual co-payment $\beta * \lambda(e)$ scheme which must be completely paid only in case of worst information (λ=1). This will be true if the information is completely diluted and no "value of information" is available for the insurer. Moreover, the monitoring activity is only perfect when λ=0. With other words the effect price for the insurance rises the worse the information is perceived by the insurer and the worse the information is revealed by the patient.

As already mentioned we take a look at a two-stage game and apply the method of backward induction. At the first stage, the insurer decides about the level of medical services and contract parameters and at stage two, it is the patient that decides about this utility maximising preventive activity. Hence, for the patient at stage two holds:

$$\max_e EU = p(e)U[W - \pi - L(x) - x\beta\lambda(e,m)] + (1 - p(e))U[W - \pi] - C(e) \tag{2.10}$$

The first-order condition for this problem is

$$\frac{\partial EU}{\partial e} \Rightarrow p'(e)\left(U_S - U_H\right) - p(e)U'_S\left(\beta\frac{\partial\lambda}{\partial e}x\right) = C' \tag{2.11}$$

[15] The information disturbance λ is deliberately integrated in the patient's utility function to show the impact of different risk aversion scenarios on the expected valuation. Recent research concerning risk preferences contingent to deductible choice within car-insurance shows a higher heterogeneity of risk preferences compared to the risk itself (cf. Cohen and Einav 2007).

If λ=0 the last term of the right-hand side of the equation (2.11) vanishes and the simpler form of the first-order condition where only the control problem occurs is:

$$\frac{\partial EU}{\partial e} \Rightarrow p'(e)\left(U_S - U_H\right) = C'. \qquad (2.12)$$

Comparing this result with the first-best equation for the prevention activities (2.5) and ignoring that β=0 it is obvious that the term $p'(e)(1-\beta)x\left[p(e)U'_S - (1-p(e))U'_H\right]$ is missing. In the asymmetric case the patient neglects the effect of his prevention activity on the zero-profit-condition of the insurance company. Hence, we can infer two problems for the contract environment. First, in consequence of the diluted information the insurer cannot directly observe patient's prevention activity. Second, the dilution of information goes along with worse means for controlling patient's activities.

With a look at the equation 2.11 we can elaborate another effect the patient is conscious of in the case of an asymmetric information case. The term $p(e)U'_S(\beta \cdot \partial\lambda/\partial e \cdot x)$ describes the influence of the individual co-payment scheme on the patient's expected utility for a strictly positive value of λ. For λ=0, in equation 2.11 the term of the "first-best expression" $p'(e)(1-\beta)x\left[p(e)U'_S - (1-p(e))U'_H\right]$ is missing. If there is perfect information (λ→0), the influence of patient´s activity upon the expected utility for both health states U_S and U_H becomes evident. Basically, the difference between equation (2.5) and (2.11) is due to the missing zero profit condition in the maximisation problem under asymmetric information. This means that even if the insurer has undertaken some monitoring activities and is perfectly informed about the preventive behaviour, the premium effects of monitoring are not considered by the patient. The opposite case is when λ=1 is valid. The term $p(e)U'_S(\beta \cdot \partial\lambda/\partial e \cdot)$ is at a maximum und is subtracted from the first part of the equation 2.11. This will only hold if the prevention activity *e* is very low. If λ is at the highest level indicating a low level of patient's prevention effort, equation 2.11 shows the dominant influence of monetary co-payments. But the more λ gets smaller the more information about the prevention activities could be shared by both parties of the insurance contract. We can conclude:

Proposition 1: As long as the information distribution is not perfect, a lower level of prevention activities can be inferred. This result would also be true with corresponding efforts of patient control (additional monitoring) because the difference in perception of information *has to be considered.*[16] *Hence, we can conclude a lack of information as well as problems of appropriate organisational structures for enhancing the co-production of health by the patient.*

Following that results, it is possible to analyse the effects of contract parameters on the prevention activity. Therefore, we have to consider that in the focus of the insurer, the outcome depends not only on the (expected) agent's effort but also on a monitoring component. Hence, the insurer's break-even-condition must reflect this effect by rearranging the equation (2.2) which can be set as:

$$\pi = p(e)((1-\beta\lambda(e,m))x+m) \quad (2.13)$$

[17]

The difference to the first break-even condition is the second term on the right-hand side of the equation which is now dependent on signal λ and therefore reflects the insurer's imagination of the post-contract patient's behaviour.

Considering the influence of the disturbance variable we can conclude that the more informed the insurer is the less she additionally needs to increase the co-payment parameter. Differentiating the equation 2.11 over the co-payment parameter the one gets:

$$\frac{\partial\pi}{\partial\beta} = -p(e)\lambda(e,m)x \quad (2.14)$$

Here, the influence of the co-payment parameter on the insurance premium is also contingent on the weight set by the illness probability and the perceived information distribution depicted inversely by the dilution parameter λ. Therefore, we can denote this effect as direct insurance effect.

By totally differentiating equation (2.11) and taking the result of (2.15) we take a look at the "cost sharing-effect" (See appendix for the detailed computation of the effect): [18]

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[16] This result resembles ideas of time-inconsistency where there is a bias in information perception due to strategic intolerance. This effect is not independent on the costs of being intolerant (cf. Brocas and Carillo 2000)

[17] Similar to the assumption of Shavell (c.f. Shavell 1979) the costs of screening are constant and only contingent on the probability $p(e)$.

