

Medical Malpractice: The Optimal Negligence Standard under Supply-side Cost Sharing

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Abstract

This paper elaborates on the optimal negligence standard in a world where physicians choose damage prevention subject to erroneous court judgements and to the degree of supply-side cost sharing. Liability uncertainty in malpractice lawsuits leads some physicians to provide excessive prevention and others to underprovide, which results in a welfare loss compared to the pooled first-best equilibrium under perfect information. The standard that minimizes the welfare loss depends on the cost share: Under traditional, close to full cost reimbursement it is lower than the first-best standard, while under substantial supply-side cost sharing it increases and may exceed the first best.

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1 Introduction

Medical treatment, although utility enhancing in the first place, exposes patients to the risk of an injury. The magnitude of risk depends partially on the physicians' prevention activities, determined by their choice of diagnostics and therapies. As prevention increases treatment costs, physicians will not necessarily reduce the risk to an appropriate level.

However, adequate incentives for damage avoidance may be triggered by a liability rule. In this paper, I examine the impact of the negligence rule - the predominant liability principle for medical malpractice in the western world. Under this rule courts award a compensation to injured patients only if physicians fail to comply with a particular negligence standard. This provides physicians with an incentive to apply an appropriate level of damage prevention.

I will focus my analysis on liability uncertainty arising from erroneous judgments of courts. Brennan et al. (1996) report from medical malpractice lawsuits that courts sometimes erroneously hold physicians liable who adhere to the relevant negligence standard, and fail to detect careless behavior. This, in turn, affects the incentives of the liability rule and physicians, fearing the threat of liability, may provide excessive damage prevention. Likewise, reckless physicians may underprovide in the hope to escape liability.

In fact, evidence for both behavior patterns can be found. Kessler and McClellan (2002b) show for the treatment of cardiovascular diseases and Dubay et al. (1999) for obstetrics that excessive prevention exists. An estimated number of 75.000 fatal injuries per year can be attributed to medical negligence in the USA (see Danzon, 2000).

Using a formal model of physicians' behavior this paper offers a joint explanation for both phenomena. It demonstrates how erroneous court judgments induce deviations of damage prevention from a given negligence standard, and thereby goes beyond approaches found in the literature. For instance, a few papers have discussed that excessive prevention is attributed to an excessive

level of compensation and other malpractice costs (see Kessler and McClellan, 2002a or Baicker and Chandra, 2004). Quinn (1998) links uninsurable reputation losses to excessive prevention in a formal analysis.

The derived separated equilibrium in damage prevention implies a loss of the negligence rule's effectiveness and with it a decrease of welfare. This is because the society's expected total costs of health care increase beyond the first-best level achieved under perfect information. In line with that, experts argue that excessive prevention significantly contributes to the ever rising costs of health care (Kessler and McClellan, 1997). The same allegation applies to insufficient prevention because it increases the probability of a damage occurrence (Kohn et al., 2000).

Under changing reimbursement conditions for health care the effectiveness of liability incentives plays a particular role. Recently most western countries changed their traditional, close to full cost reimbursement schemes to include a substantial supply-side cost sharing in order to stop the steady increase of treatment costs. By assigning physicians a considerable share of treatment cost, more efforts are exerted at cost containment (compare e.g. Ellis and McGuire, 1993).

As supply-side cost sharing increases expected marginal treatment costs, physicians also reduce prevention activities and thereby increase the probability of a damage occurrence. For this reason a discussion has arisen on whether the liability incentives need to be changed (see e.g. for the USA Kessler and McClellan, 2002b). German legal experts, focusing on the appropriate level of negligence standards, generally disapprove changes. In particular they refuse lower standards that incorporate a trade-off between costs and benefits (see e.g. Steffen, 2000). Consequently most of the standards developed under the generous reimbursement scheme in the past are also considered to be optimal under the new reimbursement conditions.

In contrast I show that given a particular reimbursement scheme, imperfectly informed courts should trade-off costs and benefits of damage prevention and apply an optimal negligence standard that minimizes the society's

expected total costs with respect to damage prevention. Under such optimal liability conditions, excessive and insufficient prevention cause different welfare effects at the margin and, therefore, deviate from first-best prevention, as defined under perfect information, in different directions. This first-best level, then, allows me to adequately define defensive and negligent medicine.

Given traditional, close to full cost reimbursement I prove that defensive medicine dominates the society's expected total costs with respect to damage prevention, rendering a standard lower than the first-best standard optimal. The introduction of a substantial cost share changes the level of damage prevention and with it the valuation of defensive medicine compared to negligent medicine at the margin. This tends to increase the optimal standard.

The rest of the paper is organized as follows: **Section 2** presents the model and derives the physicians' optimum in damage prevention and efforts under uncertain liability. **Section 3** determines the optimal negligence standard under traditional reimbursement. The optimal adjustment of the standard following the introduction of a substantial supply-side cost sharing is derived in **Section 4**. Afterwards a comparison between the optimal standard under uncertain liability and the first-best standard is drawn. Conclusions and a discussion of the results can be found in **Section 5**.

2 The physicians' behavior under uncertain liability

Providers of medical treatment are assumed to be risk-neutral. They decide on the level of damage prevention y and efforts at cost containment e , of which the former is imperfectly observed by courts and the latter is unobservable.

