Should I stay or should I go?
On the relation between primary and secondary prevention*

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Abstract

Referring to papers concerning prevention strategies in an insurance environment, we analyze the possible trade off between incentives for accepting medical prevention and engaging in non-medical prevention. Our theoretical model shows the trade-off between medical and non-medical prevention and their strategic dependences. In detail, the patient’s decision considers the costs of prevention and medical treatment as well as changes in the affinity for accepting medical prevention. In the consequence, we compare insurance as well as premium aspects of prevention. The results allow expanding the discussion to an intertemporal focus.

Keywords: Incentives in primary and secondary prevention; prevention affinity, premium effect;

JEL classification: I12, D82
1 Introduction and motivation

Some research activities have been undertaken to elaborate appropriate incentive schemes fostering enduring prevention results in treatment strategies especially concerning chronic diseases\(^1\). An important role regarding incentive remedies are cost-sharing ideas which have been discussed in Health Economics for almost 30 years after the famous Health Insurance Experiment (HIE) of the Rand Corporation was published. But within the last years influences of managed care organizations and therefore cost-sharing activities have manifestly risen and the importance of chronic diseases has become more relevant. But traditional forms of risk- and cost-sharing may not always help to foster appropriate prevention strategies.

Moreover, there is an ongoing debate on the effectiveness and the efficiency of medical prevention because recent evaluation results do not really help to develop sustainable prevention strategies.\(^2\) Macroeconomics of prevention, especially the question for cost-savings in the long run, often neglect the discussion on sustainable incentive strategies that could simultaneously incorporate relevant incentives which encompasses monetary as well non-monetary aspects like information of doing “right forms” of prevention. For instance, regarding prevention for chronic illness a mixture of an appropriate financial and organizational environment for improving the quality of care is necessary (cf. Roski et. al. 2003). For some chronic diseases, e. g. coronary heart diseases, the complementary primary prevention strategy has already been established as part of a national prevention program but these attempts seem to be exceptions to standard health care.\(^3\) In the National Cholesterol Education Program for the U.S. the following quote could be cited: “However, for prevention to be effective in reducing health disparities, a comprehensive approach that goes beyond education is necessary” (p. 8).

For controlling risk factors that could be monitored by the means of medical prevention the supplementation with preventive medications become more important. In the consequence, chronic diseases often reflect the need for simultaneous primary and secondary prevention (cf. Russell. 2008).

In the case of typical primary prevention strategies, the information distribution becomes very relevant for organizing prevention activities. Beyond the recent research activities in that case, e.g. Treadwell and Lenert (1999) and Winter et al (2003) have outlined the health state de-

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\(^1\) Cf. Glasgow (2001) et. al. for the discussion of the relevance of Chronic Care Model for improving prevention.

\(^2\) Cf. Cohen (2008) et. al. who discuss about 500 prevention strategies for effectiveness and cost-effectiveness. They do not find a majority of programs that really helps cost-savings in the long run (p. 662 f.).

\(^3\) The National Cholesterol Education Programme for the U.S. has already integrated the complementarity of primary prevention to secondary prevention in 1999 (c. f. Goldman et. al. 1999). We do not discuss the effect which level of primary prevention can possibly incite people to do more secondary prevention. Our focus is related to the question whether there will some economical reasons for complementarity or substitution.
pendency of medical treatment. Furthermore, for secondary prevention strategies the impact of information and the availability of appropriate supply of medical treatment play an important role. But there is lack of a common discussion of prevention strategies that combine primary and secondary prevention in the context of an insurance-based setting. Byrne and Thompson (2001) discuss a model of screening and prevention that tries to outline a general idea of subsidies for primary prevention and screening (secondary prevention) that are directly contingent on the technological environment. Especially they outline that non-optimality often results of a non-constant discounting. The choice of an appropriate discounting can be directly related to the possible coincidence of screening or prevention strategies. Opposite to the case of the appropriate discounting we want to discuss whether there is a higher chance for doing secondary prevention when a higher level of primary prevention antecedes. For our special interest we analyze the behavior of a patient who is incorporated in a typical insurance based setting where the insurer conducts as a health care provider. Some questions accrue within this problem set:

- Is there an additional relation of prevention organization that must also be considered within an insurance-based prevention environment?
- What will be the impact of simultaneous prevention strategies on cost-effectiveness from a health insurance point of view?
- Does an organized form of medical prevention (secondary prevention) help the patient to be more self-compliant?