[18] We can denote the denominator as Ω. The value Ω reflects the second derivation of the first-order condition und has always to be negative in consequence of the concavity of the utility function (see appendix for the exact computation).

$$\frac{de}{d\beta} = \frac{p'(e)U_S'\left(\lambda(e)x - p(e)\lambda x\right) + p'(e_i)U_H'(p(e)\lambda x)}{\Omega} +$$

$$\frac{p(e)U_S''[(-\beta\frac{\partial\lambda}{\partial e}x)(p(e)\lambda x - \lambda x)] - p(e)U_S'(-\frac{\partial\lambda}{\partial e}x)}{\Omega} \tag{2.15}$$

A priori, the effect of a higher coinsurance level on prevention is ambiguous. Therefore, we discuss the influence of a higher cost sharing for different levels of information distribution (per variation over λ):

$$\frac{de}{d\beta}_{|\lambda=0} = 0 \tag{2.16}$$

With no disturbance in the information distribution there is no additional need to use co-payments for enhancing prevention activity, which is in fact the first-best case. In other words, we have only elaborated the necessary condition for the first-best case. In addition to this result, we have to consider the impact of this cost-sharing effect upon insurer's maximisation problem at stage one. Therefore, implementing higher co-payments might have an influence on the impact of additional monitoring.

If we instead evaluate the sign of the numerator in expression (2.15) for λ>0, we find that increasing the level of co-payments has a positive effect on preventive activities.

$$\frac{de}{d\beta}_{|\lambda>0} > 0 \tag{2.17}$$

Discussing the last equation we can state: If both insurer and insurant do not perceive any disturbance in information distribution there is no additional need to use co-payments for enhancing prevention activity which is in fact the first-best case. Moreover, focussing on results between the extreme values of λ we can infer that there is a need to permanently increase the level of effort. The more the information between both parties is diluted the more is a need for higher levels of co-payments. In addition, the better the insurer can observe the effort signal the better she can set its own assumption of the adequate co-payment parameter β.

The second contract parameter influencing the decision about preventive activities is the level of medical services (*x*). Regarding typical results elaborated in the literature we can expect a negative relation of higher levels of coverage upon prevention activity (cf. Zweifel and Manning 2000). With respect to the level of medical services, totally differentiation of equation 2.11 gives together with $\frac{d\pi}{dx} = p(e)(1-\beta\lambda(e,m))$ the so called "coverage-effect" (cf. appendix):

$$\frac{de}{dx} = \frac{p'(e)U'_S\left(p(e)(1-\beta\lambda)+\frac{\partial L}{\partial x}+\beta\lambda\right) - p'(e)U'_H(p(e)(1-\beta\lambda)}{\Omega}.+ \frac{p(e)U''_S[(\beta\frac{\partial\lambda}{\partial e}x)(-p(e)(1-\beta\lambda)-\frac{\partial L}{\partial x}-\beta\lambda)] + p(e)U'_S(\frac{\partial\lambda}{\partial e}\beta)}{\Omega} \quad (2.18)$$

In this case, the total effect of a higher level of medical services on preventive activities is ambiguous. But this result only holds for a level of x greater than the first best level. Therefore, the impact of a change in x must be simultaneously explored with a change in the values of λ between the range $\lambda \in [0,1]$. Following the computation given in the appendix we can conclude:

$$\begin{aligned} &\frac{de}{dx} \to 0, \textit{iff } \lambda \to 1 \wedge x \le x^* \\ &\frac{de}{dx} < 0, \textit{iff } \lambda < 1 \wedge x \le x^* \\ &\frac{de}{dx} < 0, \textit{iff } \lambda \to 0 \wedge x \le x^* \\ &\frac{de}{dx} \to ?, \textit{iff } \lambda \to 0 \wedge x > x^* \end{aligned} \quad (2.19)$$

Therefore the following results can be inferred: In contrast to the usual result that a higher level of medical services reduces the preventive activities, we find that the coverage level has no effect on patient's activities for a high level of λ. If λ decreases and the information is less deluded, the common result holds. Only if the coverage level is above the first best level, there might be a complementary relation between coverage and prevention.

Altogether, the need for additional co-payment is reduced. For x< x*, this leads to the conclusion that a higher level of medical services leads c.p. to a lower prevention activity $(de/dx < 0)$.

In order to complete the analysis of the influence of the contract parameters on prevention, we look at the monitoring activities of the insurer (*m*). With regards to our assumption, the informed patient can anticipate the efforts of the insurer.[19] Therefore it is interesting to show the relation between the patient's prevention effort and the costs of monitoring which could be a proxy for the insurer's own effort of monitoring ("monitoring effect").

$$\frac{de}{dm} = . \frac{-p'(e)U'_S(\frac{\partial\lambda}{\partial m}\beta x[p(e)-1] - p(e)) + p'(e)U'_H[p(e)\frac{\partial\lambda}{\partial m}\beta x - p(e)]}{\Omega} + \frac{p(e)U''_S(\frac{\partial\lambda}{\partial m}\beta x[p(e)-1] - p(e))(\beta\frac{\partial\lambda}{\partial e}x)) + p(e)U'_S(\beta\frac{\partial^2\lambda}{\partial e\partial m}x)}{\Omega} \tag{2.20}$$

When discussing different levels of *m* we get (compare the whole computation in the appendix):

$$\begin{aligned} &\frac{de}{dm} < 0,\ iff\ \ e \to 0 \wedge p(e) \to 1; \\ &\frac{de}{dm} > 0, iff\ \ e \to 1 \wedge p(e) \to 0 \end{aligned} \tag{2.21}$$

We can conclude that $de/dm > 0$ will be valid if a very high prevention level can be assumed but this value alters to $de/dm < 0$ for low levels of *e*. Hence, patient's rejection of monitoring declines the higher is the level of *p*(*e*). In other words, additional monitoring works more productive the lower is the probability of getting sick.

