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Expert Incentives: Cure versus Prevention

Kris de Jaegher

Universiteit Utrecht

Utrecht School of Economics

Tjalling C. Koopmans Research Institute
Utrecht School of Economics
Utrecht University

Janskerkhof 12
3512 BL Utrecht
The Netherlands
telephone +31 30 253 9800
fax +31 30 253 7373
website www.koopmansinstitute.uu.nl

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How to reach the authors

Please direct all correspondence to the first author.

Kris de Jaegher
Utrecht University
Utrecht School of Economics
Janskerkhof 12
3512 BL Utrecht
The Netherlands
E-mail: k.dejaegher@econ.uu.nl

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Expert Incentives: Cure versus Prevention

Kris de Jaegher[a]

[a]Utrecht School of Economics
Utrecht University

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Abstract
This paper distinguishes between two scenarios for the expert-client encounter. In the cure scenario, the client does not know whether a loss can be recovered. In the prevention scenario, the client faces a threat but does not know whether this threat is real enough to justify preventive action. The client wants to induce the expert both to give an accurate diagnosis and to put appropriate effort into cure or prevention. It is shown that in the cure scenario, a contingent fee solves both these incentive problems. In the prevention scenario, however, putting up with low effort makes it easier to get an accurate diagnosis, and the use of contingent fees should be limited. These results are interpreted as providing a rationale for observed exceptions to legal and ethical restrictions on the use of contingent fees. Indeed, such exceptions are often granted for cases that fit the cure scenario.

Keywords: Prevention, Cure, Expert Incentives, Principal-Agent Models

JEL classification: D82, K1

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I. INTRODUCTION

A recurring issue in economics is the trustworthiness of an expert (she) who sells services to a client (he), and at the same time sells advice on whether the client needs these services. Very often, the client cannot tell whether or not he needs the services, creating a *hidden information problem* (Wolinsky 1993, Taylor 1995, Emons 1997). And even if the client does obtain trustworthy advice, he still faces the problem that he cannot exactly observe how much effort the time-constrained expert puts in her services. Therefore, in addition to the hidden information problem, there is a *hidden action problem* (Holmström 1979).

The focus of this paper is on analyzing the interaction between these two problems. It is shown that in one type of expert-client encounters, referred to as the *prevention scenario*, this interaction is problematic, whereas in another type, the *cure scenario*, it is not. The basic intuition for these two scenarios is extremely simple. In the *cure scenario*, the client has suffered a loss, and knows that the loss will not be repaired if nothing is done about it. At the same time, the client is uncertain whether the expert's curative services can repair his loss. When the loss is repaired after the expert predicted that recovery was possible, the client learns that the expert was right. He therefore wants to reward the expert for having provided the right advice. And he has all the more reason to do so since rewarding the expert in case of recovery gives her an incentive to put high effort into her curative services. When paying the expert by means of a contingent fee, the client is therefore able to kill two birds with one stone.

In the *prevention scenario*, the client faces a possible threat, and can rest assured that this threat is averted if he buys preventive services from the expert. However, the client is uncertain whether the threat is real enough in the first place. When the threat materializes after the expert prescribed preventive services, the client learns that these services were indeed necessary. Therefore, he would again like to reward the expert for having made the right prediction. But the reward this time induces the expert to put low effort into her preventive services, as this makes it more likely that she gets proven right. There is therefore a conflict between eliciting the right advice and the right level of effort. Put otherwise, the client can only induce the right level of necessary preventive effort when rewarding the expert for successful prevention; but the expert may now take credit for the client's continued wellbeing in cases where his wellbeing was never at risk. It follows that it is in the client's interest to limit the use of contingent fees, and to put up with low preventive effort.

These intuitions are confirmed by what is observed for examples of prevention and cure scenarios in the context of law and medicine. *Firstly*, let us look for examples in medicine. Here, a good example of the cure scenario is plastic surgery. Unlike the ugly duckling, we do not usually become beautiful by ourselves, and there is no danger that the surgeon would take credit for successes to which she made no contribution. A contingent contract ensures that the surgeon only prescribes surgery when the probability of success is sufficiently high, and that she puts sufficient effort into surgery. And indeed, it is precisely for plastic surgery that, in several countries, exceptions can be observed to the general rule that physicians are not liable for the results of treatment, but only for applying a due level of care. In particular, there have been court rulings in both France, Spain and the UK where plastic surgeons have been held liable for the results of plastic surgery (Magnus and Micklitz 2004). Other European examples where the physician has been considered liable for the results of treatment are sterilization (ibid.), and the placing of prostheses by dentists (Sargos

2000). Both these examples again fit the cure scenario. In the US, result-based compensations in medicine have been observed for vasectomy reversals, in vitro fertilization, vein stripping, and laser vision correction (Hyman and Silver 2000). Again, these are all procedures that fit the cure scenario.

However, the prevalent scenario in medicine is probably the prevention scenario. Many diseases are self-limited (Morreim 2000), and it may thus not be clear whether a regained good health status had anything to do with treatment. The physician could thus claim to be preventing future ill-health, whereas ill-health is unlikely to persist. It is then necessary to limit the use of contingent fees.

Secondly, let us look at litigation and defense in the case of legal services. Here, the cure scenario has a clear interpretation in terms of *litigation*. By letting the attorney share in the proceeds of the lawsuit, the plaintiff can both ensure that the attorney only advises him to bring his case before a court when it is sufficiently likely that the case will be won, and that the attorney puts sufficient effort into a worthy lawsuit. And indeed, it is precisely in litigation that contingent legal fees are most frequently observed in the US.

Looking next at *defense*, here instances of the cure and prevention scenario coexist. The prevention scenario applies when the defendant is uncertain whether or not the lawsuit that he is facing is a frivolous one. Letting the defense attorney share in success induces the attorney to set up a defense for cases that are very likely to be won anyway. The rationale for limiting the use of contingent fees then again applies. On the other hand, a cure scenario applies when the defendant faces the choice between accepting a take-it-or-leave-it settlement offer and paying a given amount of money on the one hand, and defending himself in court on the other hand. And indeed, for such cases, US attorneys are often paid by means of a so-called *reverse contingent fee* (or defense contingent fee). Such a fee lets the attorney share in the savings that she ensures to the client by defending his case in court (*American Bar Association Journal* 1996).[1]

The intuitions provided by the cure and prevention scenarios can also help explain the legal and ethical restrictions on paying physicians and attorneys by means of contingent fees that exist on both sides of the Atlantic, and the exceptions to these restrictions. At first sight, the rationale for such restrictions is unclear. In the prevention scenario, given that only a treatment contract with a limited degree of contingency induces an accurate diagnosis, competing experts will end up working under such contracts, and there is no need for restrictions. However, the client faces a commitment problem. Once the expert has agreed to provide preventive services under a contract with a limited degree of contingency, the client finds out that he needs these services. It is in the interest now of the client to negotiate a new, fully contingent contract that still induces high preventive effort. The client can ensure that the expert accepts this new contract by allowing the expert the same profit margin on this new contract. But when deciding whether or not to prescribe preventive services, the expert now anticipates that she will eventually work under a fully contingent treatment contract, and again gets an incentive to prescribe services for nonexistent threats. Legal and ethical restrictions now serve as a commitment device to the client,

[1] An alternative explanation for the use of contingent fees in some types of expert-client encounter, such as the relation between plaintiff and litigation attorney, but not in the physician-patient relationship, is the following. In litigation, the damages that the plaintiff obtains are easily observed, as they come in the form of money. However, as argued by McGuire (2000), a patient could always claim that 'it still hurts', and a contingent contract is not enforceable then. Yet, it would often seem possible to use objectively observable outcomes as the basis for the contract.

ensuring that he cannot renegotiate a fully contingent contract even after he has found out that the threat is real.

The paper is structured as follows Section II starts out with the type of simple examples of prevention and cure scenarios that initiated this research. Section III gives an overview of related literature. Section IV constructs a principal-agent model that generalizes the simple examples of Section II, under the assumption that the client cannot renegotiate the contracts in the course of the game. Section V shows that the second-best contract derived for the prevention scenario in Section IV cannot be maintained under the plausible assumption that renegotiation is possible. The paper ends with a discussion in Section VI, where some areas of future research are suggested.