For this reason the following paper is supposed to develop a basic framework for a prevention environment consisting of primary and secondary prevention. Referring to other papers discussing prevention strategies in an insurance-based setting we can conclude that prevention strategies are combined by a mixture of information, organization and incentives (cf. Barigozzi 2004 or Miceli and Heffley 2002). Up to now, the interrelation between primary and secondary prevention has not really been discussed economically. Referring to Cohen and Mooney (1984) who distinguish between utility in use and utility in anticipation a person faces when doing prevention we compare the expected positive impact of a reduced probability of getting sick (use in anticipation) with the disutility of doing prevention efforts (negative utility in use). For the present analysis we assume that primary and secondary prevention occurs simultaneously.
The paper is organized as follows. First we introduce our basic model which combines a typical principal-agent idea with a managed care environment within a simultaneous model. Afterwards we discuss a first-best strategy that helps discussing problems when patient’s prevention activities are not in concordance with the first best. In the third chapter we outline some conditions and obstacles that convey or that hinder an efficient prevention strategy considering either primary or secondary prevention.

2 The basic model

2.1 The structure of the model

Our model refers to the standard setting of a moral hazard problem within an insurance environment but sets the principal as an insurer in the sense of an HMO. This idea resembles the model used in Schneider and Zerth (2008) which is basically related to ideas set by Miceli and Heffley (2002) and the approach formulated by Shavell (1979). All these models can be referred to the paper of Ehrlich and Becker (1972) describing the patient’s interest for being insured and the interaction between the demand for insurance and forms of “self-insurance” and “self-protection”. Our model resembles the idea of “self-protection”, but additionally we also introduce the idea of a “prevention environment” which stands for the interaction between primary prevention as a form of self insurance and secondary prevention as a provider induced offer of prevention. Hence, we want to figure out relevant monetary as well as non-monetary effects that are necessary and efficient for an appropriate prevention strategy. We make use of a principal-agent setting in which the patient is acting as an agent in deciding about his preventive effort.

Primary prevention is completely in the patient’s responsibility and the efforts done in this context will be denoted with the parameter \( e \). Secondary prevention describes forms of screening or other medical induced prevention where the health care provider undertakes some actions and hence primary prevention is a kind of a co-production. The level of secondary prevention is denoted with the parameter \( y \). With other words secondary prevention is a kind of offered prevention by the health care provider and primary prevention is completely vested to the patient’s responsibility.

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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).
For discussing effects of appropriate preventive activity we refrain from discussing aspects of contract choice and possibly aspects of adverse selection and assume the patient has already accepted a contract offered by the insurer in the first period. In other words, the patient will assume the health care provider to behave as completely “fair” and only charge the fair premium which is necessary to cover the medical induced coverage. In the second best world the insurance can also charge some co-payments which will be accepted by the patient if his expected utility with insurance is higher than without. Moreover, we do not focus on renegotiation within the simultaneous model.

For the patient’s von Neumann-Morgenstern utility function $V$, 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 $p \in [0,1]$. This probability depends on the effort of engaging in primary (e) and secondary prevention (y). Due to the patient’s decision to choose secondary prevention or not we assume that:

$$p(e, y) < p(e, 0) \equiv q(e) \text{ for } e \geq 0 \quad (2.1)$$

This means that given the level of primary prevention $e$, engaging in secondary prevention always reduces the probability of getting ill. Hence the probability of getting sick can be formulated as $p(e, y)$ with $p_e(e, y) < 0$ and $p_{ee}(e, y) > 0$ as well as $p_y(e, y) < 0$ and $p_{yy}(e, y) > 0$. Moreover, it follows that without secondary prevention $q_e(e) < 0$ and $q_{ee}(e) > 0$ holds.

In the case of illness, the patient suffers a health shock in monetary units $L$. Relating to the idea formulated by Stewart (1994) the health shock is exogenous and will be compensated by a medical treatment (or coverage) ($K \leq L$). Additionally, the patient decides to undertake own primary prevention activities outside of the contract, denoted with e, which could lessen the possibility of getting sick in further periods.

The patient’s prevention activities $e$ is associated with disutility $C(e)^5$. For the disutility parameter the following shall be valid:

$$\frac{\partial C(e)}{\partial e} > 0, \frac{\partial^2 C(e)}{\partial e^2} > 0; > 0$$

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5 Generally, it is possible to think of patient’s disutility as being influenced by the amount of secondary prevention. In this case, disutility increases with a higher level of $y$, i.e. opportunity costs are higher.
The expected utility is additive-separable in income and disutility. Because of the structure of the utility function we can assume that there will be no difference in utility status when considering the elements of the argument. Hence, we can write:

- \( U(W - \pi) \equiv U_H \)
- \( U(W - \pi - L + K) \equiv U_S \)

and therefore

\[
V_0 = v \cdot [(1 - p(e, y)) \cdot U_H + p(e, y) \cdot U_S] \\
+ (1-v) \cdot [(1 - q(e)) \cdot U_H + q(e) \cdot U_S] - C(e) \tag{2.2}
\]

Patient’s decision about accepting the offer for secondary prevention is expressed through the parameter \( v \in (0, 1) \). That parameter could be seen as a proxy for the affinity of the patient to anticipate health effects when doing prevention. The parameter \( v \) could also express the type of patient where high values correspond to those patients who are willing to make use of secondary prevention supplied by the managed care organization. A change in \( v \) describes a higher level of patients with higher affinity for accepting prevention at all that are enrolled in a definite health care plan. For the first attempt the parameter \( v \) is set exogenous.