Corollary1: In the case of asymmetric information between the insurer and the patient the level of preventive active depends positively on the co-payment but a lower level of co-payment has to be charged the more the information distribution can be enhanced. Additionally the conflictive relationship between the level of medical service and preventive activities becomes more apparent in consequence of a diluted information distribution. It can be reasoned that an increase in monitoring activities can partly compensate charging higher co-payments but this effect is contingent on a concomitant increase in information.[20]

[19] The patient can interpret the management efforts of the insurer as a proxy for the insurer's own efforts.
[20] It is assumed that the insurer is able to interpret the signals properly. Screening or monitoring activities work as a productive effort enlightening vague information concerning the patient's preventive efforts but cannot investigate the patient completely.

2.3 Conclusion of the theoretical model

To sum up the above findings, asymmetric information has remarkable consequences for the individual behaviour and the design of the contract parameters. First of all, the fact that the insurance company is unable to observe the preventive activity leads to a lower level of prevention. We could affirm some of the findings of the simpler asymmetric model, especially the partly reciprocal relation between co-payment and prevention effort. But there has also come true an additional need for an information environment which can be influenced by the parties of the treatment. The insurer has an additional parameter for governing patient's behaviour by deciding about monitoring activities. Moreover, the informational distribution within the managed care environment plays an important role. The insurer can partly substitute co-payment with more monitoring efforts that could be organised in special forms of managed care like disease management or case management. These findings correspond with the results outlined in the literature from a medical viewpoint describing the importance of good mutual compliance.[21]

3 The empirical investigation

The recent theoretical work has already outlined the mutual necessity of monetary parameters and the complementary informational structures which could enforce the effectiveness of prevention efforts. Within our theoretical analysis, we concentrated on the second stage of the model for describing the structure and the process of managed care concerning better prevention activities. Therefore, the empirical analysis concentrates on the effects at stage two that directly describes the patient's role in prevention activities. In detail, we look at the prevention activities of an individual and in how far contract parameters of health insurance systems and information have an impact on this behaviour. From the results of the theoretical model, we are able to derive the following two testable hypotheses:

1. Contract parameters influence the prevention decision.
2. Health status and information are related to the individual perception of prevention.

The first hypothesis describes the findings that the individual's prevention decision depends on the influence of co-payments (cost-sharing effect) and on the coverage defined in the contract (coverage effect). The second hypothesis captures aspects of individual behaviour that are not directly implemented in the theoretical model and the influence of insurer's monitoring activities. Here, it is important that individual's health status might be on the one hand the

[21] Cf. Dracup and Meleis (1982) or Greenlund et al (2000). Greenlund et al stress the importance of the positive impact on the patient's effort when there is a consistent and truthful behaviour of the clinician.

result of preventive action but on the other hand reflects the experience with medical care as well as health relevant behaviour and influences the decision. Moreover, a better informed individual tends to behave c. p. in a healthier manner than an uninformed would do.

Our variable of interest is the primary preventive behaviour of a patient. This is a multidimensional construct depending on a variety of health behaviours that cannot be observed directly. Therefore, we have to reformulate our notion of prevention. Instead of a general concept of prevention, we use a specific form of health relevant behaviour, namely people's attitude towards smoking. In detail, we look at the individual decision to change this behaviour. Starting with a set of individuals who are current smokers in the relevant year, we can observe their decision to quit or to go on smoking. For this variable, a series of eight years is available that allows us to study changes in preventive behaviour in the context of different insurance systems.

The empirical literature on health related behaviour and especially smoking is huge. Kenkel (1991) for example analyses the relation between school attendance, smoking, alcohol consumption, and exercises. As an explanatory variable, he uses the answer to the question whether an individual is aware of the health risks that are related to a specific behaviour. As a result, better health knowledge leads individuals to behave healthier, e. g. to smoke less. An instrumental-variable approach in the estimation of the number of cigarettes smoked is presented by Mullahy (1997). After correcting for unobserved heterogeneity, cigarette price, income age and education can be identified to influence the amount of smoking. Foster and Jones (2001) investigate the role of tobacco taxes in starting and quitting smoking. For British data, they get the result that higher taxes lead to a lower consumption of tobacco products. The effect of health behaviours on the individual perception of health is at the core of a paper by Contoyannis and Jones (2004). They find that non-smokers have a higher perception of the individual health status than smokers have. Kenkel et al (2006) look at the educational effects on the decision to smoke. Using high school competition and GED receipt as possible sources for a good health behaviour, they show that a high school degree goes along with a lower probability to smoke but has no effect on other health variables like obesity. Cowell (2006) investigates the future effects of current health behaviours and finds that future opportunity costs affect the smoking decision. Moreover, the number of schooling years has a negative impact on cigarette smoking. By using dummy variables for different educational degrees, he finds a negative gradient in higher education.