II. Simple Numerical Examples

A. Cure

During a storm, a tree from the garden of a plaintiff's neighbor falls into the plaintiff's garden, causing his wealth to go down from 1 to 0. If an attorney does not bring the plaintiff's case before a court, his wealth remains at 0. If the attorney files a lawsuit on the plaintiff's behalf and wins the case, the plaintiff is awarded damages, causing his wealth to be restored to 1; if the attorney loses the case, the plaintiff's wealth remains at zero (each time excluding any payments made to the attorney).

The plaintiff judges that, with probability ½, the case will be lost whatever the attorney's efforts, and that with the same probability, winning in court is likely enough to justify the expenses. The plaintiff can only observe whether his attorney exerts the minimal effort of filing a lawsuit, but cannot observe the extent to which she exerts extra effort. When it is possible to win the case, when the attorney files a lawsuit, and puts low (respectively high) effort into the case, the probability of success is ½ (respectively ¾). The probabilities of success as a function of the attorney's efforts are listed in Table 1.

The attorney's expected payoff equals the payment that she expects to receive from the plaintiff, minus her costs of taking effort. Her costs are listed in Table 2. The plaintiff's expected payoff is his expected wealth minus the expected payments. The attorney's cost levels are chosen in such a way that, in the state where the case can be won, a client who compensates the attorney for her costs prefers that the attorney exerts high effort rather than low effort. This can be seen by the fact that in the former case, the client obtains wealth 1 with probability ¾ and pays the attorney a fee of ½, tantamount to an expected payoff of ¼, while in the latter case the client obtains wealth 1 with probability ½ and pays a fee of ⅓, tantamount to an expected payoff of $^{1}/_{6}$

TABLE 1
CURE: PROBABILITIES OF SUCCESS FOR DIFFERENT EFFORT LEVELS

	Not to court (= zero effort)	To court, low effort	To court, high effort
Case cannot be won	0	0	0
Case can be won	0	½	¾

TABLE 2
EXPERT'S COSTS

Effort	Zero	Low	High
Costs	0	⅓	½

Denote by $w(s)$ what the plaintiff pays to his attorney when he is awarded damages, and by $w(f)$ what the plaintiff pays when he is not awarded any damages. It can now be checked that a contingent fee schedule $w(s) = ⅔$, $w(f) = 0$ both ensures that the attorney does not bring an unworthy case before court, that she is willing to take a worthy case before court and put high effort into it, and that she is willing to put high rather than low effort into a worthy case.

Let us *first* check that the attorney will not take an unworthy case to court under this fee schedule. When *not* bringing an unworthy case to court, the attorney earns a zero wage, and has zero costs; when bringing an unworthy case to court, the attorney still does not earn any wage, but incurs the cost of going to court. The attorney therefore will not bring an unworthy case to court.

Second, let us check that, under this fee schedule, the attorney is willing to bring a worthy case before a court and put high effort into it. When she does this, she wins and gets payment ⅔ with probability ¾, and she incurs a cost of ½, yielding her a total expected payoff of 0. If she drops the worthy case, she also gets a payoff of zero. The attorney therefore may as well take a worthy case to court and put high effort in it.

Third, let us check that the attorney is willing to put high rather than low effort into a worthy case under this fee schedule. When the attorney brings a worthy case to court and puts low effort into it, she wins and gets payment ⅔ with probability ½, and she incurs a cost of ⅓, yielding her an expected payoff of 0. We already saw above that she equally well obtains a zero expected payoff when putting high effort into a worthy case. She is therefore willing to put high rather than low effort into a worthy case. Finally, it can be checked that, with this fee schedule, the client obtains exactly the same payoff as in the case that he both observes his state and the attorney's effort.

B. Prevention

A patient currently does not have a toothache (his wealth equals 1), but he could get one in the future (which would reduce his wealth to 0). The patient assesses that, with probability ½, the probability of a future toothache can be reduced by undergoing a root canal treatment. He attributes the same probability to a state where the probability that he gets a toothache is zero.

The patient clearly can feel whether his dentist is treating him with a root canal treatment, but he cannot observe whether the dentist puts high or low effort into this treatment. His probabilities of success as a function of the state in which he is, and as a function of the effort exerted by the dentist, are listed in Table 3. The dentist's costs, as a function of her effort, are again listed in Table 2. Note that, analytically, the only difference with the situation of the plaintiff in Section II.A is that the state in which dentist effort is unnecessary is now one where success is always obtained.

TABLE 3
PREVENTION: PROBABILITIES OF SUCCESS FOR DIFFERENT EFFORT LEVELS

	No treatment	Treatment, low effort	Treatment, high effort
Treatment unnecessary	1	1	1
Treatment necessary	0	½	¾

For a patient who knows that he needs a root canal treatment and who compensates the dentist for her costs, it is again better that the dentist puts high effort into the root canal treatment (see calculations in Section II.A). Assume now that the client again offers payments $w(s,T) = ⅔$, $w(f,T) = 0$ to the expert, where T indicates that the dentist only gets these payments when the patient observed her providing a root canal treatment. Indeed, with such payments in place, the patient needs to offer the dentist payments $w(s,NT)$ = ⅓, $w(f,NT)$ = 0 rather than zero payments for not providing treatment (indicated by *NT*), meaning that the client is worse off than when he is fully informed. To see why, note *first* that when the dentist provides an unnecessary treatment, she obtains a payment of ⅔ with probability 1, and incurs a cost of only ½ (she has no incentive to put high effort into unnecessary treatment). This yields her a total expected payoff of ⅓. It follows that she will only be willing *not* to provide unnecessary treatment if she gets an expected payoff of at least ⅓ when she does not provide treatment. Given that the patient never gets a toothache when he does not need treatment, the payment $w(s,NT)$ = ⅓ achieves exactly this purpose.

Second, the payment $w(f,NT)$ = 0 ensures that the dentist is willing to provide treatment when it is necessary. Not prescribing treatment when it is necessary always results in failure and in a zero payment, and costs the dentist nothing, yielding her a zero total expected payoff. This expected payoff is not better than the zero expected payoff obtained from providing necessary high-effort treatment (see Section II.A). The described payments therefore both induce truth-telling and high effort. The patient's expected benefit with these payments is ½(1 – ⅓) + ½ [¾(1 – ⅔)] = 11/24.

However, the patient could instead induce the dentist to put *low* effort into a necessary root canal treatment. In this case, the patient need not make the payments dependent on whether or not he gets a toothache again. A simple rule w(*s*,*T*) = w(*f*,*T*) = ⅓, $w(s,NT) = w(f,NT) = 0$, ensures that, *first*, when treatment is necessary the dentist is willing to provide low-effort necessary treatment rather than not providing any treatment. Indeed, the fixed payment of ⅓ exactly compensates the dentist for her costs, so that she obtains a zero expected payoff when providing low-effort necessary treatment; not providing necessary treatment yields her a payment of 0 with certainty. *Second*, the dentist does not prefer to provide unnecessary treatment under this simple rule. Providing unnecessary treatment yields the dentist a wage of 0, and costs here at least ⅓; not providing unnecessary treatment also yields her a wage of 0, but does not cost her anything. While the patient does not achieve the goal of inducing high necessary effort, these payments yield him an expected payoff of ½.1 + ½ [½*1 – ⅓]

= 14/24, which is higher than the payoff of inducing high effort. The client should therefore induce low rather than high necessary effort.

But the problem now is that, if the patient is able to induce honesty by offering the simple rule just described, once he has observed the dentist embarking upon a treatment, it is in his interest to offer the dentist to tear up the treatment contract $w(s,T) = w(f,T) = ⅓$ initially offered, in favour of a new treatment contract with payments $w(s,T) = ⅔$, $w(f,T) = 0$, which still induce high necessary effort. The dentist is willing to accept this new contract, as it equally yields her an expected payoff of zero. But if the patient now offers the simple rule before the dentist has revealed that the patient needs a treatment, the dentist will anticipate that eventually, the patient will offer the payments $w(s,T) = ⅔$, $w(f,T) = 0$. The patient can therefore again only induce truth-telling by offering the dentist payments $w(s,NT) = ⅓$ and $w(f,NT) = 0$ when she does not provide treatment (see above). The patient who consults the dentist is therefore stuck with the low expected payoff of 11/24. And in fact, he should not bother going to the dentist at all. Indeed, not going to the dentist yields the patient an expected payoff of ½*1 + ½*0 = 12/24. The patient therefore benefits if legal or ethical restrictions stop him from offering contingent fees, as he then can credibly commit himself to the simple rule.

