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On Doctors, Mechanics and Computer Specialists
Or
Where are the Problems with Credence Goods

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On Doctors, Mechanics and Computer Specialists
Or
Where are the Problems with Credence Goods?*

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Abstract

With credence goods consumers cannot judge the quality they receive compared to the quality they need. The needed quality can only be observed by an expert seller who may exploit the information asymmetry by cheating. In recent years various contributions have analyzed the credence goods problem under a wide variety of assumptions yielding equilibria exhibiting various degrees of inefficiencies and fraud. The variety of results has fostered the impression that the equilibrium behavior of experts and consumers in the credence goods market sensitively depends on the details of the models. More disturbingly, apparently similar models often lead to contradicting results. The

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present paper shows that the results for the majority of the specific models can be reproduced in a very simple unifying framework. Our model is constructed so that an efficient solution is reached if a small number of critical assumptions is satisfied, and virtually all existing results on inefficiencies in the credence good market are obtained by relaxing one of these conditions. Thus, our simple unifying model not only permits a clearer discrimination between situations in which market institutions solve the fraudulent expert problem without any cost and those where they do not; it also helps to identify the forces driving the various inefficiency results in the literature. Existing results are generalized, some previous interpretations of the forces leading to the striking differences in outcomes are questioned, and a new source for inefficiencies is identified.

JEL Classifications: L15, D82, D40

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1 Introduction

Credence goods have the characteristic that, even when consumers can observe the utility they derive from the good *ex post,* they cannot judge whether the quality they received is the *ex ante* needed one. Moreover, depending on the concrete example, consumers may also be unable to observe which quality they received. An expert seller, on the other hand, is able to identify the quality that fits customers' needs by performing a diagnosis. He can then provide the right quality and charge for it, or he can exploit the information asymmetry by defrauding customers. Darby and Karni (1973) added this type of goods to Nelson's (1970) classification in ordinary, search and experience goods. Darby and Karni mention provision of repair services, execution of taxicab rides and removal of appendixes as typical examples.

The credence goods problem gave rise to a number of contributions which, taken together, yield no general picture regarding the inefficiencies arising from the information asymmetry; rather, the results seem to depend sensitively on the specific assumptions of the models. More disturbingly, apparently similar models often lead to contradicting results.

The present paper provides a very simple model of credence goods. The model is constructed so that an efficient solution is reached if a small number of critical assumptions is satisfied, and virtually all existing results on inefficiencies in the credence good market are obtained by relaxing one of these conditions. Thus, the analysis of our simple model not only permits a clearer discrimination between situations in which market institutions solve the fraudulent expert problem without any cost and those where they do not; it also helps to identify the forces driving the various inefficiency results in the literature. Existing results are generalized, some previous interpretations of the forces leading to the striking differences in outcomes are questioned, and a new source for inefficiencies is identified.

The assumptions made in the existing literature on credence goods vary along several dimensions: The analyzed market conditions range from experts having some degree of market power (Pitchik and Schotter 1987, Emons 1999) to competitive frameworks (Wolinsky 1993 and 1995, Taylor 1995, Glazer and McGuire 1996, Emons 1997). Also, some authors consider models where the right treatment fixes the problem for sure (Pitchik and Schotter 1987, Wolinsky 1993 and 1995, Taylor 1995), others focus on frameworks where success is a stochastic function of service input (Darby and Karni 1973, Glazer and McGuire 1996, Emons 1997 and 1999). Some authors assume that experts can serve arbitrarily many customers at in quantity constant (Wolinsky 1993 and 1995, Taylor 1995, Glazer and McGuire 1996) or increasing (Darby and Karni 1973) marginal cost, in other contributions experts are capacity constrained (Emons 1997 and 1999). In some contributions experts are able to post take-it-or-leave-it prices (Wolinsky 1993, Taylor 1995, Glazer and McGuire 1996, Emons 1997 and 1999), in others prices are determined in a bilateral bargaining process (Wolinsky 1995), still others consider models where prices are exogenously given (Darby and Karni 1973, Pitchik and Schotter 1987).