The insurance company charges a premium \( \pi \) which has to cover the expected costs of getting sick considering the scope of medical treatment \( K (K \leq L) \). Hence, if \( (K < L) \) is valid the patient has to bear an indirect deductible. In the case of a secondary prevention, the patient has to decide whether he would accept the offer of a secondary prevention which is given by the insurer. In the consequence, the insurant can only choose about demanding secondary prevention but is not entitled to vary the amount of secondary prevention.. In the consequence, no moral hazard in doing secondary prevention can be expected. With respect of his non-observable primary prevention efforts the patient will maximize his personal opportunity

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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-Statler and Pérez-Castrillo 2001, 19). Compared to the idea of the hyperbolic utility relationship by Newhouse (2006), we firstly refrain from discussing three period or more and do not really discuss hyperbolic preferences.
costs for a given health care program. Hence, the insurer must consider a probability of the acceptance (parameter $v$):\(^7\)

$$\pi = v \cdot (p(e,y) \cdot K + y) + (1 - v) \cdot q(e) \cdot K$$ (2.3)

### 2.2 Full commitment

In the first best case the prevention activities of the patient could be controlled completely by the insurer and he has the possibility to incite appropriate contract parameters for a sustainable strategy after the insurance contract is set. In our model, the insurance company maximizes patient’s expected utility subject to the own zero profit condition:

$$\max_{e, K, y} V = v \cdot [(1 - p(e,y)) \cdot U_H + p(e,y) \cdot U_S]$$

$$+(1-v) \cdot [(1 - q(e)) \cdot U_H + q(e) \cdot U_S] - C(e)$$ (2.4)

s.t. $\pi = v \cdot (p(e,y) \cdot K + y) + (1 - v) \cdot q(e) \cdot K$

The first best solution for the (primary) prevention $e^*$ after rearranging is:

$$\frac{\partial V}{\partial e} = (U_S - U_H) \cdot [v \cdot \frac{\partial p(e,y)}{\partial e} + (1 - v) \cdot \frac{\partial q(e)}{\partial e}] + U'_S \cdot \left(\frac{\partial \pi}{\partial e}\right) \cdot [v \cdot \frac{\partial p(e,y)}{\partial e} + (1 - v) \cdot \frac{\partial q(e)}{\partial e}]$$ (2.5)

In an optimal world when patient’s and insurer’s interest coincide, the patient anticipates his influence on the zero profit-condition when doing primary prevention. In optimum, that level of primary prevention $e^*$ is chosen that equals marginal benefits and marginal costs.

The optimal level of secondary prevention $y^*$ given the influence on the zero-profit condition

$$\frac{\partial \pi}{\partial y} = v \cdot \frac{\partial p(e,y)}{\partial y} \cdot (K + 1)$$ is:

\(^7\) Patient’s decision about secondary prevention depends on his beliefs about the productivity gain, indicated by the term $p(e,y) - q(e)$ as well as on his attitude towards medical prevention. It is possible to assume that this attitude changes over time and is also related to patient’s attitude towards primary prevention.
\[
\frac{\partial V}{\partial y} \Rightarrow (U_S - U_H) \cdot v \cdot \frac{\partial p(e,y)}{\partial y} + U'_S \cdot \left( -\frac{\partial \pi}{\partial y} \right) \cdot [v \cdot p(e,y) + (1 - v)q(e)] + U_H' \cdot [0 - \frac{\partial \pi}{\partial y} \cdot \left( (1 - p(e,y)) + (1 - v)(1 - q(e)) \right)] = 0
\] (2.6)

On the left-hand side we can outline an influence of secondary prevention on the probability of being sick \( (p_s) \) as well as on the premium and therefore on the insurance level \( (\pi_s) \). Hence, we can distinguish an immediate effect on patient’s expected utility (influence on the probability of being sick) and from the indirect premium effect.