Treatment costs $K(y, e)$ are uncertain so that the observed level of costs does not reveal the exerted level of damage prevention and efforts. In order to avoid ambiguous results I assume that the expected treatment costs $E[K(y, e)] \equiv C(y, e)$ are additively separable in damage prevention and ef-

forts, i.e. $C(y, e) = C(y) + C(e)$. Thus, the cross-derivative is zero ($C_{ye} = 0$) and no interference between first-order conditions for optimal prevention and efforts occurs. Expected costs are strictly convex in both arguments ($C_y > 0, C_e < 0, C_{yy}, C_{ee} > 0$). The physicians' efforts at cost containment cause a disutility that is measured in monetary terms $H(e)$ and which is increasing at an increasing rate ($H_e > 0, H_{ee} > 0$).

Reimbursement depends on the treatment costs. Expected reimbursement takes the form of $f + (1 - \tau)C(y, e)$ where f denotes a fixed payment and τ is the supply-side cost share. Then, $\tau = 1$ represents a pure prospective payment, $\tau = 0$ full cost reimbursement, and $0 < \tau < 1$ cost sharing.

A possible damage $L > 0$ to the patients during the treatment is measured in monetary terms. It occurs with probability $P(y)$ that decreases with the level of prevention at an increasing rate ($P_y < 0, P_{yy} > 0$). In line with the prevailing liability principle for medical malpractice, physicians take into account the potential payment of compensation. If courts were perfectly informed, the physicians' expected payment with prevention level y would depend on the given negligence standard $s > 0$:

$$EL(s, y) = \left\{ \begin{array}{ll} 0 & \text{if } y \geq s \\ P(y)L & y < s \end{array} \right\}. \quad (1)$$

It implies that in case of an injury physicians only have to compensate the patients if they exert insufficient prevention as measured by the standard ($y < s$).¹ In contrast, adhering to the standard ($y \geq s$) always leads to an acquittal.

The expected payment of compensation changes when the physicians' level of damage prevention is imperfectly observed by courts. Under this condition courts base their judgments on a vague signal of damage prevention. This signal will deviate from the exerted prevention y with error term ε , which is drawn uniformly from the interval $[-x, x]$.² The probability density function is $g(\varepsilon)$. Thus, at a level of damage prevention not lower than the relevant negligence standard $y \geq s$ the probability of erroneous liability takes the value

of $\int_{-x}^{s-y} g(\varepsilon)d\varepsilon = G(s-y)$. In case of $y < s$ the probability of an erroneous acquittal amounts to $1 - G(s-y)$. The null hypothesis assumes physicians to comply with the negligence standard, so that $G(s-y) = p^I(s,y)$ denominates the probability of an erroneous court judgment of type 1 and $1 - G(s-y) = p^{II}(s,y)$ the probability of an erroneous court judgment of type 2, respectively.

Unlike Polinsky and Shavell (1989), who assume error probabilities as given, the negligence standard and prevention activities in this model determine the error probability. The probability of a type 1 error increases with the negligence standard, decreases with the level of damage prevention, and vice versa for the probability of a type 2 error, i.e. $p_s^I, p_y^{II} > 0$ and $p_y^I, p_s^{II} < 0$.

The expected payment of compensation, therefore, amounts to:

$$\widetilde{EL}(s,y) = \left\{ \begin{array}{ll} p^I(s,y)P(y)L & \text{if } y \geq s \\ [1 - p^{II}(s,y)] P(y)L & \text{if } y < s \end{array} \right\}. \quad (2)$$

The physicians' expected profits consist of the expected reimbursement minus the expected costs of treatment and the expected payment of compensation:

$$E\pi(y,e) = f + (1 - \tau)C(y,e) - C(y,e) - H(e) - \widetilde{EL}(s,y). \quad (3)$$

Because the negligence rule forms a discontinuity in expected profits at the negligence standard, two necessary conditions for optimal prevention activities arise:

$$-\tau C_y - p^I(s,y_i^*) P_y(y_i^*)L - p_y^I P(y_i^*)L = 0 \text{ if } y \geq s, \quad (4)$$

$$-\tau C_y - [1 - p^{II}(s,y_i^*)] P_y(y_i^*)L + p_y^{II} P(y_i^*)L = 0 \text{ if } y < s. \quad (5)$$

Both conditions may be fulfilled at the same time so that a separated equilibrium arises. In this case physicians increase damage prevention un-

til expected marginal treatment costs τC_y equal expected marginal benefits. Expected marginal benefits consist of a reduced expected compensation and depend on the relative value of exerted prevention compared to the standard.

Proposition 1 *If physicians bear a positive cost share $\tau > 0$ and can not increase their expected profit by changing the level of damage prevention, a separated equilibrium with insufficient and excessive prevention $y_I^* < s < y_E^*$ arises.*

Figure 1 gives an illustration of this proposition. The physicians' expected treatment costs with respect to damage prevention $\tau C(y)$ are depicted by the continuous, strictly increasing function. The expected payment of compensation $\widetilde{EL}(s, y)$ is represented by the strictly decreasing function, having a kink at $y = s$, which is due to the transition from type 1 to type 2 errors at the standard. The probability of erroneously holding a diligent physician liable at the standard approximates the probability of holding a careless physician liable close to the standard: $p^I(s, s)P(s) \approx [1 - p^{II}(s, y)]P(y)$.