3.1 Data

The data we use is from the German Socio-Economic Panel (SOEP), a representative longitudinal study of private households in Germany.[22] Explicitly, we use the waves of the years 1995-2002. With respect to our indicator for primary prevention, we use questions of the year 2002 were respondents are asked to report the year starting and stopping smoking. With this information we construct a variable that displays for each year of our analysis whether the individual smokes or not. Starting with the year 1995, our dataset consists of 1470 individuals that are smokers in that year. In the last year of our sample, we observe only 1218 individuals are assessed to be smokers. Therefore, 271 individuals did indeed quit smoking resulting in 10850 observations for the eight years

The independent variables can be divided into four different categories (see table 1): The first category contains predisposing variables like gender and nationality. Five age categories are included and additionally, the variables 'partnership' and 'children' are indicators for the family status of the respondent. All of these variables are binary ones. Second, socioeconomic variables are included to explain general economic conditions. The first variable in this group determines the money spendable for consumer and health care goods, namely the household income. Here, we use the logarithm of the net household income to correct for the skewness of the density function. As the size of the household differs for the respondents, we use the household equivalent income. Moreover, we include a dummy variable stating whether an individual faces serious economic worries about the future. The second group of variables within this category are educational variables. Third, we include variables concerning the workload or whether an individual is unemployed. Last, a regional dummy for Eastern Germany should measure remaining differences in preventive behaviour.

Health and insurance variables build up the third category. In this group of variables the respondent's insurance status is included. We use two variables to test for hypothesis 1. First, we look at the insurance system, i.e. whether the individual is fully private insured or insured in the Statutory Health Insurance (SHI). Second, we take into account that members of the latter group might buy supplemental coverage. Both, fully private and supplemental coverage go along with a broader coverage and a cost-sharing structure that differs from that in the SHI where co-payments are low. In detail, contracts for full private insurance often go along with different forms of cost-sharing like co-insurance or deductibles that are not common in the

[22] The data used in this publication were made available to us by the German Socio-Economic Panel Study (SOEP) at the German Institute for Economic Research (DIW), Berlin.

SHI.[23] Moreover, as supplemental insurance results in a broader coverage this corresponds to a reduction of cost sharing because in the SHI these services are not included and therefore, a cost sharing of 100 percent is charged. Finally, to capture health effects of long-time smoking, we include the health capital stock of the individual in relation to others in the relevant year. With this construction, we analyse the effect of health status on health relevant behaviour. Additionally, the age at which the individual started smoking serves as a proxy for the intensity of smoking in years. An overview over some descriptive statistics for the first year in the sample is given in table 2.

Table 1: Description of the variables

Variable	**description**
nonsmoker	non-smoker yes/no
Predisposing variables	
age < 30	respondent less than 30 years old yes/no
age 30 - 45	respondent 30 to 45 years old yes/no
age 46 - 60	respondent 46 to 60 years old yes/no
age 601- 75	respondent 61 to 75 years old yes/no
age >75	respondent older than 75 years yes/no
female	1 = female, 0 = male
partner	living together with a partner yes/no
foreigner	children under 16 in household yes/no
children < 16	nationality not German yes/no
Socioeconomic variables	
Eastern Germany	living in Eastern Germany yes/no
O-level	first public examination in secondary school yes/no
high school	general qualification for university entrance yes/no
university	university degree yes/no
eq. hh-income	Log equivalent household net income in € d
economic worries	strong worries about own economic situation yes/no
working time	number of hours worked regularly
working time sq.	number of hours worked regularly sq
unemployed	unemployed yes/no
insurance and health variables	
private insurance	fully private insured yes/no
supplementary ins.	private supplemental insurance yes/no
health status	health capital stock
age started smoking	age at which the respondent first smoked

[23] From an international perspective, the co-payments in the German private health insurance sector are still comparatively low.

Table 2: Descriptive statistics for the first wave (1995): 1470 observations

Variable	Mean	Std. Dev.	Min	Max
nonsmoker	0.0238	0.1525	0	1
age < 30	0.2558	0.4364	0	1
age 31 - 45	0.4245	0.4944	0	1
age 46 - 60	0.2367	0.4252	0	1
age 61 - 75	0.0762	0.2654	0	1
age >75	0.0068	0.0822	0	1
female	0.4136	0.4926	0	1
partner	0.7510	0.4326	0	1
foreigner	0.1604	0.3670	0	1
children < 16	0.4313	0.4953	0	1
Eastern Germany	0.3027	0.4596	0	1
O-level	0.2816	0.4499	0	1
high school	0.0769	0.2665	0	1
university	0.1401	0.3472	0	1
eq. hh-income	7.7202	0.4299	4.9416	10.1165
economic worries	0.2252	0.4178	0	1
working time	28.6830	20.5206	0	80
working time sq.	1243.4930	1051.9280	0	6400
unemployed	0.0633	0.2435	0	1
private insurance	0.04423	0.2056	0	1
supplementary ins.	0.03673	0.1882	0	1
health status	0	1	-8.9966	1.0132
age started smo-king	18.0429	4.6307	7	53

3.2 Estimation method

We study the decision to quit smoking by estimating discrete-time hazard functions. Therefore, our unit of analysis is the time at risk of the event "stop smoking". In detail, we apply the stock-sampling approach specified by Jenkins (1995) meaning that we use an unbalanced panel data structure (cf. Wooldridge (2002), p. 700). This means that for the first period $t=\tau$, only those individuals that currently smoke are in the sample. Then, for the following periods, we drop all those individuals that quit smoking. Over the whole sample period, 218 of the original 1470 individuals changed their health related behaviour. This means that we observe two types of individuals. First those who quit smoking in $t=\tau+s_i$ and second those for which the observation period ends in $t=\tau+s_i$ before the might have quit (interview data). In the first case, one can speak of a complete duration data (complete spell $\delta_i=1$) whereas in the second case, we have censored duration data ($\delta_i=0$).