In the traditional literature on prevention there results a substitution between the coverage level and prevention activities. Differentiating over \( K \) we get:

\[
\frac{\partial V}{\partial K} \Rightarrow v \cdot \left[ U'_S \cdot p(e,y) \cdot \left( -\frac{\partial \pi}{\partial K} + 1 \right) \cdot (1 - p(e,y)) \right] \cdot U_H' \cdot \left( -\frac{\partial \pi}{\partial K} \right) + (1 - v) \cdot \left[ U'_S \cdot q(e) \cdot \left( -\frac{\partial \pi}{\partial K} + 1 \right) \cdot (1 - q(e)) \right] \cdot U_H' \cdot \left( -\frac{\partial \pi}{\partial K} \right) = 0
\] (2.7)

After rearranging this formula we can conclude:

\[
\frac{\partial V}{\partial K} \Rightarrow \frac{u'_S}{u'_H} = \frac{\left( \frac{\partial \pi}{\partial K} \right) \cdot (v \cdot (1 - p(e,y)) + (1 - v) \cdot (1 - q(e)))}{\left( -\frac{\partial \pi}{\partial K} + 1 \right) \cdot (v \cdot p(e,y) + (1 - v) \cdot q(e))}
\] (2.8)

Hence, in the first best case the insurer will offer a coverage that incorporates the “productivity” of doing both forms of prevention as well as patient’s affinity to engage in secondary prevention. Inserting the insurance condition into equation 2.8, we can immediately reason that there will be no co-payment necessary in the first-best case because the fraction depicted in the equation above runs again one.
3 The asymmetric case

Contrary to the first-best solution we now look at the asymmetric case, which means that the insurer is not able to control patient’s primary prevention decision $e$ opposite to secondary prevention activities which can be completely controlled by the insurer\(^8\). We refrain from problems of adverse selection but we concentrate on problems of hidden action after the contract parameters are set which is a case of ex ante moral hazard Additional to traditional forms of moral hazard, we are interested to find out the relationship between primary and secondary prevention. Hence, an insurer will try to incentivize the patients for appropriate health behavior by means on indirect control, information systems and incentive structures. For this reason our asymmetric case tries to explore the conditions that influence patient’s decision for primary prevention within a given set of information and incentive parameters and to look especially at the role of secondary prevention. Hence, the patient “knows” he gets an offer of doing secondary prevention but he is not able to manage the level of the secondary prevention.

For the sake of modeling we focus on a contract game which means that in stage one the insurer sets its parameters he is able to control and in stage two the patients has the opportunity to accept the offer of doing secondary prevention. Moreover, he also decides about the simultaneous level of primary prevention. Hence, we look at the patient’s expected utility at stage two given the contract parameter has been set.

3.1 Stage two (the patient’s decision)

For the patient, the problem is to seek that level of primary prevention that maximizes his expected utility considering the opportunity to consume secondary prevention.

$$\max_e EU = v \cdot [(1 - p(e, y)) \cdot U_H + p(e, y) \cdot U_S] + (1-v) \cdot [(1 - q(e)) \cdot U_H + q(e) \cdot U_S] - C(e)$$

(3.1)

The first order condition to this problem is:

$$\frac{\partial EU}{\partial e} = (U_S - U_H) \cdot [v \cdot \frac{\partial p(e, y)}{\partial e} + (1 - v) \cdot \frac{\partial q(e)}{\partial e}] - \frac{\partial C(e)}{\partial e}$$

(3.2)

\(^8\) The ability for complete control means a perfect “commitment” between the insurer and the patient.
Comparing this equation with the first-best \( (e^*) \), the patient does not incorporate the indirect insurance effects on his decision for doing primary prevention \( \tilde{e} \) which means his level of prevention will be lower compared to the first-best case.

Proposition 1: The patient does not anticipate the impact of primary prevention on his own insurance parameters resulting in a lower level of primary prevention.

3.1.1 The coverage level

Referring to first-order condition we are further interested in discussing the influence of the contract parameters on the patient’s decision for doing primary prevention.

By totally differentiating equation (3.2) with respect to the coverage level \( K \) and considering that

\[
\frac{\partial \pi}{\partial K} = v \cdot p(e, y) + (1 - v) \cdot q(e) > 0
\]  

(3.3)

holds, we can set:

\[
\frac{d \tilde{e}}{dK} = -\left[ (U'_S - U'_H) \cdot \left( -\frac{\partial \pi}{\partial K} \right) + U'_S \right] \cdot \left[ v \cdot \frac{\partial p(e,y)}{\partial e} + (1 - v) \cdot \frac{\partial q(e)}{\partial e} \right] \cdot \Omega
\]

(3.4)

As the denominator is negative the overall effect depends on the sign of the numerator.\(^9\) The second term is the expected productivity gain of one extra unit primary prevention is negative, i.e. the expected probability of getting sick declines. The first term in square brackets shows the marginal utilities of a broader coverage. First, a broader coverage goes along with higher premiums and therefore with a decreasing utility. This indirect effect resembles the marginal costs depicted in units of marginal utility. This effect is outweighed by the direct marginal utility of the extended coverage that results in a reduction of the monetary health shock. It follows that the numerator is negative and that the influence of \( K \) on \( \tilde{e} \) is negative.