An optimum above the standard characterizes a diligent physician who is providing excessive prevention ($i = E$). It is depicted in figure 1 at the minimum of the thick line. According to condition (4) the probability of an erroneous court judgment of type 1 determines the physician's expected benefits of extended prevention. Full cost reimbursement $\tau = 0$ is a sufficient condition for excessive prevention to be present.

An optimum below the standard, as shown in figure 1 at the minimum of the thin line, belongs to a careless physician who is providing insufficient prevention ($i = I$). Condition (5) indicates that the probability of an erroneous court judgment of type 2 reduces the incentive for providing additional damage prevention. A positive supply-side cost share $\tau > 0$, leading to increasing expected marginal treatment costs, turns out to be a necessary condition for insufficient prevention to be optimal.³

A sufficient condition for a separated equilibrium is that both types of physicians have no incentive to change the level of damage prevention. Under

a uniform fixed payment f and a positive cost share τ this is fulfilled if larger expected treatment costs of excessive prevention exactly balance the larger expected payment of compensation due to insufficient prevention:

$\tau [C(y_E^*) - C(y_I^*)] = \widetilde{EL}(s, y_I^*) - \widetilde{EL}(s, y_E^*) > 0$.⁴ This case is represented in figure 1.

Figure 1 about here

The physicians' reactions on a marginal variation of the negligence standard s and the cost share τ can be derived, applying a comparative static analysis of the first-order conditions (4) and (5). As demonstrated in the **Appendix** the level of damage prevention increases with the standard ($\frac{dy_i^*}{ds} > 0$). Since a higher standard increases (decreases) the probability of a type 1 (type 2) error, the marginal liability pressure increases, which in turn induces physicians to exert more damage prevention. In contrast, damage prevention decreases with the physicians' cost share $\frac{dy_i^*}{d\tau} < 0$, channelled by an increase of expected marginal treatment costs.

The optimal efforts at cost containment e^* follow from the condition:

$$H_e(e^*) = -\tau C_e(e^*). \quad (6)$$

Efforts, thus, only depend on the reimbursement scheme. At the optimum the marginal disutility of efforts equals the marginal benefit in form of reduced expected treatment costs. Condition (6) implies that under full cost reimbursement ($\tau = 0$) physicians have no incentive to save resources (i.e. $e^* = 0$). As in (6) the marginal benefit of reduced expected treatment costs increases with the physicians' cost share, efforts increase too ($\frac{de^*}{d\tau} > 0$).

3 The optimal standard under traditional reimbursement

With a given benefit of treatment for patients, the society's goal is to minimize the consumption of resources by medical malpractice and by insufficient efforts at cost containment. Given a particular reimbursement scheme τ courts should therefore apply an optimal negligence standard $s^*(\tau)$, which minimizes the expected total costs with respect to damage prevention and efforts at cost containment ETC . Since reimbursement is a transfer from patients to physicians and the physicians' decisions depend on the negligence standard, on the cost share as well as on the attainability of a non-negative expected profit, the expected total costs amount to:

$$ETC [y_i^*(\tau, s), e^*(\tau)] = \sum_{i=E,I} \varpi_i [C(\tau, s) + H(\tau) + P(\tau, s) L], \quad (7)$$

where ϖ_i is the share of type i physicians.

Traditional reimbursement schemes such as fee-for-services or even cost reimbursement imply a positive but very low supply-side cost share $\tau = \underline{\tau} \rightarrow 0$. This comes close to full cost reimbursement and the physicians' decisions at any negligence standard s are as expected: As expected marginal costs of damage prevention and expected marginal benefits of efforts decrease to almost zero, physicians provide excessive prevention $y_E^* > s$ and exert very low efforts at cost containment $e^*(\underline{\tau}) = \underline{e} \rightarrow 0$. On the other hand insufficient prevention plays only a minor role. Since decreasing the liability threat by more damage prevention is very cheap, the deviation from a standard is very low: $s - y_I^* = \Delta$.

The minimization of the society's expected total costs (7) under traditional reimbursement, then, yields the optimal negligence standard $s^*(\underline{\tau})$. It is determined by the first-order condition:⁵

$$\varpi_E [C_y(\underline{\tau}, s^*) + P_y(\underline{\tau}, s^*)L] \frac{dy_E^*}{ds} + \varpi_I [C_y(\underline{\tau}, s^*) + P_y(\underline{\tau}, s^*)L] \frac{dy_I^*}{ds} = 0. \quad (8)$$

This expression shows that the standard's impact on damage prevention and, as a consequence, on the society's expected total costs determine the optimal standard. Moreover, a world with perfect information about the physicians' damage prevention turns out to be a special case: Under this condition all physicians comply with every single standard so that both terms in (8) collapse into one. The expected total costs are minimized by the first-best level of damage prevention y^{FB} , where expected full marginal costs and expected marginal benefits balance $C_y(y^{FB}) = -P_y(y^{FB})L$ (see e.g. Cooter and Ulen, 2000 for the *Hand-Rule*). Courts should therefore set the standard at the first-best level of damage prevention independent of the reimbursement scheme $s^* = y^{FB}$.⁶