Finally, there is another important dimension in which the articles differ. Without exception all contributions to the credence good literature implicitly or explicitly impose one of the following two conditions (but never both): Either the type of treatment (the quality of the good) is assumed to be verifiable (Darby and Karni 1973, Emons 1997 and 1999), or a liability rule is assumed to be in effect protecting consumers from obtaining an inappropriate inexpensive treatment (Pitchik and Schotter 1987, Wolinsky 1993 and 1995, Taylor 1995). We refer to the former condition as the verifiability, to the latter as the liability assumption. Which of these two conditions is implicitly or explicitly imposed, unambiguously determines the problem on which the respective author(s) focus(es).

Two problems have been the focus of research in the credence goods literature: Provision of an inefficient treatment (of a wrong quality), and charging for a more expensive treatment (for a higher quality) than provided.

The first problem can be of two types. On the one hand, it is inefficient if a consumer receives a cheap treatment, when he actually needs an expensive one. We label this inefficiency as undertreatment; it is ruled out under the liability assumption. On the other hand, it is inefficient if a consumer receives an expensive treatment when a cheap one would be enough to solve his problem. This inefficiency is labelled overtreatment; it cannot be ruled out (by law) since it is never detected.

The second potential problem is that an expert might claim to have supplied an expensive treatment (a high quality) even if he has only provided a cheap one (a low quality).[1] We label this kind of fraud as overcharging.

[1] There are, of course, a number of other potential problems (and therewith a number of other sources for fraud) in the credence goods market. For example, experts may differ in their ability to perform a diagnosis or a treatment, and this ability may be their own private information. Or, the effort bestowed by an expert in the diagnosis stage may be unobservable. We ignore these problems here, not because we regard them as less

Overcharging is ruled out under the verifiability assumption.

If the cost of treatment is increasing in quality - an assumption typically made in the credence goods literature - then overcharging is strictly more profitable than overtreatment. So overtreatment can only be a problem if overcharging is impossible because the quality of treatment is verifiable. Emons (1997 and 1999) explicitly impose the verifiability assumption and study the problems of over- and undertreatment. Pitchik and Schotter (1987) and Wolinsky (1993 and 1995) analyze experts' temptation to overcharge customers, implicitly assuming the liability assumption to hold and verifiability to be violated. Taylor (1995) imposes these assumptions explicitly. And in Darby and Karni (1983) the implicit assumption regarding verifiability varies according to whether capacity exceeds demand or *vice versa*. For the former case they analyze experts' incentive to overtreat customers, implicitly assuming verifiability to hold. For the latter case they discuss the incentive to charge for treatments not provided, implicitly assuming verifiability to be violated.

Given the wide variety in the analyzed problems it is not surprising that the proposed solutions exhibit a broad range of different equilibrium behavior: There are pure strategy equilibria in which experts overtreat consumers (Darby and Karni 1973), and pure strategy equilibria in which the credence goods information asymmetry gives rise to excessive search and diagnosis costs (Wolinsky 1993, Glazer and McGuire 1996). There are mixed strategy equilibria where the market outcome involves fraud in the form of overcharging of consumers (Pitchik and Schotter 1987, and Wolinsky 1995). And there are also equilibria where the only inefficiencies in the credence goods market are experts' inefficient capacity levels (Emons 1997). Thus, for the non-expert reader the overall picture is rather blurred, i.e., it is fairly difficult to judge which set of conditions drives the presented results.

And even the experts (on experts) have difficulties in identifying the critical assumptions that lead to the striking diversity of results. Emons (2001), for instance, attributes the main difference between his own work and the papers by Pitchik and Schotter (1987) and Wolinsky (1993) to the fact that "they all (implicitly) assume unnecessary repairs to be costless

important, but rather because they seem to be less specific to the credence goods market. For an analysis of a situation where effort is needed to diagnose the customer and where an expert's effort investment is unobservable see Pesendorfer and Wolinsky (1999). This contribution focuses on the external effect an additional diagnosis (by a different expert) has on the consumer's evaluation of a given expert's effort.

whereas our expert needs resources for unnecessary treatments. This implies that overtreatment is always profitable in their set-up. In contrast, the profitability of overtreatment in our model depends on demand conditions and is determined endogenously" (p. 378 f.). Closer inspection of the payoff structures reveals that other differences are more important. First, Pitchik and Schotter (1987) and Wolinsky (1993) implicitly assume verifiability to be violated and liability to hold whereas Emons (2001) considers the opposite constellation. Thus, the former papers focus on the problem of overcharging while the latter studies experts' incentive to over- or undertreat customers. Secondly, Pitchik and Schotter (1987) and Wolinsky (1993) assume that the efficiency loss of diagnosing a consumer more than once is rather low (low economies of scope between diagnosis and treatment) while Emons (2001) assumes this loss to be high (profound economies of scope between diagnosis and treatment).