These simple examples confirm the intuitions from the Introduction. Still, in the given example of a cure scenario, a failed outcome always occurs when treatment is unnecessary, whereas in the example of a prevention scenario, a successful outcome always occurs when treatment is unnecessary. The question then arises whether the intuitions are maintained for more general examples. Before we answer this question, however, let us first look at literature that provides similar intuitions.

III. RELATED LITERATURE

The models that are *analytically* most related to the model in this paper are principal-agent models of simultaneous adverse selection and moral hazard (see for example Guesnerie, Picard and Rey [1988]). The hidden information problem in the model at first sight seems different from a standard adverse selection problem, as the agent (= the expert) has private information not about her own costs, but about the *principal's* (= the client) benefits. However, the expert's cost function can be reformulated as the cost of producing a certain probability of success for the client, rather than as the cost of exerting a certain effort level. The expert then has different cost functions depending on the client's type. Yet, this reformulation is only relevant when the client tries to solve the hidden action problem by paying the expert more for success than for failure. The unique feature of the model is therefore that solving the hidden action problem creates an adverse selection problem.

Next consider related papers in the expertise literature. The paper in this literature most related to the current paper is Demski and Sappington (1987), because of the simultaneous treatment of a hidden action problem and a hidden information problem. These authors' hidden action problem is as such unproblematic, as providing services is assumed to be costless to the expert. Still, it may be in the interest of the client to induce suboptimal service effort. The expert is risk averse, and the type of risk-sharing that solves the hidden information problem may induce the expert to exert suboptimal service effort, in order to reduce her risk (*induced moral hazard*). Another reason for inducing suboptimal effort is that the outcome distribution generated by suboptimal service effort may reveal more about the expert's diagnostic effort.[2]

The main differences with the current paper are that, *first*, the expert's diagnostic effort decision is not studied here, but instead her decision to tell the truth after having made a diagnosis is studied. In Demski and Sappington, the distribution of outcomes for different diagnostic effort levels on the one hand, and for completely unobservable service effort levels on the other hand, leads to tradeoffs in solving the two incentive problems. In the current model, the distribution of outcomes differs from one state to the next in such a way that the expert has an incentive not to reveal the truth, and more so the more service effort is induced. *Second*, the reason that the hidden action problem in the current model as such can easily be solved is not because exerting service effort is costless, but because the expert is risk neutral; inducing moral hazard is optimal because the expert's information rent is reduced in this way.

Prendergast's (2003) expert-client model is again similar to the current model in showing that punishing the expert for failed services can lead her to prescribe unnecessary services. In his model, an expert (a bureaucrat) needs to find out whether, according to standards of a client (the government), a commodity should or should not be allocated to a consumer. The consumer always wants to get the commodity, whether or not he needs it according to the client's standards. The client can monitor the expert by investigating consumer complaints. The problem is that consumers only complain in case they did not get the commodity and were supposed to, but not in the opposite case. Punishing the expert as a function of the number of complaints received then gives her an incentive to always allocate the commodity. In the prevention scenario of the current model, the client similarly gets a signal that the expert did not tell the truth in the case that the expert does not provide services when she was supposed to, but not in the case that the expert provides services when she was not supposed to (in the cure scenario, the opposite is the case).[3]

A further series of papers in the expert-client literature that are relevant to the analysis are Wolinsky (1993), Taylor (1995), and Emons (1997). In scenarios that fit the prevention scenario[4], these papers study how clients can reduce the information rent that the expert earns because of her expert knowledge. In Wolinsky, clients can do this by getting *second opinions*. Alternatively, clients first consult experts who cannot prescribe high levels of treatment, and these experts then refer clients who need high levels of treatments to specialists (*specialization*); effectively, this means that the provision of diagnosis and of (expensive) treatment are separated, so that the diagnostician no longer faces a conflict of interest.

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[2] Szalay (2005) recently provides a similar intuition. In this expert-client model, a client cannot observe the effort that an expert puts into finding out the client's state, but can observe the action undertaken by the expert. Expert and client prefer the same actions for each state of the world. However, it may only be worthwhile for the expert to find out the client's true state if the client induces extreme actions from the expert, rather than the first-best compromise actions.

[3] This feature makes prevention a *credence good* (Darby and Karni 1973), because the client cannot observe the quality of prevention, and can only give credence to it that a certain quality level was provided.

[4] In Wolinsky (1993), in a diseased (respectively healthy) state, the expert can produce a successful outcome with probability 1 by exerting *high* (respectively *low*) effort. The danger is that the expert prescribes high effort when only low effort is necessary. In Taylor (1995), a client is either healthy or diseased, but cannot observe his state. The disease state can turn into a lethal state which can no longer be remedied, but buying a treatment prevents the lethal state. Emons (1997) is similar to Taylor, with the difference that success does not occur with certainty upon treatment.

In Taylor, clients reduce the information rent by forcing competing experts to offer *free diagnoses*. Alternatively, they postpone consulting the expert (*procrastination*). The latter option is open to the client because the probability that the client needs preventive services increases as time goes by. Finally, the expert may enter into a long-term contract with the client, where the expert effectively insures the client against disease. Having then the same interests as the client, the expert does not overtreat. However, such a long-term contract (*health maintenance plan*) should stop the client from shirking on health investment. The current analysis excludes these instruments provided by Wolinsky and by Taylor as means to solve part of the hidden information problem not because they are considered unimportant, but because the focus is on the interaction between the hidden information and hidden action problems, with the aim of showing that this interaction is only problematic in one particular type of expert-client encounter.

In Emons, clients eliminate information rents by offering the expert the same mark-up for all levels of treatment (*equal mark-up rule*); this option is open in Emons because, contrary to what is the case in Wolinsky and in Taylor, the client is able to perfectly observe the expert's service effort. The current model takes a middle ground in assuming that the client can observe part of the expert's effort. The equal mark-up rule then loses some of its cutting ground.

Emons' argument in favor of what is effectively fee-for-service brings us to some papers that have considered the appropriateness of contingent fees and fee-for-service as means of reimbursing experts. As this is an extensive literature, let us focus on papers that use arguments similar to ones in the current paper. Dana and Spier (1993) provide a model of plaintiffs and litigation attorneys that fits the cure scenario, but which only involves a hidden information problem. They show that a contingent fee solves this hidden information problem, in giving the attorney an incentive to file a lawsuit only if the probability of winning is sufficiently high. Hyman and Silver (2000) verbally make a similar point for medical care. If a physician accepts a contingent fee, then she signals to the uninformed patient that the probability of success is relatively high, and that it is worth it to go ahead with treatment. At the same time, it has been argued that hourly fees (fee-for-service) induce the expert to provide unnecessary effort (Hyman and Silver (2000), p.170).

However, others have looked at the hidden information problem in isolation to provide arguments against contingent fees. Olson (1991) argues that paying physicians by means of contingent fees would lead them to present transient disease states, best treated by doing nothing, as life-threatening. Similarly, Morreim (2000) argues that physicians could represent patients' health status in such a way to make it look as if they contributed to their patients' success. However, a patient's success may simply be due to the self-limitedness of disease. Emons (1997) again provides a rationale in favor of fee-for-service by means of the equal mark-up rule (see above).

IV. The Model

The expert-client relationship is modeled as a principal-agent problem. The time line in Figure 1 depicts the order of events. At stage 0, the client offers payments to the expert (these are specified below). At stage 1, Nature with probability π_y (respectively π_n) decides that state y (respectively state n) occurs, meaning that treatment is valuable (respectively that treatment is valueless) for the client. At stage 2, the expert observes Nature's decision, and decides for each of the two states either not to participate in the expert-client relationship, to provide a treatment (T), or not to provide a treatment (NT). In order to provide a treatment, the expert must *at least* exert effort level e_L (where $e_L > 0$); not providing treatment automatically means providing zero effort. The effort level that the expert puts into treatment (T) in state i is denoted e_i^T, where $e_i^T \geq e_L$. For state n, it is assumed that it is always the case $e_n^T = e_L$. The rationale for letting the expert choose from a continuum of effort levels for valuable treatment, but from a single effort level when not providing treatment or when providing valueless treatment, will be explained below. The expert is modeled to fill in her effort decisions at a separate stage 3 *after* she has made her decision to provide treatment or not to provide treatment.