In contrast erroneous judgments of courts induce a separated equilibrium in damage prevention, which increases the expected total costs with respect to damage prevention beyond the first-best level. The society attempting to choose an optimal standard, thus, faces a trade-off as described by (8): Increasing the standard will increase the amount of excessive prevention. If damage prevention exceeds the first-best level [$y_E^*(\underline{\tau}, s^*) > y^{FB}$], expected total costs will increase. Consequentially I call prevention in this interval defensive medicine. At the same time insufficient prevention decreases which below the first-best level [$y_I^*(\underline{\tau}, s^*) < y^{FB}$] decreases expected total costs. On this account damage prevention in this interval is denominated negligent medicine. At the optimum the two opposite effects of defensive and negligent medicine balance.

Proposition 2 *Under traditional reimbursement $\tau = \underline{\tau}$ imperfectly informed courts should apply an optimal standard that is lower than the first-best standard $s^*(\underline{\tau}) < y^{FB}$.*

Under traditional reimbursement expected marginal costs of damage pre-

vention are so low that the probability of erroneous liability induces a share of physicians to largely extend damage prevention. So if the first-best standard $s = y^{FB}$ were applied, defensive medicine would cause substantial marginal costs to the society. At the same time the deviation of negligent medicine from the first-best standard would be very small and expected marginal benefits of decreased negligent medicine would take a very low value $C_y [y_I^*(\tau, y^{FB})] + P_y [y_I^*(\tau, y^{FB})] L \rightarrow -0$.

Considering this asymmetry of expected marginal costs and expected marginal benefits, defensive medicine turns out to be the major problem under traditional reimbursement. As a result decreasing the standard below the first-best mainly produces expected benefits on account of reduced defensive medicine. At the optimum a standard lower than the first-best standard $s^*(\tau) < y^{FB}$ ensures that the society's expected total costs with respect to damage prevention are minimized.

4 The optimal standard under cost sharing

4.1 The optimal standard

Western countries have introduced reimbursement schemes with a substantial supply-side cost sharing $\tau > \underline{\tau}$ in order to increase the physicians' efforts at cost containment. As supply-side cost sharing increases expected marginal treatment costs, physicians also reduce damage prevention activities and thereby increase the probability of a damage to the patients.

Under uncertain liability it can be shown that the society's expected total costs with respect to damage prevention and efforts at cost containment decrease with an implementation of a substantial cost share. From (7), the expected total cost function derived with respect to the physicians' cost share τ is:

$$\frac{dETC(\tau, s)}{d\tau} = \sum_{i=E, I} \varpi_i \{C_y(\tau, s) + P_y(\tau, s)L\} \frac{dy_i^*}{d\tau} + (1 - \tau) C_e(\tau) \frac{de^*}{d\tau}. \quad (9)$$

Evaluated at the point of traditional reimbursement with $\tau = \underline{\tau}$ the first term in the sum ($i = E$) takes a negative value and the second term ($i = I$) is positive, which can be interpreted as the society's expected benefits of decreased defensive medicine and expected costs of aggravated negligent medicine due to a higher cost share.

A sufficient condition for a decrease of expected total costs, therefore, is that the detrimental effect of a higher cost share on damage prevention (measured in relative marginal terms) is not larger than the relative expected benefits of decreased defensive medicine: $\frac{\frac{dy_I^*(\underline{\tau}, s)}{d\tau}}{\frac{dy_E^*(\underline{\tau}, s)}{d\tau}} \leq -\frac{\varpi_E C_y [y_E^*(\underline{\tau}, s)] + P_y [y_E^*(\underline{\tau}, s)] L}{\varpi_I C_y [y_I^*(\underline{\tau}, s)] + P_y [y_I^*(\underline{\tau}, s)] L}$. This is in particular fulfilled at the first-best standard $s = y^{FB}$, where the relative expected benefits of decreased defensive medicine are very large (compare

Section 3). From condition (8) follows that at the optimal standard under traditional reimbursement $s = s^*(\underline{\tau})$ the detrimental effect of a higher cost share on damage prevention must not be larger than the stimulating effect of

a higher standard: $\frac{\frac{dy_I^*(\underline{\tau}, s^*)}{d\tau}}{\frac{dy_E^*(\underline{\tau}, s^*)}{d\tau}} \leq \frac{\frac{dy_I^*(\underline{\tau}, s^*)}{ds}}{\frac{dy_E^*(\underline{\tau}, s^*)}{ds}}$ (compare the **Appendix**).

The sign of the third term is negative because increased efforts unambiguously curb expected treatment costs $C_e < 0$. In conclusion (9) can become negative $\frac{dETC(\tau, s)}{d\tau} \Big|_{\tau=\underline{\tau}} < 0$, indicating that the society benefits from an introduction of a substantial cost share.