\(^9\) For guaranteeing a maximum level of \( e \) the second-order condition has to be negative: <0. Considering the impact of the SOC for the implicit differentiation we can denote SOC with \( \Omega \):

\[
\Omega \equiv \frac{\partial^2 U_0}{\partial \tilde{e}^2} \Rightarrow \varphi \cdot \frac{\partial^2 p(e,y)}{\partial \tilde{e}^2} \cdot (U_S - U_H) + (1 - \varphi) \cdot \frac{\partial^2 q(e)}{\partial \tilde{e}^2} \cdot (U_S - U_H) - \frac{\partial^2 C(e)}{\partial \tilde{e}^2} < 0
\]
3.1.2 Impact of secondary prevention

If the patient has already accepted some forms of secondary prevention in a broader sense, e.g. some organized forms of medical screenings etc., a change in the level of medical prevention could enforce or lessen the impact for doing additional primary prevention. Considering the effect of secondary prevention on the insurance premium, the sign of the latter effect is unclear and depends on the marginal productivity of secondary prevention.

\[
\frac{\partial \pi}{\partial y} = v \left( \frac{\partial p(e,y)}{\partial y} * K + 1 \right)
\]  

(3.5)

Therefore, for the resulting impact of higher level of secondary prevention on the level of primary prevention we have to distinguish several cases.

\[
\frac{d \tilde{e}}{dy} = - \frac{v \cdot \left[ \frac{\partial^2 p(e,y)}{\partial e \partial y} \cdot \left( U_s - U_H \right) + \frac{\partial p(e,y)}{\partial e} \cdot \left( - \frac{\partial \pi}{\partial y} \right) \cdot \left( U'_s - U'_H \right) \right]}{\Omega}
\]

\[
+ \left( 1 - v \right) \cdot \left[ \frac{\partial q(e)}{\partial e} \cdot \left( - \frac{\partial \pi}{\partial y} \right) \cdot \left( U'_s - U'_H \right) \right]
\]

(3.6)

The relevant question is whether secondary prevention reduces health care costs of the insurance company or whether it results in rising health expenditures. We further refer to this as the premium effect of secondary prevention. In the first case, the decreasing probability of getting sick and therefore the declining expected treatment costs outweigh the costs of secondary prevention borne by the insurance company \((- \frac{\partial \pi}{\partial y} > 0)\).

For the further analysis, we assume a possible positive influence of \( y \) on \( \tilde{e} \) and try to explore under which conditions this assumption holds. As we can infer from the fraction above the sign of numerator is indeterminate. After some simplification we can write:

\[
\frac{d \tilde{e}}{dy} = - \left[ \left( - \frac{\partial \pi}{\partial y} \right) \cdot \left( U'_s - U'_H \right) \right] \cdot \frac{v \cdot \frac{\partial p(e,y)}{\partial e} + \left( 1 - v \right) \cdot \frac{\partial q(e)}{\partial e}}{\Omega}
\]

\[
+ \frac{v \cdot \frac{\partial^2 p(e,y)}{\partial e \partial y} \cdot \left( U_s - U_H \right)}{\Omega}
\]

(3.7)
Considering the numerator we can set:

\[
\left[ (-\frac{\partial m}{\partial y}) \cdot (U_s - U_h) \right] \cdot \left[ \frac{\partial p(e,y)}{\partial e} \cdot (1 - \nu) \cdot \frac{\partial q(e)}{\partial e} \right] \cdot (U_s - U_h) > 0
\]

(3.8)

The first term in square brackets is the indirect effect of a higher level of secondary prevention on patient’s utility. As the second term is always negative, the total effect is driven by the sign of the premium effect and is negative. The sign of the second addend depends on the cross-derivative of the probability of getting sick \(\frac{\partial^2 p(e,y)}{\partial e \partial y}\). This derivation shows how the marginal productivity of the primary prevention changes due to an increase in the level of secondary prevention (productivity effect). In the literature, the expressions strategic complements, strategic substitutes, and strategic independence are used to describe this behavior (cf. Bulow et al. (1985), 494). In difference to the common concept of complements and substitutes, which describes a direct relation between variables, the strategic concept illustrates the effect of one variable on the marginal product of the other one. This means that e. g. additional secondary prevention activities raise the marginal effect of primary prevention. Thus, the probability of sickness decreases (strategic complements \(\frac{\partial^2 p(e,y)}{\partial e \partial y} < 0\)). In the reverse case, a higher level of secondary prevention lowers the marginal effect of primary prevention (strategic substitutes \(\frac{\partial^2 p(e,y)}{\partial e \partial y} > 0\)). An example for the former effect is obeying an advice from the result of secondary prevention whereas strategic substitutes are present if the marginal effect of training is reduced because of a long-term electrocardiogram.