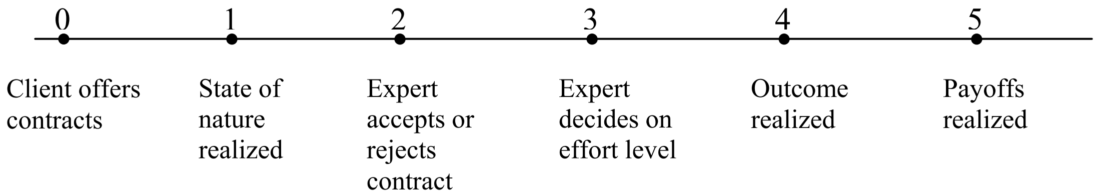

FIGURE 1.–Time line without renegotiation.

The client can observe whether or not the expert provides treatment, but cannot observe how much effort the expert puts into treatment/non-treatment. Put otherwise, the client can observe whether the expert exerts at least effort e_L, but not whether she exerts any effort beyond that.[5]

At stage 4, Nature determines whether the client obtains a successful outcome (case s) or a failed outcome (case f). The probability that these outcomes are obtained depends on the state $i \in \{y, n\}$ chosen by Nature and on the effort level $e \in \{0, e_i^T\}$ chosen by the expert, and is denoted as $\pi(k|e, i)$, where $k \in \{s, f\}$. The client observes whether success or failure is obtained, but does not observe whether this occurs in state y or in state n. If the expert provided a treatment (that is, if the expert was observed to at least provide effort level e_L), the client gives a payment $w(k, T)$ to the expert, with $k \in \{s, f\}$. If the expert did not provide treatment (effort level smaller than e_L), the client gives a payment $w(k, NT)$.[6] Note that these payments are determined by the choices made by the client at stage 0. If the expert decided not to participate in the expert-client relationship, no payments are made.

Finally, the client and the expert obtain their payoffs. For simplicity, the model abstracts from risk-sharing problems, and assumes that the expert and the client are both risk neutral. The client's payoff equals his outcome minus the payment made.

[5] The minimal treatment effort e_L is what Alger and Salanié (2004) refer to as a *fraud cost*. The expertise literature has only considered two extreme cases, namely one where there is a zero fraud cost (leading to the possibility of *overcharging*; for example Wolinsky [1993]; Taylor [1995]); and cases where the fraud cost is the full cost of providing treatment (leading to the possibility of *overtreatment*; for example Emons [1997]). Following Alger and Salanié, the model takes a middle-ground, in assuming an intermediate fraud cost.

[6] The payments are allowed to be negative. This is because one of the purposes of the analysis is to find cases where there is a rationale against contingent fees, and thereby a rationale for limited liability. It does not make sense then to impose an exogenous limited liability constraint.

His outcome is normalized to 1 in the case of success and to 0 in the case of failure. The expert's payoff equals the payment she receives minus her costs, where her costs are assumed to equal her effort level e itself.

Three features of this principal-agent model deserve special attention. *First*, the expert is assumed to observe the client's state at no cost. There is therefore no diagnostic hidden action problem. *Second*, the expert only decides whether to treat the client's case *after* having observed his state (*ex post contracts*).[7] This is assumed because experts are mostly observed only to make ex post commitments. The focus on ex post contracts then puts the emphasis on expert truth-telling rather than on expert diagnostic effort, and the assumption of zero diagnostic effort is taken for simplicity. *Third*, the menu of contracts that the client offers at stage 0 cannot be renegotiated at succeeding stages. This assumption will be relaxed in Section V.

When treatment is valuable (state y), it is assumed that the benefits to the client from expert effort only kick in when the expert exerts at least minimal treatment effort (e_L). For instance, a plaintiff will only benefit from the time that an attorney spends on his case if she spends at least the necessary time for filing a lawsuit. Moreover, a single effort level e^* (referred to as the first-best effort level) higher than the minimal treatment effort maximizes the expected payoff of a client who compensates the expert for her efforts (formalizing the fact that treatment is efficient, or "valuable" in state y). Formally:

$$\begin{gathered}\text{if } e < e_L \text{, then } \pi'(s|e,y) = 0\,; \\ \text{if } e \geq e_L \text{, then } \pi'(s|e,y) > 0 \text{ and } \pi''(s|e,y) < 0\,; \\ \text{there exists precisely one } e^* \text{ such that } \pi'(s|e^*,y) = 1\,, \end{gathered} \qquad (y)$$

where $\pi'(.)$ denotes the first derivative with respect to effort, and $\pi''(.)$ the second derivative, and where it should be noted that the expert's marginal cost is equal to 1. The effect of the assumption that $\pi'(s|e,y) = 0$ for $e < e_L$, together with the assumption about the client's information, is that an expert who does not provide valuable treatment prefers not to exert any effort.

When treatment is valueless (state n), it is assumed that the expert cannot contribute to the client's success. Formally:

$$\forall e : \pi'(s|e,n) = 0\,. \qquad (n)$$

Assumption (n) implies that $\pi(s|e,n)$ is constant, and we will write $\pi(s|n)$ in the rest of the paper. A further effect of assumption (n) is that the expert who provides valueless treatment always adopts the minimal treatment effort, or $e_n^T = e_L$, and that an expert who does not provide valueless treatment adopts a zero effort level. Finally, it should be noted that in an adverse-selection interpretation of the model, (y) and (n) together imply a *single-crossing property* (see below).

[7] If the expert could commit herself to participating before having observed the client's true state (*ex ante contracts*), there would not be any incentive problems in the case of risk-neutral parties (cf. Taylor [1995]), as the expert then becomes the residual claimant to the client's outcomes.

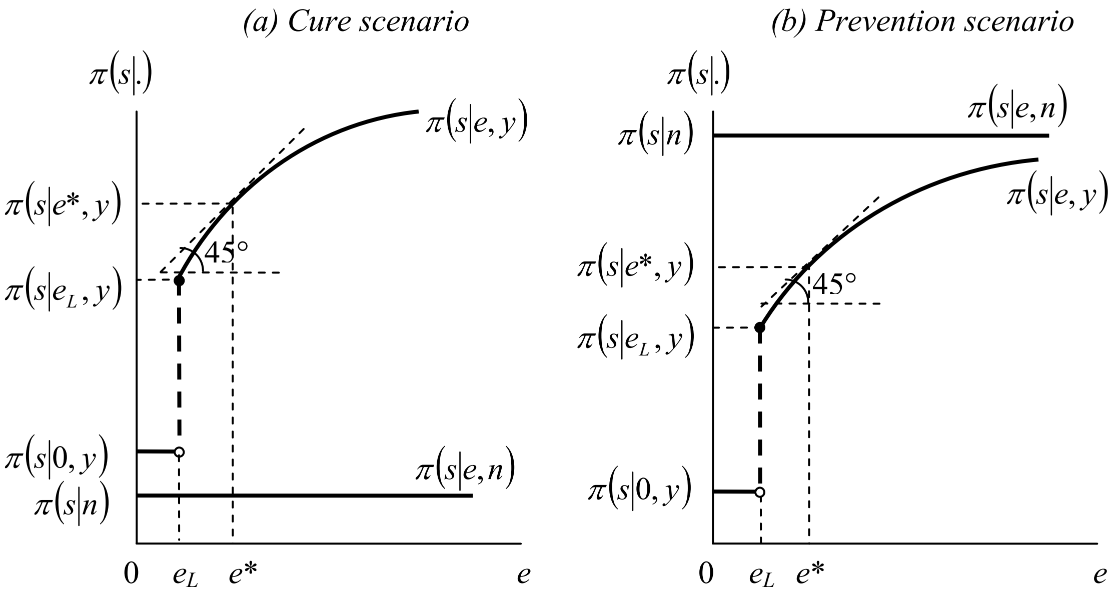

FIGURE 2.–Examples of cure and prevention scenarios.