The simple model of credence goods provided in the present paper shows that differences in a small number of critical assumptions explain the striking diversity of results. The analysis of our framework not only helps to identify the forces driving the various inefficiency results in the literature; it also permits a clearer discrimination between situations in which market institutions solve the fraudulent expert problem without any cost and those where they do not. First we present conditions leading to an efficient solution for the credence goods problem regardless of all other parameters. Then we show that virtually all existing results on inefficiencies in the credence goods market can be obtained by relaxing one of these conditions. The conditions leading to an efficient solution are (i) that there exist large economies of scope between diagnosis and treatment, (ii) that either the verifiability or the liability assumption holds, or both, and (iii) that expert sellers face homogeneous customers.

Ad (i) Economies of scope between diagnosis and treatment are often seen as a constituent feature of credence goods since they make separate provision of these services by independent experts unattractive. The magnitude of these economies depends upon the good or service considered. Clearly, the assumption of large economies of scope is more plausible in environments where repair is quasi a by-product of diagnosis and where a repair expert who learns the diagnosis from a diagnosis expert does not gain much because the recommendation does not reveal anything that would not have been revealed during the repair process anyway. For example, in surgery and in complicated repairs this assumption is appropriate[2], whereas for simple repairs and prescription and preparation of drugs it is not. Profound economies of scope between diagnosis and treatment have the effect that customer and expert are tied together once the diagnosis is made.

Ad (ii) The assumption that the type of treatment is verifiable is more plausible in environments where the customer is physically and mentally present during the treatment than for the alternative case where he is not.[3] For example, for dental services and minor car- or appliance-repairs this assumption is likely to be appropriate, whereas for more sophisticated repairs (where the customer is unlikely to wait for the repair to be performed in his sight) and surgery (where the patient is often in a coma during the treatment) it is not. Whereas for the verifiability assumption to hold the type of treatment has to be verifiable, for liability we need verifiability of results. Thus, liability rules are more likely to be in force for repair services than for medical treatments where the result is often very subjective, i.e. only observed by the patient.[4]

Ad (iii) That consumers are homogeneous is a standard assumption in the formal literature on credence goods.[5] This assumption is obviously unrealistic and the present paper shows that inefficiencies that have not yet been discussed in the literature may emerge if this assumption is violated.

We shall show that equilibria involving overcharging of customers, or duplication of search and diagnosis costs may result if condition (i) is violated, that inefficient rationing and inefficient treatment of some consumer groups may arise if condition (iii) fails to hold, and that the credence goods market

[2]As Darby and Karni (1973, FN 2) have put it, "..it is easier to repair any damage while the transmission or belly is open to see what is wrong, than to put everything back together and go elsewhere to repeat the process for the actual repair."

[3]There are, of course, exceptions to this rule. For instance, a customer is likely to be able to verify whether the muffler of his car has been replaced or only repaired even if he has taken the car to the mechanic in the morning and picked it up in the evening. For repairs concerning interior parts, on the other hand, the rule seems to apply: The customer is able to evaluate only the result, but not the typ of treatment, if he was not physically present during the repair process.

[4]An alternative to a general liability rule (introduced by law) is a warranty (drawn up by the expert) in which the expert promises to pay the customer a sufficiently large amount of money if the treatment fails. As for the liability rule, verifiability of results is required to enforce the rule.

[5]To our best knowledge the only contribution with heterogeneous consumers is the more verbal paper by Darby and Karni (1973).

may break down altogether if condition (ii) doesn't hold.