For the estimation at hand, the probability to quit smoking at time t incorporates information on the duration distribution. Following Jenkins (1995), the discrete-time hazard rate h_{it} is:

$$h_{it} = \Pr\left(T_i = t \mid T_i \geq t, X_{it}^{'}\beta\right) \tag{3.1}$$

Here, X_{it} is a vector of covariates that varies over time and T_i is a discrete random variable representing the time at which the smoking period ends. Then, the conditional probability of observing an incomplete spell at a given time period is given by:

$$\Pr\left(T_i > t + s_i \mid T_i > \tau - 1\right) = \prod_{t=\tau}^{\tau+s_i}\left(1 - h_{it}\right) \tag{3.2}$$

The conditional probability of observing the event history of someone completing a spell is:

$$\Pr\left(T_i > t + s_i \mid T_i > \tau - 1\right) = \left[h_{i\tau+s_i} / \left(1 - h_{i\tau+s_i}\right)\right]\prod_{t=\tau}^{\tau+s_i}\left(1 - h_{it}\right) \tag{3.3}$$

For the whole sample, the resulting log-likelihood of observing the smoking history data can be written as:

$$\log L = \sum_{i=1}^{n}\delta_i \log\left[h_{i\tau+s_i} / \left(1 - h_{i\tau+s_i}\right)\right] + \sum_{i=1}^{n}\sum_{t=\tau}^{\tau+s_i}\log\left(1 - h_{it}\right) \tag{3.4}$$

To simplify the estimation method, Jenkins defines the variable y_{it}=1 if t=τ+s_i and δ_i=1 and y_{it}=0 otherwise. Hence, for all individuals who carry on smoking during the complete sample period, y_{it}=0 and for those who quit smoking, y_{it}=0 for the periods prior to the one when they stop smoking, where y_{it}=1. Then, the log-likelihood corresponds to the following expression:[24]

$$\log L = \sum_{i=1}^{n}\sum_{t=\tau}^{\tau+s_i} y_{it} \log\left[h_{it} / \left(1 - h_{it}\right)\right] + \sum_{i=1}^{n}\sum_{t=\tau}^{\tau+s_i}\log\left(1 - h_{it}\right) \tag{3.5}$$

Hence, the estimation is carried out using a standard log-likelihood but the dataset is organised differently using the stock sampling approach. In detail, this means that for each individ-

[24] It is worth mentioning that the above log-likelihood function has the same form as a standard log-likelihood when estimating models for a binary variable (y_{it}) (cf. Jenkins (1995), p. 134).

ual, there are as many data rows as there are time intervals at risk of the event 'quit smoking' for each person (cf. Jenkins (1997), p. 112).[25]

For a complete specification, the expression for the hazard rate has to be determined. Jenkins uses a complementary log-log hazard rate that is defined as follows:[26]

$$h_{it} = 1 - \exp\{-\exp[\theta(t) + \beta' X_{it}]\} \quad \Leftrightarrow \quad \log[-\log(1 - h_{it})] = \theta(t) + \beta' X_{it} \tag{3.6}$$

Here, θ(*t*) is the baseline hazard. The model allows for a non-parametric form of this baseline hazard with a separate parameter for each duration interval (cf. Jenkins (1997), p. 110).[27] This is done by including a dummy variable for each year with 1995 as reference group. Moreover, a second version of the discrete-time proportional hazards model incorporates a gamma-distributed random variable to describe unobserved heterogeneity between individuals.

3.3 Modeling individual's health stock

According to our second hypothesis, individual health status plays a crucial role in determining preventive behaviour. In the SOEP data measures of health like self-assessed health are included. Such measures of health and their validity have caused a considerable debate (cf. Jones (2007), p. 21). Concerning these variables, the self-assessed health that is part of the dataset might be vulnerable to a reporting bias because of anticipation and measurement errors (cf. Hagan et al. (2006), p. 11 and Hernández-Quevedo et al. (2005), p. 4). The original self-assessed health variable is a five-point scale variable ranging from very good to bad. To correct for a possible bias, we apply a technique proposed by Disney et al. to correct for a possible reporting bias. We estimate a model of self-assessed health as a function of objective health measures *m*, e.g. the utilisation of health care or physical and mental well being as well as personal characteristics *x* like age and education (cf. Disney et al. (2006), pp. 625). First, we can write the unobservable health status as a function of *x* and *m*:

$$\eta_{it} = x_{it}^{'} \beta + m_{it}^{'} \gamma + u_{it} \tag{3.7}$$

[25] For the specification presented, it follows that there are $\tau+s_i$ rows for each individual i=1,…*n*.
[26] One main property of this specification is that the resulting model is the discrete-time counterpart of an underlying continuous-time proportional hazards model (cf. Jenkins (1997), p. 134).
[27] Alternatively, using a Weibull distribution or a Cox-hazard model to estimate the model leads to comparable results but assumes a specific baseline hazard. The main advantage of our approach is that no explicit functional form for the baseline hazard has to be specified and that this non-parametric form also allows for a non-monotonic function.

Instead of η_{it}, self-assessed health h_{it} is observed in the data set. The latent health stock h^* is the counterpart of the observed self-assessed health and is a function of the unobservable health status η_{it} and a reporting error ε_{it}:

$$h_{it}^* = \eta_{it} + \varepsilon_{it} \qquad (3.8)$$

The latent health variable can be linked to the dichotomous indicator h_{it} using the following observation mechanism:

$$h_{it} = j \,, \quad \text{if} \quad \mu_{j-1} < h_{it}^* < \mu_j \;, j = 1 \,, \ldots \,, 5 \qquad (3.9)$$

Equation (3.9) shows that our observable health variable takes the value j if the latent health stock lies between the two thresholds μ_{j-1} and μ_j. Combining the observation mechanism with equation (3.7), the model can be estimated using ordered probit techniques. Following Disney et al. (2006), we estimate the health stock for each wave separately using the wave specific values of m and x. Using the predicted values form these estimations, we can normalise the health stock using a z-transformation. This yields to a health capital stock that has a zero mean and a constant variance of one for each wave. Furthermore, positive values of our health capital stock variable indicate that the respondent's health is above the sample mean in this period.