The simple examples of Section II suggest that the form of the optimal contracts depends on how the success rates compare between states *u* and *n*. Let us maintain the dichotomy of a prevention and a cure scenario, where we now allow the possibility of success in the case that cure is valueless, and the possibility of failure in the case that prevention is valueless. These more general scenarios are referred to as the *generalized prevention scenario* and the *generalized cure scenario*. For the generalized prevention scenario, in terms of the example in Section II.B, the following is assumed. Suppose a patient needs a root canal treatment, and undergoes one. Then he is still more likely to suffer from a future toothache than in the case that he does not need any treatment. Intuitively, prevention never eliminates all risk. For the cure scenario, in terms of the example in Section II.A, suppose that winning is sufficiently likely to justify a lawsuit. Then the plaintiff will always be more likely to get a repair from his neighbor than in the case that winning is too unlikely to justify a lawsuit. Formally, it is either met that

$$\forall\, e:\ \pi(s|n) < \pi(s|e,y), \tag{GC}$$

or it is met that

$$\forall\, e:\ \pi(s|n) > \pi(s|e,y). \tag{GP}$$

In the adverse-selection interpretation of the model, (GC) and (GP) correspond to a standard *monotonicity constraint* (more on this below).[8] Two examples of success

[8] It can be shown that all the results of the cure scenario apply when $\forall\, e > 0:\ \pi(s|n) < \pi(s|e,y)$, and $\pi(s|n) = \pi(s|0,y)$. However, leaving this case out simplifies the proof.

rates as a function of effort in accordance with the (GC) and (GP) scenarios, and in accordance with assumptions (y) and (n), are represented in Figure 2.

The following short-hand notations are useful for formulating the principal-agent problem[9]:

$$\pi(s|n)w(s,NT)+[1-\pi(s|n)]w(f,NT)=M_n \tag{1}$$

$$\pi(s|e_y^T,y)w(s,T)+[1-\pi(s|e_y^T,y)]w(f,T)-e_y^T=M_y \tag{2}$$

$$[\pi(s|n)-\pi(s|e_y^T,y)][w(s,T)-w(f,T)]+[e_y^T-e_L]=IR_n^T \tag{3}$$

$$[\pi(s|0,y)-\pi(s|n)][w(s,NT)-w(f,NT)]=IR_y^{NT}, \tag{4}$$

where M_y (respectively M_n) is the expert's expected mark-up when providing effort level $e_y^T \geq e_L$ (respectively effort level 0) in state y (respectively state n); IR_y^{NT} (respectively IR_n^T) is the expert's *information rent* when providing no treatment (respectively treatment with minimal effort) in state y (respectively in state n). The information rent IR_y^{NT} is defined as the difference between the mark-ups of not providing treatment when it is valuable and when it is valueless; the information rent IR_n^T is defined as the difference between the mark-ups of providing treatment when it is valueless and when it is valuable.

These notations allow us to formulate the client's constrained maximization problem in a concise manner:

$$\max_{w,e_y^T} \pi_n\pi(s|n)+\pi_y[\pi(s|e_y^T,y)-e_y^T]-\pi_nM_n-\pi_yM_y \tag{MAX}$$

$$\text{s.t. } \pi'(s|e_y^T,y)[w(s,T)-w(f,T)]-1\leq 0 \tag{AC}$$

$$M_i \geq 0 \text{ for } i\in\{y,n\} \tag{PC$_i$}$$

$$M_n \geq M_y + IR_n^T \tag{IC$_n$}$$

$$M_y \geq M_n + IR_y^{NT} \tag{IC$_y$}$$

$$e_y^T \geq e_L, \tag{T}$$

where w in (MAX) denotes the different wages. Constraint (T) says that an expert who wants to receive the treatment payments $w(s,T)$ and $w(f,T)$ needs to exert at least minimal treatment effort. Action incentive constraint (AC) says that the effort level that maximizes the expert's expected payoff from providing valuable treatment either meets $e_y^T > e_L$ (constraint (AC) is met with equality), or meets $e_y^T = e_L$, (constraint (T) binding, left-hand side of constraint (AC) smaller than zero).[10] Note

[9] This approach follows Laffont and Martimort (2001), Chapter 2.

[10] If the left-hand side of (AC) is positive for $e_y^T \geq e_L$, then the expert will adopt a higher effort level. Constraint (AC) means that a first-order approach is adopted (see Rogerson [1985]). If (T) is slack, then the effort level $e_y^T > e_L$ for which (AC) is met with equality represents a maximum to the expert.

that assumption (n), and the part of assumption (y) saying that $\pi'(s|e,y)=0$ for $e<e_L$, save us from having to formulate three additional action incentive constraints. It can be shown that the results apply as long as zero effort is efficient in state n, and as long as effort $e^*>e_L$ is efficient in state y; however, as this more general setting involves formulating further action incentive constraints, the analysis is considerably more complex.

Participation constraint $(PC)_i$ says that an honest expert who observes state i should prefer to participate. Put otherwise, in state y, the expert should prefer providing treatment to opting out, where the effort put in treatment is determined by constraint (AC). The expert in state n should prefer not to provide any treatment to opting out. Informational incentive constraints $(IC)_n$ and $(IC)_y$ say that the expert should be honest, where intuitively a dishonest expert earns the mark-up offered for the other state, plus a (possibly negative) information rent. In state y, the informational incentive constraint again takes into account the effort decision determined by constraint (AC). The central proposition of this paper now follows.

Proposition 1

In the expert-client game, let the client set the payments once and for all at stage 0. For any optimal menu of contracts, it is met that the induced valuable treatment effort is not larger than the first-best effort ($e_y^T \le e^*$), and that the expert earns a zero mark-up on valuable treatment ($M_y = 0$). Moreover:

(i) In the *generalized cure scenario* (GC), the client induces the first-best effort ($e_y^T = e^*$). In any optimal contract, the expert earns a zero mark-up when not providing treatment $(M_n = 0)$, and the client offers fully-contingent treatment payments ($w(s,T)=\pi(f|e^*,y)+e^*$, $w(f,T)=-\pi(s|e^*,y)+e^*$, where $[w(s,T)-w(f,T)]=1$). The class of optimal contracts includes fixed zero payments for not providing treatment ($w(s,NT)=w(f,NT)=0$).

(ii) In the *generalized prevention scenario* (GP), the client induces lower effort than in the first best ($e_y^T < e^*$).

(a) Either the client finds it optimal to induce higher than minimal treatment effort $(e_y^T > e_L)$, in which case the expert earns a positive mark-up when not providing treatment ($M_n > 0$). All payments are contingent in this case ($w(s,T)>w(f,T)$, $w(s,NT)>w(f,NT)$), but the treatment contracts are not fully contingent ($[w(s,T)-w(f,T)]<1$).

(b) Or the client finds it optimal to induce minimal effort ($e_y^T = e_L$), in which case the expert earns a zero mark-up from not providing treatment ($M_n = 0$). The class of optimal payments includes fixed zero payments for not providing treatment ($w(s,NT)=w(f,NT)=0$), and fixed payments for treatment that exactly compensate the expert for her costs ($w(s,T)=w(f,T)=e_L$).

This is because the assumptions that $\pi''(s|e,y)<0$ (see (y)) and that the expert's costs equal her effort, and the fact that for $e_y^T > e_L$ it needs to be met that $[w(s,T)-w(f,T)]>0$, imply that the expert's second-order condition is met.

Proof:
See Appendix.

Proposition 1 confirms the intuitions of the simple examples in Section II. In the generalized cure scenario, a contingent fee yields the client the same expected payoff as he gets when he has the same information as the expert. In the generalized prevention scenario, the client puts up with lower effort than in the first best, and the degree of contingency of the treatment fee is reduced (where either higher than minimal treatment effort is induced and the expert receives a positive mark-up when she does not prescribe treatment, or minimal treatment effort is induced and the expert receives a zero mark-up).

The intuition for this result becomes clear by looking at the case where there is no hidden action problem ($e_L = e*$, and therefore $e_y^T = e*$). As pointed out by Dulleck and Kerschbamer (2006), in order to induce truth-telling, it suffices to apply the equal-mark up rule, and give the expert a risk-free zero mark-up for each of the states. However, given that the expert is risk neutral, depending on the scenario, there are also risky payments that induce truth-telling.

In particular, in the generalized cure scenario without hidden action ($\pi(s|e*,y) > \pi(s|n)$, $\pi(s|0,y) > \pi(s|n)$), it is clear from the expressions for the information rents (see (3) and (4)) that both information rents can be kept smaller than or equal to zero as long as $w(s,T) \geq w(f,T)$, $w(s,NT) \leq w(f,NT)$. These payments follow the Principle of Incentives for Expertise (Gromb and Martimort 2003), saying that the expert should be rewarded when her prediction is confirmed. Indeed, successful treatment confirms the expert's prediction of possible cure. Given then that one can put $w(s,T) > w(f,T)$ to induce truth-telling, adding a hidden action problem does not cause any additional complication.