A substantial supply-side cost share changes the level of negligent and defensive medicine, which may have an effect on the optimal negligence standard s^* . In order to clarify this correlation condition (8) is totally differentiated with respect to the negligence standard and the cost share, yielding:

$$\frac{ds^*}{d\tau} = \frac{\sum_{i=E, I} \varpi_i (C_{yy} + P_{yy}L) \frac{dy_i^*}{ds} \frac{dy_i^*}{d\tau} + \varpi_E (C_y + P_y L) \frac{d^2 y_E^*}{ds d\tau} + \varpi_I (C_y + P_y L) \frac{d^2 y_I^*}{ds d\tau}}{-ETC_{ss}}. \quad (10)$$

With s^* as the unique optimum, the denominator is negative. The first term

in the nominator is negative too: Because expected treatment costs and the damage probability are convex in damage prevention, the society's expected total marginal benefits of a higher standard increase with a higher cost share. Since a supply-side cost share can be assumed not to increase the standard's positive influence on damage prevention $\frac{d^2 y_i^*}{ds d\tau} \leq 0$, the second term in the nominator is non-positive.

Only the third term can become positive: As demonstrated above, the society benefits from a higher standard that reduces negligent medicine. However, if cost sharing decreases the positive influence of the standard $\frac{d^2 y_I^*}{ds d\tau} < 0$, the society's benefits of a higher standard decreases.

Proposition 3 *The introduction of a substantial supply-side cost share should be accompanied by an increase of the optimal negligence standard $\frac{ds^*}{d\tau} > 0$ if cost sharing weakly affects the standard's influence on negligent medicine.*

This proposition is driven by three distinct forces: An increase of the supply-side cost share leads physicians to decrease prevention activities. This in turn decreases expected marginal costs of defensive medicine and increases the society's expected benefits of less negligent medicine (first term in the nominator). Furthermore, the society's expected total costs of defensive medicine as such are not increased by supply-side cost sharing (second term).

Due to the third term in the nominator the proposition need not always hold. As shown in the **Appendix**, by inserting the necessary condition for an optimal standard (8) into the nominator of (10) and a minor transformation, a sufficient condition for **Proposition 3** evolves. It emphasizes the importance of elasticities $-\eta_{\frac{dy_i^*}{ds}, \tau} = -\frac{d^2 y_i^*}{ds d\tau} \frac{\tau}{\frac{dy_i^*}{ds}} \geq 0$: As long as a higher cost share does not have more impact on the standard's effectiveness in decreasing negligent medicine than in increasing defensive medicine, the optimal negligence standard increases with supply-side cost sharing:

$$\text{If } -\eta_{\frac{dy_I^*}{ds}, \tau} \leq -\eta_{\frac{dy_E^*}{ds}, \tau}, \text{ then } \frac{ds^*}{d\tau} > 0. \quad (11)$$

According to this condition, **Proposition 3** holds in particular under traditional reimbursement with $-\eta \frac{dy_i^*}{ds}, \tau = \underline{\eta} \rightarrow 0$ and under a zero cross-derivative $\frac{d^2 y_I^*}{ds d\tau} = 0$.

4.2 Comparison with the first-best standard

The introduction of a substantial supply-side cost share may require an increase of the optimal negligence standard. In this case the optimal standard approximates the first-best standard and may even exceed it. The evaluation of (8) at the first-best standard $\frac{dETC}{ds}|_{s=y^{FB}}$ gives a condition indicating the value of the optimal standard $s^*(\tau)$ compared to first-best standard. If the stimulating effect of a higher standard on damage prevention (measured in relative marginal terms) exactly equals the relative costs of increased defensive medicine, the optimal standard takes the first-best value $s^*(\tau) = y^{FB}$:

$$\frac{\frac{dy_I^*(\tau, y^{FB})}{ds}}{\frac{dy_E^*(\tau, y^{FB})}{ds}} = - \frac{\varpi_E C_y [y_E^*(\tau, y^{FB})] + P_y [y_E^*(\tau, y^{FB})] L}{\varpi_I C_y [y_I^*(\tau, y^{FB})] + P_y [y_I^*(\tau, y^{FB})] L}. \quad (12)$$

The optimal negligence standard does not take the first-best level, if the left hand side of (12) is always lower than the right hand side. This is, for example, the case with a very large share of defensive physicians $\frac{\varpi_E}{\varpi_I} \rightarrow \infty$ or if defensive physicians react very sensitively to an increase of the standard beyond the first-best level $\frac{\frac{dy_I^*(\tau, y^{FB})}{ds}}{\frac{dy_E^*(\tau, y^{FB})}{ds}} \rightarrow 0$. In both cases the expected marginal costs of a standard equal to or higher than the first-best standard are too high due to defensive medicine and the society's expected total costs with respect to damage prevention are minimized by a lower standard $s^*(\tau) < y^{FB}$.

5 Conclusions and Discussion

This paper addresses provider incentives for preventing damages to patients in course of a medical treatment. Under the negligence rule - the predominant liability principle for medical malpractice - physicians have to pay a compensation to injured patients only if the court observes that they failed to comply

with the promulgated negligence standard. In order to avoid this payment physicians exert the level of damage prevention given by the standard.

A problem arises when information about the physicians' level of damage prevention is imperfect. If courts base their judgments on a vague signal of damage prevention, the incentives of the negligence rule change. Since physicians account for uncertain liability in their profit optimization, a welfare-decreasing separated equilibrium in damage prevention arises. If physicians deviate from first-best damage prevention, as defined under perfect information, in different directions defensive and negligent medicine occur.