If primary and secondary prevention are strategic independent, the sign of the numerator depends on the premium effect only. This means that in this case \(\frac{de^*}{dy} < 0\). If primary and secondary prevention react as strategic complements \(\frac{\partial^2 p(e,y)}{\partial e \partial y} < 0\) the second addend is positive. Hence, the numerator will be positive if the premium effect is offset by the productivity effect \(\frac{de^*}{dy} > 0\). Otherwise, the impact of secondary on primary prevention is negative. Assuming the prevention forms react as strategic substitutes \(\frac{\partial^2 p(e,y)}{\partial e \partial y} > 0\) the productivity as
well as the premium effect is negative and results in a negative influence of secondary on primary prevention \( \frac{de^*}{dy} < 0 \).

**Proposition 2:** If secondary prevention saves money (at least in the long-run), a higher level of secondary prevention supplied by the insurance company usually leads to a reduction of primary prevention. Only in the case of strategic complements it might be possible that secondary prevention incites primary prevention.

In case two, we assume a positive premium effect of secondary prevention \( \frac{\partial \pi}{\partial y} > 0 \):

\[
\left[ \frac{\partial \pi}{\partial y} \right] \cdot \left[ \frac{\partial p(e,y)}{\partial e} + (1 - v) \cdot \frac{\partial q(e)}{\partial e} \right] + v \frac{\partial^2 p(e,y)}{\partial e \partial y} \cdot (U_S - U_H) > 0
\]

(3.9)

The indirect effect of secondary prevention on patient’s utility has a positive sign. If we consider the case of strategic independence, the overall sign of the numerator is positive. The effect of secondary prevention on primary prevention is then positive. Assuming that primary and secondary prevention react as strategic complements \( \left( \frac{\partial p^2(e,y)}{\partial e \partial y} < 0 \right) \) this results in a positive effect of secondary on primary prevention \( \frac{de^*}{dy} > 0 \). If instead primary and secondary prevention react as strategic substitutes \( \left( \frac{\partial p^2(e,y)}{\partial e \partial y} > 0 \right) \) the numerator is still positive as long as the premium effect dominates the productivity effect. Otherwise, with a large productivity effect, the incentive for doing own prevention activity in the case of strategic substitutes declines.

**Proposition 3:** If secondary prevention leads to rising health care expenditures in the long-run, a higher level of secondary prevention supplied by the insurance company leads to a rise in patient’s primary prevention activities. Only in the case of strategic substitutes it is possible that secondary prevention discourages primary prevention.

The effect of secondary on primary prevention is mainly driven by the financial consequences of the extended supply of secondary prevention. If the insurance premium increases, this encourages the patient to expand own prevention activities to save money. Hence, we observe that he uses his own prevention activities to compensate for the premium increase. If instead
we observe a premium decreasing effect of secondary prevention, the patient’s reaction can be compared to the well-known case of risk-enhancing moral hazard.

3.1.3 Affinity for secondary prevention

Up to now, we have discussed the impact of insurer’s parameter $K$ and $y$ on patient’s primary prevention activities. Moreover, it is interesting to analyze the impact of the affinity to choose secondary prevention on the level of doing primary prevention. This affinity parameter has been denoted by the parameter $v$. Hence, in comparison to a change in the level of medical prevention which is denoted by the parameter $y$ the parameter $v$ highlights the affinity for patients accepting medical prevention when there will be chance to get it. We assume that for all patients involved in a statutory health insurance this parameter could be a signal for the prevention attitude patients generally have. Moreover, if $v$ rises there could a plausible idea that more that the “type” of the patient has been changed. Although the parameter $v$ is exogenous in our simultaneous model there may be some plausible reason for a change in $v$. From a model point of view “$v$” is chosen by nature but the “nature” is not independent form impacts of education level, health care environment, working conditions that may also influence the “type” of a person. Referring to the insurance condition it should be true:

$$\frac{\partial \pi}{\partial v} = (p(e, y) * K + y) - q(e) * K$$

The sign of the derivative is ambiguous and depends on the strength of influence of secondary prevention on the probability of getting sick $p(e, y)$. The treatment costs are reduced by $(p - q)K$ whereas the costs of doing secondary prevention are $y$. As long as the cost savings compensate for the prevention costs, equation (3.10) is negative. This means that a higher affinity for secondary prevention is a necessary condition for saving money in the long run. On the opposite, if the productivity of secondary prevention is very small, the case that a higher value of $v$ goes along with a premium increase cannot be ruled out.