3.4 Results

The estimation results for the second version of the hazard model that incorporates individual heterogeneity are obtainable from table 3. There, in the second column, the value of the estimated coefficient is presented. Columns three and four show the z-value and the p-value and the last column gives the hazard ratio. A value greater than one means that the specific factor increases the probability of quitting smoking whereas a value below one denotes the reverse interpretation. In the group of predisposing and family variables, only the two age dummies for the highest classes show a significant positive influence. This means that older people tend to stop smoking more often than younger people do.[28] There is no difference between our reference group (younger than 30) and the age classes between 30 and 60 years. This effect

[28] It is important to mention that we do not possess any information about the reasons why people quit smoking,, i.e. we have no data on whether the decision might be physician initiated or not.

maybe due to illness experiences related to smoking and could be interpreted as an effect of a higher risk aversion.

In the group of socioeconomic variables, it is remarkable that people in Eastern Germany have a higher probability of stopping smoking. First, in our sample 30 % of the smokers in the year 1996 live in Eastern Germany compared to 19 % for the whole population, which means that this group has a higher tendency to smoke. Second, there seem to remain differences in living habits and conditions between east and west several years after the reunification. From the subgroup of educational dummies, only the one for a university degree is significantly positive. If we interpret this as a better capability to process the available information and this confirms our hypothesis that information is one key for enhancing prevention activities. The household income does not show a significant effect but the influence of the variable economic worries is strongly negative. Worries about the future economic situation can then be interpreted as a proxy of social status leading to the conclusion that people with strong worries and therefore low status tend to quit smoking less often than others do. Concerning the working time, we observe a non-linear effect. First, increases in working time decrease the probability of stopping smoking. This may result due to work related burdens and stress. Second, with a further increase, the magnitude of this effect decreases.

For the group of health and insurance variables, our measure of the health capital stock shows a significantly positive sign resulting in a lower probability of quitting. Here, we have instrumented the original self-assessed health variable using age and educational variables as well as measures of physical and psychical well being and the utilisation of medical care. Therefore, one can conclude that people in a good health status and with fewer experiences concerning e.g. respiratory diseases caused by smoking do not feel the pressure to change their preventive behaviour.

Neither the age when the respondent started smoking nor the insurance variables have any effect on the decision to quit smoking. Therefore, we cannot draw a conclusion concerning our first hypothesis. This result may be due to our data availability. First, our insurance dummies only capture in which system the individual is insured or whether there exists supplemental insurance. In Germany, about 90 % of the population are compulsory insured in the Statutory Health Insurance (SHI) and only people with an earned income above the compulsory insurance income threshold are qualified to choose between social and private insurance. Moreover, people working as civil servant are partly privately insured. Therefore, insurance status incorporates also information about socioeconomic status, profession and the status and education of the parents. Second, three effects could be derived from the theoretical model but from our data it is not possible to separate these effect. To do so, it would have been necessary to have information on coverage, co-payments and insurer behaviour. Instead, we only have the information about the insurance system.

For the SHI insured individuals this means that there is no variation in the insurance contract because with few exceptions, benefits catalogue and co-payments are settled by the government. Third, our prevention variable '"quit smoking" covers only one single aspect of the multidimensional factor preventive activities.

Table 3: Estimation results

hazard	**coefficient**	**z**	**P>|z|**	**hazard r.**
predisposing and family variables				
age 31 - 45	0.1907	0.56	0.571	1.2100
age 46 - 60	0.7255	1.52	0.131	2.0658
age 61 - 75	1.1127**	1.82	0.069	3.0424
age >75	1.7531*	1.65	0.103	5.7721
female	-0.3314	-1.10	0.269	0.7179
partner	0.2838	0.97	0.330	1.3282
foreigner	0.4044	0.96	0.336	1.4984
children < 16	-0.2211	-0.84	0.396	0.8016
socioeconomic variables				
Eastern Germany	0.6736*	1.73	0.086	1.9612
O-level	0.3555	1.03	0.302	1.4269
high school	0.4646	1.07	0.273	1.5913
university	1.1489***	2.57	0.010	3.1546
eq. hh-income	-0.1531	-0.49	0.628	0.8580
economic worries	-0.4344**	-1.88	0.060	0.6476
working time	-0.0330**	-2.04	0.040	0.9675
working time sq.	0.0007**	2.55	0.011	1.0007
unemployed	-0.1850	-0.47	0.638	0.8311
insurance and health				
private insurance	0.1386	0.38	0.703	1.1486
supplementary ins.	0.3289	0.94	0.348	1.3895
health status	-0.2964***	-2.96	0.004	0.7435
age started smoking	-0.0316	-1.02	0.311	0.9689
constant	-2.9011	-1.21	0.223	
d96	0.1276	0.42	0.677	
d97	0.5076	1.35	0.177	
d98	1.0718**	2.34	0.019	
d99	1.2862**	2.29	0.022	
d00	1.9986***	2.94	0.003	
d01	2.8025***	3.19	0.001	
d02	2.0021**	2.06	0.041	
Gamma var.	13.2575***	2.61	0.000	
LR test (χ^2)	16.8519***		0.000	