When there is no hidden action problem ($e_L = e*, e_y^T = e*$) in the generalized prevention scenario ($\pi(s|e*,y) < \pi(s|n), \pi(s|0,y) < \pi(s|n)$), both information rents can be kept smaller than or equal to zero as long as $w(s,T) \leq w(f,T)$, $w(s,NT) \geq w(f,NT)$.[11] Indeed, successful non-treatment now confirms the expert's prediction that prevention was unnecessary, and failed treatment confirms the expert's prediction that prevention was necessary. Intuitively, it then follows that the client should not punish failed prevention too much, and should put up with lower effort than the first-best effort level.

Further insight into Proposition 1 can be gained by reinterpreting the hidden information part of the model as an adverse selection problem. *First*, this allows us to get a better understanding of the function of some of the assumptions underlying Proposition 1. In particular, assumptions (*y*) and (*n*) together boil down to a single-crossing property. It is easy to see that $\pi'(s|e,i)^{-1}$ with $i \in \{y,n\}$ is the expert's marginal cost corresponding to her cost function expressed as a function of the probability of success produced. Given assumptions (*y*) and (*n*), for any given effort, the slope of this cost function in one state is always larger than in the other. Moreover,

[11] Emons (2000) finds contingent fees to be inefficient in a case that fits the prevention scenario, because they lead to undertreatment. However, Emons considers the expert's prescription decisions for all the clients that she can treat given her capacity (see also Emons 1997). Unless the expert is then paid for observed effort, she may find it optimal to see as many clients as possible.

assumptions (GC) and (GP) boil down to a monotonicity constraint[12], as they ensure that the output (meaning the probability of success) is always higher in one state than in the other. The dichotomy between the cure and prevention scenarios thus naturally arises from a standard assumption in the adverse selection literature.

Second, the adverse-selection interpretation of the model increases insight into the role of information rents in the results. Specifically, the prevention scenario can be interpreted as a case where an expert can either produce success at high cost (prevention is necessary), or at low cost (prevention is unnecessary). The low-cost expert earns an information rent when pretending to have high costs, as she can produce success at a lower cost than the high-cost expert ($IR_n^T > 0$) (oppositely, the high-cost expert has no incentive to pretend to have low costs, or $IR_y^{NT} \leq 0$). In order for the expert to tell the truth, she should therefore receive a positive expected mark-up for exerting zero effort ($M_n > 0$). Moreover, this mark-up needs to be larger the higher the success rate induced, as the low-cost expert then has even more reason to pretend to have high costs. Because of the additional cost of this mark-up, the client will prefer to put up with a low success rate. Indeed, looking at (MAX), given that the mark-up for providing treatment can be kept equal to zero, the client faces a trade-off between efficiency and rent extraction.

Interpreted in this manner, the prevention scenario confirms the results of a standard principal-agent adverse selection model. However, a specific feature of the model is that the client can always fall back on the equal mark-up rule, and induce minimal preventive effort.[13] Indeed, as long as payments do not depend on output, there simply *is* no adverse selection problem in the model: the expert's costs of producing success only differ across the client's states if the client rewards success and failure differently. Put otherwise, there only is an adverse selection problem when the client tries to solve the hidden action problem. Moreover, as soon as the client tries to induce an effort level even the slightest bit larger than the minimal treatment effort, he needs to cross the hurdle of paying the expert a nonzero mark-up. The reason for this discontinuity is that, for every effort level induced the slightest bit larger than e_L, the client can no longer use the equal mark-up rule, but needs to pay a fee with a certain degree of contingency. An adverse selection problem then pops up, earning the expert a positive information rent. Thus, when finding that, for a certain effort level higher than the minimal treatment effort, the client's marginal benefit (marginal efficiency gain) is equal to his marginal cost (extra information rent, and therefore extra mark-up paid), one still needs to check whether the client's proceeds cover his fixed costs.

Concretely, given Proposition 1(ii)(a), using (MAX) and using (AC), the fixed cost of inducing higher than minimal treatment effort can be calculated to equal

$$\pi_n \left[\pi(s|n) - \pi(s|e_L, y)\right] \pi'(s|e_L, y)^{-1}. \qquad (5)$$

[12] See for example Laffont and Martimort (2001) pp.38-39.

[13] In a standard adverse selection problem, where the client does not observe the expert's effort at all but only observes the outcome, the client's alternative to paying an information rent is not to consult the expert at all, and this may be the optimum. Note that, in the current model, with the equal mark-up rule, as e_L approaches zero, we approach this solution, as inducing minimal effort then means inducing zero effort. Note as well that, if it is still optimal in this case for the client to induce positive effort, the expert picks the contracts *not* by either exerting or not exerting minimal treatment effort, but purely by choosing to be paid by one contract or the other.

It follows from (5) that this fixed cost is larger the more likely it is that prevention is unnecessary. It is also larger the higher the probability of success in the case that prevention is necessary compared to the case that prevention is unnecessary (where $[\pi(s|n)-\pi(s|e_L,y)]$ can be considered as a measure of the client's uncertainty about the expert's contribution to his successes). The fixed cost is larger the less the client is able to observe the expert's effort (the lower e_L). Finally, the fixed cost is larger the higher the marginal cost of increasing the success just above the success rate obtained with minimal treatment effort. From these results, it is clear that a strictly input-based payment may often be preferable to the client (solution given in Proposition 1(ii)(b)).

In the adverse-selection interpretation of the *cure* scenario, the costs of inducing success that the high-cost expert is facing are so high that no attempt should be made to increase the success rate (cure is valueless), while the low-cost expert faces costs that are low enough to justify increasing the success rate (cure is valuable). Because the high-cost expert should not produce extra success, and therefore can be given a zero payment, there is no incentive for the low-cost expert to pose as a high-cost expert this time. The optimal contract for the cure scenario is what Laffont and Martimort (2001) refer to as a contract with shut-down of the least efficient (= high-cost) type. Indeed, it is clear from Proposition 1(i) that the expert need not actually offer a menu of contracts, but that a single screening contract $w(s)=\pi(f|e^*,y)+e^*$, $w(f)=-\pi(s|e^*,y)+e^*$ suffices.[14] The extent to which the client can observe the expert's effort is therefore of no importance in this case. Put otherwise, even if the client can observe some of the client's input, it suffices here to reward the expert solely as a function of her output.

IV RENEGOTIATION

The results of Section III apply under the assumption that the client can commit himself to not renegotiating the contracts at stages succeeding stage 0. But this is unrealistic. Note first that the client of an attorney will observe beforehand whether the attorney is planning to go to court. Similarly, the physician who decides to provide treatment to a patient will first make an appointment with the patient. With a menu of contracts in place that induce truth-telling, the client's state y is therefore revealed to him after the expert has made her treatment decision stage 2, and before the expert makes her effort decision at stage 3. In order to maintain the contracts described in Proposition 1 as solutions, one needs to check whether a client who finds out that treatment is valuable does not prefer at stage 2' (see Figure 3) to offer a new contract; as long as this new treatment contract leaves the expert at least as well off as the old treatment contract, she will be willing to accept it at stage 2''. As shown in Proposition 2, when the client cannot commit himself to not renegotiating, the solution remains the same for the cure scenario, but changes for the prevention scenario.

[14] Dana and Spier (1993) obtain the same type of screening optimal contract in a model of litigation that fits the cure scenario, where there is hidden information but no hidden action. However, these authors do not point out that one can equally apply the equal mark-up rule in their model.

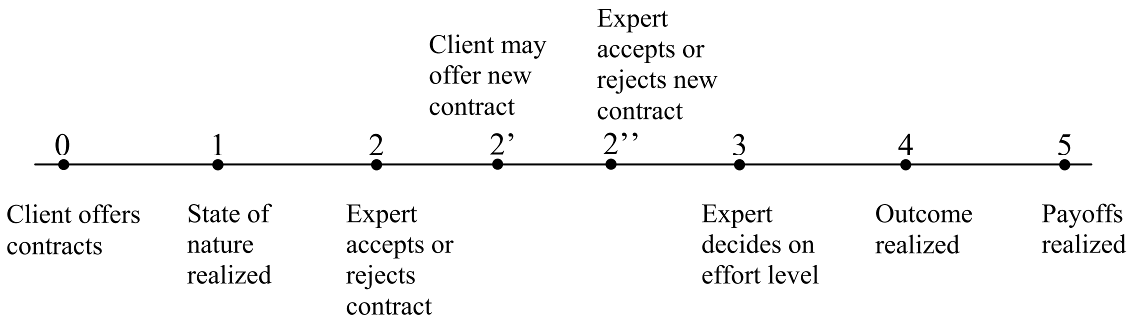

FIGURE 3.–Time line with renegotiation.