Considering this we can write for the effect of a higher affinity on the level of primary prevention:

$$\frac{d\bar{e}}{dv} = -\left[\left(U_S - U_H\right) \cdot \left(\frac{\partial p(e, y)}{\partial e} - \frac{\partial q(e)}{\partial e}\right)\right]$$

(3.11)
\[
\frac{\left(U_S - U_H\right) \cdot \left(-\frac{\partial \pi}{\partial v}\right) \cdot \left[\nu \frac{\partial p(e,y)}{\partial e} + (1 - v) \cdot \frac{\partial q(e)}{\partial e}\right]}{\Omega}
\]

As the first addend of the numerator will be negative as the difference in the marginal probabilities is positive for the given convex probability function. Therefore, if we look at the case where a higher affinity for secondary prevention leads to an increase in the level of primary prevention \(\frac{\partial \bar{\sigma}}{\partial v} > 0\), the following condition must hold:

\[
(U_S - U_H) \cdot \left[\frac{\partial p(e,y)}{\partial e} - \frac{\partial q(e)}{\partial e}\right] + (U_S - U_H) \cdot \left(-\frac{\partial \pi}{\partial v}\right) \cdot \left[\nu \frac{\partial p(e,y)}{\partial e} + (1 - v) \cdot \frac{\partial q(e)}{\partial e}\right] > 0
\]

(3.12)

As the first addend of the inequality is negative, the sign of the numerator depends on the effect of \(v\) on \(\pi\). The second addend can be positive if and only if this effect is positive \(\left(\frac{\partial \pi}{\partial v > 0}\right)\) meaning that a higher affinity leads to higher premiums. In this case, secondary prevention is ineffective if looking at the cost side. If a higher affinity leads to a reduction in insurance premiums so that doing secondary prevention is cost effective, this leads to a negative impact on primary prevention because the numerator of equation (3.11) is negative.

**Proposition 4:** If secondary prevention is productive an increase in the affinity \(v\) reduces the incentive for doing primary prevention. Again, the patient reacts to changes in the insurance costs by altering his own prevention activities.

### 3.2 Stage one (the insurer’s contract)

Following the idea of a backward induction the insurer will anticipate the patient’s behavior given the contract parameters \(y\) and \(K\) are set and therefore the maximization of the insurer can be written\(^\text{10}\):

\[
\max_{K,y} V = v \cdot [(1 - p(e,y)) \cdot U_H + p(e,y) \cdot U_S] + (1-v) \cdot [(1 - q(e)) \cdot U_H + q(e) \cdot U_S] - C(e)
\]

s.t. \(\pi = v \cdot (p(e,y) \cdot K + y) + (1 - v) \cdot q(e) \cdot K\)

s.t. \(\arg\max_e EU = v \cdot [(1 - p(e,y)) \cdot U_H + p(e,y) \cdot U_S] + (1-v) \cdot [(1 - q(e)) \cdot U_H + q(e) \cdot U_S] - C(e)\)

---

\(^{10}\) We refer to the idea of the „First-Order-Approach“ where the maximization problem of the effort will be solved by the first-order condition (cf. Holmström 1979 and Rogerson 1985).
When maximizing equation (3.13) over the coverage level \( K \) and considering that \( (\frac{d\pi}{dK} = \nu \cdot \frac{dP(e,y)}{dK} \cdot K + \nu \cdot P(e,y) + (1-\nu) \cdot \frac{dq(e)}{dK} \cdot K + (1-\nu) \cdot q(e) > 0) \) we get: \(^{11}\)

\[
\frac{\partial EU}{\partial K} \Rightarrow \frac{U'_H}{U'_S} = \frac{\left(\frac{d\pi}{dK}\right) \cdot [\nu \cdot (1 - p(e,y)) + (1 - \nu) \cdot (1 - q(e))]}{\left(-\frac{d\pi}{dK} + 1\right) \cdot [\nu \cdot p(e,y) + (1 - \nu) \cdot q(e)]} \tag{3.14}
\]

First, compared with the first-best case (2.8) an altered premium effect is incorporated: The expression \( \frac{d\pi}{dK} = \nu p(e,y) + (1-\nu)q(e) \) used in the first-best does not consider the effect of increasing coverage on the level of primary prevention \( (dK/dK) \). Second, the denominator on the right equation (3.14) shows the effect of doing primary and secondary prevention on the probability of being sick weighted by the net benefit of an extended coverage \( \left(-\frac{d\pi}{dK} + 1\right) \). This term is always positive since the marginal utility of an extra unit of coverage has to exceed the marginal costs for the patient in order to accept the contract. The numerator stands for the willingness to accept higher premiums when the probability of getting ill declines. In contrast to the first-best case, the left hand side of the equation is greater than one as the insurance company seeks to limit ex ante moral hazard effects by reducing \( K \) and therefore increasing co-payments. In the case of asymmetric information, i.e. if prevention efforts are low the denominator increases and the numerator decreases c. p. Then it follows that the insurer has to reduce his coverage (i.e. higher co-payments) to implement additional incentives for doing primary prevention that work against the effect of the information asymmetry.