The time dummies show a significant effect from the year 1998 on stating that we have a non-monotonic increase of the baseline hazard. In detail, we observe an increasing effect over time but for the year 2002 it decreases. During this time period, cigarette prices in Germany increased from 12.38 to 14.80 cent/cigarette (cf. van Deuverden (2004), p. 12). At the same time, tobacco taxes grew from 6.96 to 8.62 cent/cigarette. Therefore, one can conclude that the observed coefficients of the baseline hazard show to a great deal the effect of taxes and price increases. Finally, a likelihood ratio test is performed to check whether a model including individual heterogeneity using a gamma mixture distribution fits better than the standard Bernoulli distribution. Here, the hypothesis that there exists no difference between the two models can be rejected at the 1 % level of significance.

4 Conclusion and aspects for ongoing research

Our analysis describes the hidden conflict between the two aspects in the trade-off between the disutility of prevention activities and the probability of illness. In detail, the effects of an insurance contract on preventive behaviour work through the co-payment the patient has to bear, the coverage of medical services and the monitoring activities that the insurer performs. In the analysis at hand, we assumed the patient's ability to fully control his prevention activities. But the comparison of investment in prevention in the present time and the expected outcome in the future may possible lose sight of the utilities of prevention goods when doing prevention. Therefore, Cohen and Mooney (1984) distinguish between the utility in use and the utility in anticipation when doing prevention.

Our empirical specification tried to test the hypotheses of the theoretical part using German micro data. Applying a discrete-time proportional hazards model to the question of quitting smoking as a proxy of preventive behaviour, we find evidence that health capital stock and information play a central role in the decision about prevention. For the data at hand, the effects of different insurance systems remain unclear for two reasons. First, health insurance serves as a kind of proxy for socioeconomic status and second, we do not find much variation in the data because information on co-payments and coverage is missing. Moreover, our variable of health behaviour (quit smoking) covers only a small part of preventive activities.

Further research have to be undertaken for illustrating a better understanding of stable prevention efforts over a longer period of time. In fact, short look at recent literature shows different attempts by using time inconsistency models or ideas relating to the older forms of rational addiction[29]. It could be possible that fewer co-payments could decrease pharmaceutical costs at the moment but is confronted with higher life-time costs in the future compared with models with fewer co-payments[30]. Moreover, the interrelation between information distribution within a managed care environment caring for chronic diseases and the impact of information upon the valuation of non-monetary losses due to chronic diseases has to be explored. For a forthcoming exploration, we might discuss "positive disutilities" when doing prevention which probably go along with a time-dependent prevention path.

Moreover there is still a lack in discussing concomitant patients and physicians behaviour over a longer period of time which helps enhancing viable prevention settings. Recent research activities, e. g. Treadwell and Lenert (1999) and Winter et al (2003) have outlined the health state dependency of medical treatment. The next steps for discussing could be an investigation of changing of the values of contract parameters contingent to the level of sickness probability and the distance to an expected illness.

[29] Cf. Yaniv 2006 who compares different models of explaining behaviour of addiction. In addition, our approach is to figure out the basic difference between addiction problems and problems of prevention activities in moral hazard surroundings. The former models stress ideas of time inconsistency whereas the latter concentrate on governing incentives.

[30] Some empirical models discussing different indications explore the effects of differences in co-payment schemes on the long-term medical adherence (cf. Hsu et. al. 2006 or Chandra et. al. 2007).

Appendix: Computation of the theoretical model

a) Co-payment effect

By totally differentiating equation (2.11) and taking the result of (2.15) we can formulate with respect to coinsurance the "cost sharing-effect", that generally can be written as:

$$\frac{de}{d\beta} = \frac{p'(e_i)U_S'\left(\lambda(e)x - p(e)\lambda x\right) + p'(e_i)U_H'(p(e)\lambda x)}{\Omega}$$

$$+\frac{p(e)U_S''[(-\beta\frac{\partial\lambda}{\partial e}x)(p(e)\lambda x - \lambda x)] - p(e)U_S'(-\frac{\partial\lambda}{\partial e}x)}{\Omega} \qquad \text{(A.1)}$$

with $\Omega = p''(e)(U_S - U_H) - C'(e) - 2p'(e)U_S'(\beta\frac{\partial\lambda}{\partial e}x)$

$$+p(e)U_S''(\beta\frac{\partial\lambda}{\partial e}x)^2 - p(e)U_S'(\beta\frac{\partial^2\lambda}{\partial e^2}x) < 0, \textit{if } \lambda(e) \textit{ is not too convex.}$$

The sign of (A-1) depends on the disturbance variable. Considering that the denominator of (A-1) is negative and the case that λ=0, from the fact that $\frac{\partial\lambda}{\partial e} \to 0$ one gets:

$$\frac{de}{d\beta}_{|\lambda=0} = \frac{0}{p''(e)(U_S - U_H) - C''(e)} = 0 \qquad \text{(A.2)}$$

If instead the parameter λ in the numerator is greater than zero we can show that the numerator will always be smaller than zero. The numerator increases the more λ approaches 1. Hence we can set:

$$\frac{de}{d\beta}_{|\lambda>0} = \frac{p'(e)U_S'[\lambda(e)x - p(e)\lambda(e)x] + p'(e)U_H'(p(e)\lambda(e)x)}{\Omega}$$

$$+\frac{p(e)U_S''[(\beta\frac{\partial\lambda}{\partial e}x)(p(e)\lambda(e)x - \lambda(e)x)] + p(e)U_S'(\frac{\partial\lambda}{\partial e}x)}{\Omega} > 0. \qquad \text{(A.3)}$$