Proposition 2
In the expert-client game, let the client set the payments at stage 0, but let him be able to offer new contracts at stage 2'. Then the client either induces the first-best effort ($e_y^T = e^*$), and offers the expert a fully-contingent treatment contract ($w(s,T) = \pi(f|e^*, y) + e^*$, $w(f,T) = -\pi(s|e^*, y) + e^*$, where $[w(s,T) - w(f,T)] = 1$) that earns the expert a zero mark-up ($M_y = 0$), or the client does not buy any services from the expert. Concretely:

(i) in the *generalized cure scenario* (GC), the optimal contract is the same as in Proposition 1(i);

(ii) in the *generalized prevention scenario* (GP),

(a) either the client induces the first-best effort ($e_y^T = e^*$), but the expert earns a positive mark-up when not providing treatment ($M_n > 0$);

(b) or the client does buy any services from the expert.

This result is straightforward. Assume that, in the prevention scenario, the client has offered at stage 0 one of the menus of contracts described in (ii)(a) and (ii)(b) of Proposition 1, and that the expert believes that the client will not renegotiate these contracts. Then the expert is honest, and immediately after the expert's treatment decision (stage 2), the client finds out that his true state is *y*. At stage 2', it is now in his interest to offer a new, fully contingent treatment contract that still induces the first-best effort. From her side, at stage 2'', the expert has an incentive to accept such a contract given that her participation constraint continues to be met. Thus, the contracts specified in Proposition 1(ii) for the prevention scenario are not ex post Pareto efficient, and therefore not *renegotiation-proof* (Fudenberg and Tirole 1990).

But the expert will now anticipate that renegotiation will take place at stages 2' and 2'', and knows that eventually she will have to exert the first-best effort *e**. To induce her to tell the truth, at stage 0 the client will have to offer the expert an even higher mark-up for not providing treatment. The *only* contract that the client can therefore credibly offer at stage 0 is a third-best contract where the first-best effort *e** is still induced, but where a large mark-up for not providing treatment is paid. The client in this case may even find it optimal not to buy any preventive services from the expert, as the alternative of using the equal mark-up rule and of inducing minimal treatment effort is now no longer available.[15] If the degree of contingency that the treatment fee is allowed to have is not restricted, the provision of preventive services may therefore fail.

It is now in the interest of the client to have a commitment device at his disposal that limits the extent to which he can offer contingent fees. Legal and/or ethical restrictions on contingent fees may function as such a commitment device.[16] At the same time, Proposition 2 implies that restrictions on contingent fees should be lifted for cases that fit the cure scenario.

VI. DISCUSSION

It should be noted that the analysis is based on orthodox assumptions about the information possessed by the client and about the client's psychology, where client and expert have a common prior about the incidence of the states, and where the client is an expected utility maximizer. First, the model is based on the assumption that the client knows the probability that he needs and does not need treatment. Such an assumption may be justified by arguing that the client has learned these probabilities through experience. For the cure scenario, this is plausible. A client who believes that a cure exists when in fact it does not, will quickly realize his mistake when his predicament persists after he bought a treatment. But a client who continues to buy unnecessary treatments based on the belief that they prevent nonexistent future dangers will not learn about his mistake: the fact that he continues to buy the treatment precludes any learning.[17]

Second, the analysis is based on the assumption that clients care only about absolute outcomes, and not about changes in outcomes. For a client who cares about changes as well as about absolute levels, the cure scenario offers the possibility of an improvement, while the prevention scenario contains the danger of a loss (Kahneman and Tversky, 1979). A client who suffers from losses more than he benefits from equally-sized improvements may have a natural tendency to buy preventive services, even if it means putting up with a large information rent earned by the expert.

Third, the analysis is based on the assumption that the client is always better off when finding out his true state. However, in the prevention scenario, a client who faces the possibility of a future loss may not only suffer from this loss at the time it occurs, but may already suffer now from the anxiety of anticipating the loss (Közsegi 2006). It may then be in the interest of the client not to find out about the possibilities of a future danger. In the cure scenario, on the contrary, the client may benefit from a future gain not only in the future, but also now, by the happiness of anticipating it. The client in this situation may on the contrary have more reason to learn his true

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[15] Given that it is no longer possible to induce minimal effort and forego paying a positive mark-up, one now has a standard adverse selection model. Indeed, the results obtained in this section confirm Laffont & Martimort's (2001, p.63) treatment of adverse selection with renegotiation.

[16] In a standard moral-hazard problem, there is a trade-off between insurance and efficiency that leads to underprovision of insurance by the principal. After the risk-averse agent has exerted effort (stage 3), and before the outcomes have materialized (stage 4), the principal has an incentive to renegotiate and still provide full insurance to the agent, which ex ante takes away the agent's incentive to provide effort. Contrary to what is the case in the model in this paper, restrictions on the use of *fixed* fees are then necessary.

[17] The fact that the expertise literature has so far paid little attention to client learning has been pointed out by Shaked (1995).

state. How client learning, loss aversion, and loss anticipation affect the results in this paper is an interesting avenue for future research.

APPENDIX

The Lagrangian of the constrained maximization problem is:

$$\begin{aligned}\max_{w,e_y^T} & \pi_n \pi(s|n) + \pi_y \left[\pi(s|e_y^T, y) - e_y^T\right] - \pi_n M_n - \pi_y M_y + \\ & \mu\{\pi'(s|e_y^T, y)[w(s,T) - w(f,T)] - 1\} + \lambda_n M_n + \lambda_y M_y + , \\ & \gamma_n\left(M_n - M_y - IR_n^T\right) + \gamma_y\left(M_y - M_n - IR_y^{NT}\right) - \delta\left[e_y^T - e_L\right]\end{aligned} \quad \text{(A1)}$$

where μ is the Lagrangian multiplier belonging to (AC), λ_n (respectively λ_y) belongs to (PC)$_n$ (respectively (PC)$_y$), γ_n (respectively γ_y) belongs to (IC)$_n$ (respectively (IC)$_y$), and δ belongs to (*T*). A negative sign is written in front of the multiplier for (*T*) because intuitively, the client will be better off the higher the minimal treatment effort that he is able to observe, in which case $\delta \geq 0$.

The first-order conditions of (A1) are now

$$(\lambda_n + \gamma_n - \pi_n)\pi(x|n) - \gamma_y \pi(x|0, y) = 0 \text{ with } x \in \{s, f\} \quad \text{(A2)}_x$$

$$\mu\pi'(x|e_y^T, y) + (\lambda_y + \gamma_y - \pi_y)\pi(x|e_y^T, y) - \gamma_n \pi(x|n) = 0 \text{ with } x \in \{s, f\} \quad \text{(A3)}_x$$

$$\begin{aligned}\pi_y \pi'(s|e_y^T, y)\{1 - [w(s,T) - w(f,T)]\} + (\lambda_y + \gamma_y)\{\pi'(s|e_y^T, y)[w(s,T) - w(f,T)] - 1\} + \\ \mu\pi''(s|e_y^T, y)[w(s,T) - w(f,T)] - \delta = 0,\end{aligned} \quad \text{(A4)}$$

where constraints (A2) and (A3) are labeled according to the value taken on by *x*.

The proof is structured as follows. Step 1 shows that $\gamma_y = 0$. Step 2 shows part (i) of Proposition 1. Step 3 shows that $e_y^T < e^*$ in the case (GP). Step 4 shows part (ii)(a) of Proposition 1. Step 5 shows part (ii)(b) of Proposition 1.

Step 1: $\gamma_y = 0$.

Adding (A2)$_s$ to (A2)$_f$, and (A3)$_s$ to (A3)$_f$,, one obtains

$$(\lambda_i + \gamma_i - \pi_i) - \gamma_j = 0 \text{ for } i, j \in \{y, n\},\ i \neq j, \quad \text{(A5)}_i$$

where (A5) is labeled according to the value taken on by *i*. Using (A5)$_n$ to substitute for $(\lambda_n + \gamma_n)$ in (A2)$_s$, one obtains that $\gamma_y[\pi(s|n) - \pi(s|0, y)] = 0$. By (GC) and (GP), it is the case that $\pi(s|n) \neq \pi(s|0, y)$. It follows that $\gamma_y = 0$.