By assuming that the negligence standard and exerted prevention determine the probability of an erroneous court judgment, I derive a standard that balances marginal welfare effects of negligent and defensive medicine, minimizing the society's expected total costs with respect to damage prevention. Furthermore the reimbursement scheme is shown to influence the optimal standard. Under traditional, close to full cost reimbursement a standard lower than the first-best standard is optimal. With an introduction of a substantial supply-side cost share, the optimal standard may increase. Interestingly there's no guarantee that the optimal standard ever achieves the first-best negligence standard. If the share of defensive physicians is very large or defensive physicians react very sensitively to an increasing standard, the optimal standard should always be lower than the first-best standard.

This is in line with Danzon (2000) noting that the first-best level of damage prevention is certainly not the appropriate negligence standard. She argues that, given the costs of obtaining information and controlling moral hazard in health care markets, a deviating standard is more likely to maximize welfare.

With the findings of this paper the question of whether liability incentives should be made compatible with the new reimbursement schemes for medical health care services can be answered - at least with respect to the negligence standard. This topic is of some importance especially in countries where a substantial supply-side cost sharing in health care has been introduced. Since the cost share determines the optimal negligence standard, a realignment of

the standards is actually indicated. Danzon (1997) points out that standards, as they develop under traditional reimbursement, fail to incorporate a trade-off between marginal benefits and costs of prevention activities. In the context of the model presented here traditional standards exceed the first-best level by far and preserving them, as suggested by legal experts, certainly causes a welfare loss.

Feess and Ossig (2004) also examine the relationship between liability and reimbursement incentives. In contrast to the present paper they adopt the insurer's point of view and determine the optimal supply-side cost share at a given degree of liability risk. Furthermore, Feess and Ossig base the analysis on some kind of a strict liability rule and assume prevention costs as unobservable. The latter is implemented by $H(y, e) > 0$, $H_y > 0$ and a positive cross-derivative $H_{ye} > 0$. This connects a higher liability risk with a higher supply-side cost share, backing and complementing my result: If cost sharing not only directly but also indirectly (via a positive cross-derivative) decreases negligent and defensive medicine, the society's expected total marginal benefits of a higher standard additionally increase.

Apart from that, the perspective of the analysis chosen by Feess and Ossig can be challenged. At present, reimbursement schemes with a substantial supply-side cost share have already been introduced and the question is, rather, whether liability incentives need to be adjusted. For example, there is an ongoing discussion among German legal experts whether negligence standards need to be adapted to new reimbursement conditions established by the statutory health insurance (Kern, 2002). Empirical research in the USA concerns the optimal liability policy in an era of managed care (see **Section 1**). Therefore, the model developed in the paper at hand fits better the problems of today.

In consideration of the interdependence of provider incentives, an innovative approach would be to simultaneously optimize cost share and negligence standard. Keeping the derivation tractable and the results practicable is demanding and I leave this for future research. Furthermore Demougin and Fluet (2005) demonstrate that the standard of proof determines the liabil-

ity incentives under imperfect information. Due to technical similarities with the negligence standard in the present model, the dependence of the optimal standard of proof on the supply-side cost share could be shown.

Notes

¹As in the standard literature I assume that courts can not determine the potential damages under compliance with the negligence standard. Under this realistic assumption physicians are always held liable for the total damage L .

²Edlin (1994) models imperfect information about prevention in the same way. A normal distribution of errors would not change the results if additional assumptions about second-order derivatives of the cumulative distribution function are imposed.

³See the **Appendix** for the second-order conditions.

⁴The **Appendix** shows that splitted fixed payments f_i or a particular preference for diligence among a share of physicians also lead to the separated equilibrium.

⁵See the **Appendix** for the complete approach and also for the second-order condition.

⁶As shown by Olbrich (2004) y^{FB} is also the optimal negligence standard when courts are perfectly informed and physicians differ w.r.t. intrinsic motivation.

Appendix

Appendix Section 2

Excessive damage prevention $y_E^* > s$ is a globally optimal decision, since $E\pi_{yy}(y_E^*) = -\tau C_{yy}(y_E^*) - 2p_y^I P_y(y_E^*) L - p^I(s, y_E^*) P_{yy}(y_E^*) L$ is negative.

Insufficient damage prevention $y_I^* < s$ constitutes a global optimum, since $E\pi_{yy}(y_I^*) = -\tau C_{yy}(y_I^*) + 2p_y^{II} P_y(y_I^*) L - [1 - p^{II}(s, y_I^*)] P_{yy}(y_I^*) L$ is negative.

A **separated equilibrium** arises if physicians expect equal profits independent of their behavior $E\pi(y_E^*, e^*) = E\pi(y_I^*, e^*)$. With

$$f_i = \tau C(y_i^*, e^*) + H(e^*) + \widetilde{EL}(s, y_i^*)$$

expected profits are zero and the fixed payment can but need not differ between physicians (see **Section 2**).