**Proposition 5:** In a world of asymmetric information the insurer reduces the coverage level to give the patient incentives to engage in prevention activities and therefore to reduce the ex ante moral hazard. This means that co-payments are charged in order to balance the incentive structure.

\(^{11}\) In this case, the derivation of the premium with respect to the coverage level considers the effects of \( K \) on the level of primary prevention.
The insurer also optimizes his supply of secondary prevention. As already shown, the insurer transfers the decision for acceptance or non-acceptance of medical prevention to the patient. After the acceptance the insurer determines the level and the amount of secondary prevention.

When maximizing (3.13) and inserting
\[
\frac{\partial \pi}{\partial y} = v \cdot \left( \frac{\partial p(e,y)}{\partial e} \cdot \frac{de}{dy} + \frac{\partial p(e,y)}{\partial y} \right) \cdot K + v^+ (1-v)^- \cdot \frac{\partial q(e)}{\partial e} \cdot \frac{de}{dy} \cdot K
\]
we get:

\[
\frac{\partial EU}{\partial y} \Rightarrow \frac{U_S}{U_H} = \left( \frac{\partial \pi}{\partial y} \right) \cdot [v \cdot (1 - p(e,y) + (1 - v) \cdot (1 - q(e))] + v \cdot (U_H - U_S) \cdot \frac{\partial p(e,y)}{\partial y}
\]

(3.15)

Comparing the formula (3.15) with (2.6) there is no difference in the terms prima facie. But from the insurer’s point of view we must consider an uncertainty regarding the patient’s affinity for doing secondary prevention. In the first-best case \(\frac{\partial \pi}{\partial y} = v \cdot \frac{\partial p(e,y)}{\partial e} \cdot K + 1\) is valid whereas in the asymmetric case the insurer has to incorporate the impact of the level of secondary prevention upon the unknown level of primary prevention \(\varepsilon\). First, the direct effect of \(y\) on \(p\) can be positive or negative (cf. page 12). Second, together with the strategic dependency of primary and secondary prevention, the overall effect of \(y\) on the premium level is indefinite. Therefore, the choice of \(y\) to balance the incentive structure is difficult for the insurer. Moreover, in our setting this result depends on the exogenous affinity for secondary prevention.

Proposition 6: The low influence of the insurer on the patient’s choice of secondary prevention and the corresponding problem of compliance leads to a change in insurer behavior: He has to anticipate the influence \(\frac{de}{dy}\) for the contract parameters. In detail, they depend on the effectiveness of prevention as well as the disutility the patient has to bear. Both may be influenced by the affinity for doing secondary prevention indirectly.
4 Conclusion and Outlook for expanding research

As we have seen in the asymmetric case the relationship between primary and secondary prevention directly depends on three relevant factors. First, the impact of a prevention strategy is contingent on the perception of the effectiveness of prevention. The more quality indicators help to strengthen the results of medical screening strategies and reduce the share of false-positive results the more the acceptance of screening strategies can be expected which is related to the acceptance of secondary prevention as well. Second, the level of potential cost savings by prevention methods directly influences the acceptance of additional prevention strategies. The more the medical prevention can reduce the insurance premium the more the patient will value additional opportunity costs for doing additional primary prevention. The more the health care shock influences the patient’s welfare the more the opportunity costs for doing primary and secondary preventions decrease. Finally, the affinity for doing medical prevention is one of the relevant criteria for accepting and fostering a sustainable strategy which can only be influenced partially by the means of an insurance system

In the paper we established a basic approach for discussing the combination of medical and non-medical prevention in a simultaneous way. In this model we neglect the intertemporal aspects of prevention activities, i.e. the relation between the costs of prevention and the potential future effectiveness. In health care, primary and secondary prevention often temporarily diverge. As primary prevention in form of lifestyle habits already occurs in younger years of life whereas patients choose to seek secondary prevention when getting older. This raises two questions for future research: First, it is necessary to analyze under which conditions prevention activities in period one encourage prevention in latter periods. Second, how can an insurer induce an optimal time path of prevention by his contract setting? This leads to problems of time consistency and renegotiation proofness (cf. Chiappori et al. 1994).
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