This result only holds when $-\frac{\partial\lambda(e,m)}{\partial e}\|e \to \min > -\frac{\partial\lambda(e,m)}{\partial e}\|e \to \max, \textit{given} \frac{\partial\lambda(e,m)}{\partial e} < 0$ which must be true by assumption.

b) Coverage Effect

Totally differentiating of equation 2.11 relating to the coverage *x* gives the following result:

$$\frac{de}{dx}=\frac{p'(e)U_S'\left(p(e)(1-\beta\lambda)+\frac{\partial L}{\partial x}+\beta\lambda\right)-p'(e)U_H'(p(e)(1-\beta\lambda)}{\Omega}$$
$$+\frac{p(e)U_S''[(\beta\frac{\partial\lambda}{\partial e}x)(-p(e)(1-\beta\lambda)-\frac{\partial L}{\partial x}-\beta\lambda)]+p(e)U_S'(\frac{\partial\lambda}{\partial e}\beta)}{\Omega}. \quad \text{(A.4)}$$

Again, the denominator is sufficient condition for a utility maximum and negative. For the numerator, the second term is always positive (considering times -1) and the fourth term is always positive. The third term will also be positive as long as $U_S''<0$ holds. The first term will be positive as long as $\partial L/\partial x<-p(e)(1-\beta\lambda(e))-\beta\lambda(e)$ is valid. Taken into account the convexity of the loss function the result holds for all level of medical services smaller than the first best which was set in equation 2.6. If the level of medical services exceeds the first best x^*, the derivative of the loss function with respect to *x* decreases. By this, it is more likely that $\partial L/\partial x>-p(e)(1-\beta\lambda(e))-\beta\lambda(e)$ holds.

By inserting λ=0 the reduced fraction can be depicted as follows:

$$\frac{de}{dx}=\frac{p'(e)U_S'\left(p(e)+\frac{\partial L}{\partial x}\right)-p'(e)U_H'(p(e))}{\Omega_{\lambda=0}}$$
$$+\frac{p(e)U_S''[(\beta\frac{\partial\lambda}{\partial e}x)(-p(e)-\frac{\partial L}{\partial x}]+p(e)U_S'(\frac{\partial\lambda}{\partial e}\beta)}{\Omega_{\lambda=0}}. \quad \text{(A.5)}$$

Discussing the reduced numerator we see that the second and the third part will be always positive and the last part will be negative. Hence, the complete numerator will be positive if the first part is also positive and the sum of the first three parts exceeds the last part. Focussing the first term and considering again that *L*(*x*) and *p*(*e*) are both convex, this can only be true if *L*'<-*p*(*e*) holds which must be true if *x*<*x** is valid. But this assumption is only necessary and not sufficient because $\left|p(e)_{e\to\max}\right|<\frac{\partial L}{\partial x}$ has to be also valid. The more *p*(*e*) reacts to alteration in prevention effort the higher is the probability that the sufficient condition can be accepted.

Regard to formula A-4 and considering the other level of λ=1 only *L*'<-*p*(*e*) (1-β)-β is left for discussion in the numerator. This expression is always valid if and only if *L*(*x*) is convex which must be true by assumption and the co-payment level is not too high. The more x is reduced the more additional β is necessary for fulfilling the inequality. Hence the "productivity" of additional co-payments diminishes.

c) Monitoring Effect

Totally differentiating equation 2.11 with respect to monitoring efforts gives:

$$\frac{de}{dm} = \frac{-p'(e)U_S'(\frac{\partial\lambda}{\partial m}\beta x[p(e)-1]-p(e)) + p'(e)U_H'[p(e)\frac{\partial\lambda}{\partial m}\beta x - p(e)]}{\Omega} + \frac{p(e)U_S''(\frac{\partial\lambda}{\partial m}\beta x[p(e)-1]-p(e))(\beta\frac{\partial\lambda}{\partial e}x)) + p(e)U_S'(\beta\frac{\partial^2\lambda}{\partial e\partial m}x)}{\Omega} \quad \text{(A.6)}$$

For discussing the numerator, we must split it into the separate terms and considering different levels of prevention activity e. Because of the expected negative impact of an additional amount of monitoring on the disturbance variable $\partial\lambda/\partial m < 0$ we can assert the second term will be always positive. The sign of the fourth term depends on the sign of the cross derivation $\partial^2\lambda/\partial e\partial m$, which reflects the impact of monitoring on the marginal product of prevention on information. As long as more monitoring enhances the information transmission of patient's prevention, the forth term is positive.

For the first and the third term, their sign depends on the expression in brackets:

$$-p'(e)U_S'(\frac{\partial\lambda}{\partial m}\beta x[p(e)-1]-p(e)) \quad \text{(A.7)}$$

The exact sign is influenced by the contract parameters coverage level, co-payment and monitoring. Moreover, the probability of getting sick depends on the prevention level. Given that this probability is bounded between 0 and 1 and that p is a convex function of effort, the expression is c.p. positive for lower preventive activities. Independent of this intermediate result, the signs of the first and the second term always point in same direction.

Assuming that the cross derivation of the disturbance term is zero, for a high probability of getting sick, the effect of better monitoring on prevention is negative. In contrast, for a given low probability of getting sick the effect of monitoring on prevention might turn positive.

Hence, as the probability depends on the preventive effort, this result means that for higher levels of prevention better monitoring has a positive effect.

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