If expected treatment costs plus payment of compensation under a uniform payment f are lower with insufficient prevention, a separated equilibrium also arises with a share ϖ_E of physicians who suffer a sufficiently large disutility D when acting recklessly:

$$D > \tau [C(y_E^*) - C(y_I^*)] + [\widetilde{EL}(s, y_E^*) - \widetilde{EL}(s, y_I^*)].$$

Optimal damage prevention and efforts respond to a variation of the negligence standard and the cost share. In order to determine the reactions a comparative static analysis of the physicians' necessary conditions (4), (5) and (6) is applied. It reveals for the standard:

$$\frac{dy_E^*}{ds} = \frac{p_s^I P_y(y_E^*)}{E\pi_{yy}(y_E^*)/L} > 0, \quad \frac{dy_I^*}{ds} = \frac{p_s^{II} P_y(y_I^*)}{-E\pi_{yy}(y_I^*)/L} > 0,$$

and for the cost share:

$$\frac{dy_i^*}{d\tau} = \frac{C_y(y_i^*)}{E\pi_{yy}(y_i^*)} < 0, \quad \frac{de^*}{d\tau} = \frac{C_e(e^*)}{-H_{ee}(e^*)} > 0.$$

Appendix Section 3

The complete **optimization program** of (8) is:

$$\begin{aligned} & \min_s ETC [y_i^*(\tau, s), \underline{e}] \\ & = \sum_{i=E,I} \varpi_i \left\{ f_i + (1 - \tau)C [y_i^*(\tau, s), \underline{e}] + P [y_i^*(\tau, s)] L - \widetilde{EL} [s, y_i^*(\tau, s)] \right\} \\ & \text{w.r.t. } E\pi [y_i^*(\tau, s), \underline{e}] \geq 0 \text{ with } i = E, I. \end{aligned}$$

The **second-order condition of the optimal** negligence standard is obtained from (8). Deriving it w.r.t. the negligence standard, s^* is a global solution if:

$$\varpi_i \sum_{i=E,I} [C_{yy}(s^*) + P_{yy}(s^*) L] \left(\frac{dy_i^*}{ds} \right)^2 + [C_y(s^*) + P_y(s^*) L] \frac{d^2 y_i^*}{(ds)^2} > 0.$$

Assuming that the positive influence of the standard on damage prevention non-increasing $\frac{d^2 y_i^*}{(ds)^2} \leq 0$ ($i = E, I$), overcautious physicians should react rather insensitively at the margin so that $\left| \frac{d^2 y_E^*}{(ds)^2} \right|$ is low or zero.

Appendix Section 4

The **society's expected total costs with respect to damage prevention and efforts at cost containment** can be shown to **decrease** with an implementation of a substantial cost share at the optimal standard under traditional reimbursement $s^*(\tau)$. Evaluating (9) at $[\tau, s^*(\tau)]$ and inserting condition (8) yields a sufficient condition for this result:

$$\varpi_E [C_y(\tau, s^*) + P_y(\tau, s^*) L] \left[\frac{dy_E^*(\tau, s^*)}{d\tau} - \frac{\frac{dy_E^*(\tau, s^*)}{ds}}{\frac{dy_I^*(\tau, s^*)}{ds}} \frac{dy_I^*(\tau, s^*)}{d\tau} \right] \leq 0.$$

Since the expected total costs increase with more defensive medicine, the first term in brackets is negative and the second term positive, this is true for

$$\frac{\frac{dy_I^*(\tau, s^*)}{d\tau}}{\frac{dy_E^*(\tau, s^*)}{d\tau}} \leq \frac{\frac{dy_I^*(\tau, s^*)}{ds}}{\frac{dy_E^*(\tau, s^*)}{ds}}.$$

A **sufficient condition for Proposition 3** to hold derives by inserting (8) into the nominator of (10). The nominator, then, takes

$$\sum_{i=E,I} \varpi_i (C_{yy} + P_{yy} L) \frac{dy_i^*}{ds} \frac{dy_i^*}{d\tau} + \varpi_E (C_y + P_y L) \left[\frac{d^2 y_E^*}{ds d\tau} - \frac{\frac{dy_E^*}{ds}}{\frac{dy_I^*}{ds}} \frac{d^2 y_I^*}{ds d\tau} \right],$$

which is always negative with a non-positive term in brackets. Transforming it yields

$$\frac{d^2 y_I^*}{ds d\tau} \frac{\tau}{\frac{dy_I^*}{ds}} \geq \frac{d^2 y_E^*}{ds d\tau} \frac{\tau}{\frac{dy_E^*}{ds}} \text{ OR } -\eta \frac{dy_I^*}{ds}, \tau \leq -\eta \frac{dy_E^*}{ds}, \tau.$$

References

Baicker, Katherine, and Amitabh Chandra. (2004). "The effect of malpractice liability on the delivery of health care." NBER Working Paper Series.

Brennan, Troyen A., Colin M. Sox, and Helen R. Burstin. (1996). Relation between negligent adverse events and the outcomes of medical-malpractice litigation. *The New England Journal of Medicine* 335, 1963-1967.

Cooter, Robert, and Thomas Ulen. (2000). *Law and Economics*. Reading, Mass.: Addison-Wesley.

Danzon, Patricia M. (1997). "Tort liability: A minefield for managed care." *The Journal of Legal Studies* 26, 491-519.