Step 2: If (GC), then $e_y^T = e^*$, $M_y = M_n = 0$, $w(s,T) = \pi(f|e^*, y) + e^*$, $w(f,T) = -\pi(s|e^*, y) + e^*$, where $[w(s,T) - w(f,T)] = 1$. The class of optimal contracts includes contracts with payments $w(s, NT) = w(f, NT) = 0$.

Consider a potential solution with $e_y^T > e_L$. Then (AC) should be met with equality, meaning that

$$[w(s,T) - w(f,T)] = \pi'(s|e_y^T, y)^{-1}. \quad \text{(A6)}$$

Plugging (A6) into (3), one obtains that

$$IR_n^T = [\pi(s|n) - \pi(s|e_y^T, y)]\pi'(s|e_y^T, y)^{-1} + [e_y^T - e_L]. \quad \text{(A7)}$$

It is easy to check now that, given (GC), it follows that $IR_n^T < 0$ for $e_y^T = e_L$, and $\frac{\partial IR_n^T}{\partial e_y^T} < 0$ for $e_y^T \geq e_L$. Moreover, $IR_y^{NT} = 0$ for $w(s,NT) = w(f,NT) = 0$ (see (4)). It follows that, in the case (GC), it is possible to have $M_n = M_y = 0$ for any e_y^T with $e_y^T > e_L$. This includes the case $e_y^T = e^*$. As inducing the first-best effort level yields the client the same expected utility as when he has the same information as the expert, this is necessarily the global maximum for the case (GC).

Step 3: If (GP), then $e_y^T < e^*$.

It suffices here to show that, *if* a solution with $e_y^T > e_L$ exists in the case (GP), then it must be met that $e_y^T < e^*$. We start by showing that $\mu > 0$ for any solution with $e_y^T > e_L$ in the case (GP). Equation (A7) again denotes IR_n^T for $e_y^T > e_L$. It is easy to check that, given (GP), we have $IR_n^T > 0$. By $IR_n^T > 0$, and by (PC)$_y$ and (IC)$_n$, it follows that $M_n > 0$ and $\lambda_n = 0$. By $\lambda_n = 0$ and by $\gamma_y = 0$ (Step 1), it follows from (A5)$_n$ that $\gamma_n = \pi_n$. By $\gamma_n = \pi_n$ and by $\gamma_y = 0$ (Step 1), it follows from (A5)$_y$ that $\lambda_y = 1$. Plugging $\lambda_y = 1$, $\gamma_y = 0$ and $\gamma_n = \pi_n$ into (A3)$_s$, one obtains that

$$\mu = \pi_n [\pi(s|n) - \pi(s|e_y^T, y)]\pi'(s|e_y^T, y)^{-1}. \quad \text{(A8)}$$

Case (GP) implies that $[\pi(s|n) - \pi(s|e_y^T, y)]$ in (A8) is larger than zero. It follows from (A8) that $\mu > 0$.

We now go on to show that $e_y^T < e^*$. Given that $\lambda_y = 1$ (see above), given that $\gamma_y = 0$ (Step 1), and given that $\delta = 0$ ((AC) binds and (*T*) is slack)), (A4) now becomes

$$\pi_y \pi'(s|e,y)\{1 - [w(s,T) - w(f,T)]\} + \mu\pi''(s|e,y)[w(s,T) - w(f,T)] = 0. \quad \text{(A9)}$$

Given that we are treating a potential solution where $e_y^T > e_L$, we have $w(s,T) > w(f,T)$. Given that $\mu > 0$, $\pi''(s|e,y) < 0$ (see (*y*)) and $w(s,T) > w(f,T)$, it follows that the second term of (A9) is smaller than zero. This implies that the first term of (A9) must be positive, meaning that $1 > [w(s,T) - w(f,T)]$. By action constraint (AC) and by assumption (*y*), it follows from $1 > [w(s,T) - w(f,T)]$ that $e_y^T < e*$.

Step 4: Consider the case (GP). Denote $[1] = \pi_y [\pi'(s|e_y^T, y) - 1]$, and $[2] = \pi_n [\pi(s|n) - \pi(s|e_y^T, y)] \pi'(s|e_y^T, y)^{-2} |\pi''(s|e_y^T, y)|$. If an e_y^T exists with $e_y^T > e_L$ such that $[1] = [2]$, then a local maximum exists with $e_L < e_y^T < e*$, $M_n = IR_n^T > 0$, $M_y = 0$, $IR_y^{NT} < 0$, $w(s,T) > w(f,T)$ (where $[w(s,T) - w(f,T)] < 1$), $w(s,NT) > w(f,NT)$.

Let us focus on the parts of Step 4 that were not already shown in Step 3. Given that, by Step 3, it is met that $\lambda_y = 1$, it follows that $M_y = 0$. By $M_y = 0$, and by $\gamma_n > 0$ (see Step 3), it follows from (IC)$_n$ that $M_n = IR_n^T$. By $M_y = 0$, and by $M_n > 0$ (see Step 3), it follows from (IC)$_y$ that $IR_y^{NT} < 0$. Expression (4), $IR_y^{NT} < 0$ and (GP) imply that $w(s,NT) > w(f,NT)$.

Let us now derive the conditions for which a local maximum exists such that $e_y^T > e_L$. Reworking (A9), one obtains

$$\mu = \pi_y \pi'(s|e_y^T, y)\{1 - [w(s,T) - w(f,T)]\} \left| \pi''(s|e_y^T, y)[w(s,T) - w(f,T)] \right|^{-1}. \text{(A10)}$$

Substituting (A6) into (A9) and (A10), and equalizing (A9) and (A10), it follows that a solution with $e_y^T > e_L$ only exists if it is met for this e_y^T that $[1] = [2]$. The implied condition $[1] - [2] = 0$ is nothing but the first derivative of (MAX) with respect to e_y^T, putting $M_y = 0$ and $M_n = IR_n^T$, and using (AC). This shows that the client's maximization problem in this candidate solution takes the form of a trade-off between efficiency and rent extraction. Expression [1] is the marginal efficiency gain from increased effort, expression [2] is the marginal cost of extracting less information rent. By Step 3 and by (*y*), it follows that $[1] > 0$, where it should be noted that [1] approaches zero as e_y^T approaches *e**. In the case (GP), we have $[2] > 0$. This leaves out the following possible cases.

1. If there exists an $e_y^T = e'$ with $e_L < e' < e*$ such that $[1] = [2]$, and if $\frac{\partial\{[1] - [2]\}}{\partial e} \leq 0$, then e' forms a local maximum.
2. If there exists an $e_y^T = e''$ with $e_L < e'' < e*$ such that $[1] = [2]$, and if $\frac{\partial\{[1] - [2]\}}{\partial e} > 0$, then e'' forms a local *minimum*. However, by definition, for $e_y^T > e''$, it is met that $[1] - [2] > 0$. Moreover, by (AC), it is met that $\lim_{e \to e*}[1] = 0$, which together with the fact that $[2] > 0$ implies that $\lim_{e \to e*}\{[1] - [2]\} < 0$. It follows

that, if a local minimum exists at e'', there is also a local maximum at some e' as described in 1., where $e' > e''$.

3. If for all e_y^T with $e_L < e_y^T < e*$, it is met that $[1] < [2]$, then a local maximum which we now go on to describe (Step 5) is the global maximum.

Step 5: If (GP), then a solution with $e_y^T = e_L$, $w(s,T) = w(f,T) = e_L$, $w(s,NT) = w(f,NT) = 0$ is a local maximum, and can be a global maximum.

Given that $e_y^T = e_L$, it follows that $\mu = 0$. Given that $\mu = 0$, and given that by (A5)$_y$, it is met that $(\lambda_y + \gamma_y - \pi_y) = \gamma_n$, it follows from (A3)$_x$ that $\gamma_n = 0$. Plugging $\gamma_n = 0$ and $\gamma_y = 0$ (see Step 1) into (A5)$_y$ and (A5)$_n$, we obtain $\lambda_n = \pi_n$ and $\lambda_y = \pi_y$. Plugging $\gamma_y = 0$, $\lambda_y = \pi_y$ and $\mu = 0$ into (A4), we obtain $\delta = \pi_y [\pi'(1|e_y^T, y) - 1]$. It can be checked that the above payments are in line with these values of the Lagrange multipliers. The fact that this solution can be a global maximum follows from case 3. in Step 4.

Q.E.D.

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