Danzon, Patricia M. (2000). "Liability for medical malpractice." In Culyer, Anthony J., and Joseph P. (eds.), *Handbook of Health Economics*, Vol. 1B. Amsterdam: Elsevier Science.

Demougin, Dominique, and Claude Fluet. (2005). "Deterrence versus judicial error: A comparative view of standards of proof." *Journal of Institutional and Theoretical Economics* 161, 193-206.

Dubay, Lisa, Robert Kaestner, and Timothy Waidmann. (1999). "The impact of malpractice fears on cesarean section rates." *Journal of Health Economics* 18, 491-522.

Edlin, Aaron S. (1994). "Efficient standards of due care: Should courts find more parties negligent under comparative negligence?" *International Review of Law and Economics* 14, 21-34.

Ellis, Randall P., and Thomas G. McGuire. (1993). "Supply-side and demand-side cost sharing in health care." *Journal of Economic Perspectives* 7, 135-151.

Feess, Eberhard, and Sonja Ossig. (2004). "Reimbursement schemes for hospitals, malpractice liability, and intrinsic motivation." Working Paper Aachen University.

Kern, Bernd-Rüdiger. (2002). "Haftungsrechtliche Aspekte bei der Abweichung von medizinischen Qualitätsstandards und qualitätssichernden Vorgaben in der gesetzlichen Krankenversicherung." *Gesundheitsrecht* 1, 5-9.

Kessler, Daniel, and Mark McClellan. (1997). "The effects of malpractice pressure and liability reforms on physicians perceptions of medical care." *Law and Contemporary Problems* 60, 81-106.

Kessler, Daniel, and Mark McClellan. (2002a). "How liability law affects medical productivity." *Journal of Health Economics* 21, 931-955.

Kessler, Daniel, and Mark McClellan. (2002b). "Malpractice law and health care reform: optimal liability policy in an era of managed care." *Journal of Public Economics* 84, 175-197.

Kohn, Linda T., Janet Corrigan, and Molla S. Donaldson (eds.). (2000). *To err is human*. Washington, DC: National Academy Press.

Olbrich, Anja. (2004). "Heterogeneous physicians, imperfect courts, and the negligence standard." Unpublished Working Paper.

Polinsky, A. Mitchell, and Steven Shavell. (1989). "Legal error, litigation, and the incentive to obey the law." *Journal of Law, Economics & Organization* 5, 99-108.

Quinn, Robert. (1998). "Medical malpractice insurance: The reputation effect and defensive medicine." *Journal of Risk and Insurance* 65, 467-484.

Steffen, Erich. (2000). "Die Arzthaftung im Spannungsfeld zu den Anspruchsbegrenzungen des Sozialrechts für den Kassenpatienten." In Hans Erich Brandner, Horst Hagen, and Rolf Stürner (eds.), *Festschrift für Karlmann Geiß: Zum 65. Geburtstag*. Köln: Carl Heymanns Verlag.

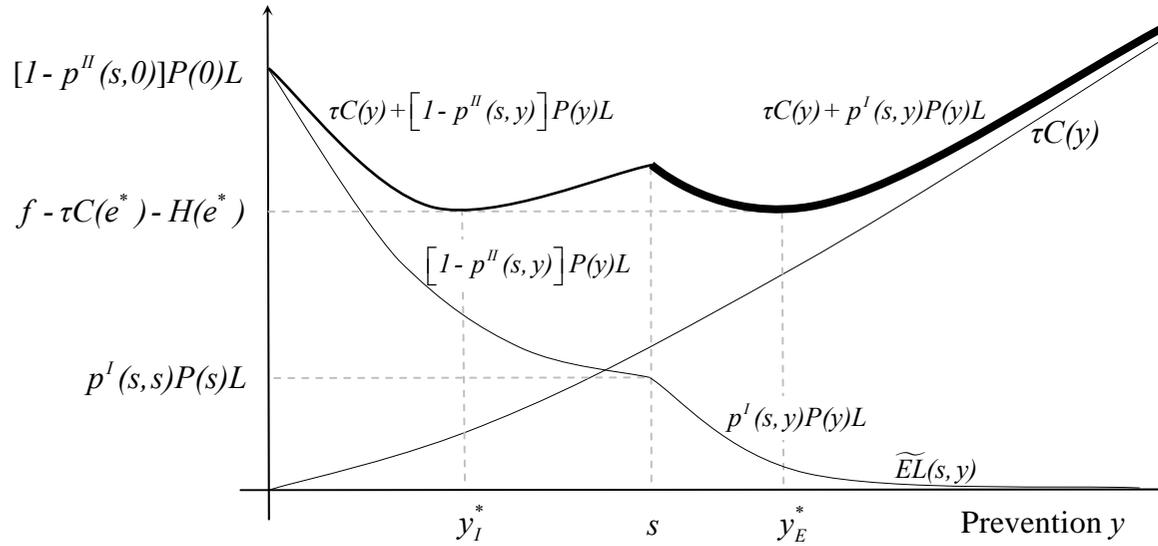


Figure 1. Expected costs at separated equilibrium (y_I^*, y_E^*) with a uniform payment f .