The rest of the paper is organized as follows. The next section introduces the model. In Section 3 we show that market institutions solve the fraudulent expert problem at no cost when conditions (i), (ii) and (iii) hold. In the subsequent section we characterize the inefficiencies that arise if at least one of these conditions is violated. Section 5 concludes. Some proofs are relegated to the Appendix.

2 A Basic Model of Credence Goods

In this section, we first introduce a simple model of credence goods, characterized by their quality (or cost) and the utility they generate for customers. Then we specify the market for these goods.

With credence goods, even when customers can observe the utility they derive from the good *ex post,* they cannot tell whether the quality of the good or service they received is the *ex ante* needed one. Furthermore, depending on the concrete framework, consumers may also be unable to observe which quality they actually received. Thus, with credence goods customers need to trust expert sellers. To refer to examples, consider personal computers. An expert seller can help to find the right quality that fits customers' needs. A customer will not be able to tell whenever he received a too high quality. Only an inappropriate low quality is detected. Similarly, a car with a new muffler will work as well as with the repair of the old muffler when a repair would have been sufficient. The customer cannot tell whether the new part was really needed. The same problem arises when seeing a doctor: As long as the patient feels as healthy as he thinks it was possible, he cannot tell whether he was treated correctly or was overtreated. As in the other examples, customers are only able to detect too little treatment.

To model this situation, we assume that a customer (he) has either a (minor) problem requiring a cheap treatment $\underline{c}$, or a (major) problem requiring an expensive treatment $\overline{c}$.[6] The customer knows that he has a problem, but does not know how severe it is. He only knows that he has an *ex ante* probability of h that he has the major problem and a probability of $(1-h)$ that he has the minor one. An expert (she), on the other hand, is able to detect

[6] Our main results can also be obtained in an extended model that allows for more than two types of problem and more than two types of treatment. However, since our goal is to provide a *simple* unifying framework, we stick to a binary model.

Customer's utility		Customer needs	
		$\underline{c}$	$\overline{c}$
Customer gets	$\underline{c}$	v	0
	$\overline{c}$	v	v

Table 1: Utility from a Credence Good

the severity of the problem by performing a diagnosis. She can then provide the appropriate treatment. The cost of the expensive treatment is $\overline{c}$ and the cost of the cheap treatment is $\underline{c}$, with $\overline{c} > \underline{c}$.[7] The expensive treatment fixes either problem while the cheap one is only good for the minor one.

Table 1 represents the gross utility of a consumer given the type of treatment he needs and the type he gets. If the type of treatment is sufficient, a consumer gets utility v. Otherwise he gets 0. The credence good characteristic stems from the fact that the customer is satisfied in three out of four cases. In general, he is satisfied whenever he gets a treatment quality at least as good as the needed one. Only in one case, where he has the major problem but gets the cheap treatment, he will discover *ex post* what he needed and what he got.

As mentioned before, the focus of the credence goods literature has been twofold: inefficient treatment, either under- or overtreatment, and overcharging. The inefficiency of treatment can be described by referring to Table 1. The case of undertreatment is the upper right corner of the table, the case of overtreatment is the lower left corner. Note that overtreatment is not detected by the customer ($v = v$) and hence cannot be ruled out by institutional arrangements. This is not the case with undertreatment; it is detected ($0 < v$) and we refer to institutional arrangements that make an expert liable for the provision of inappropriate low quality as a case where the liability assumption (Assumption L) holds.

Assumption L (Liability) *An expert cannot provide the cheap treatment $\underline{c}$ if the expensive treatment $\overline{c}$ is needed.*

Referring again to Table 1, the second potential problem is that the customer might never receive a signal that discriminates between the upper left

[7] For convenience, both the type of treatment and the associated cost is denoted by c.

and the lower right cell of the table. If this is the case, an expert who discovers that the customer has the minor problem can diagnose the major one so that the customer might authorize and pay her the expensive treatment although she provides only the cheap one. This overcharging is ruled out if the customer is able to observe and verify the delivered quality (he knows and can prove whether he is in the top or the bottom row of the table), and we refer to situations in which consumers have this ability as cases where the verifiability assumption (Assumption V) holds.[8] In the introduction we classified the contributions that assume verifiability and others that assume liability.

Assumption V (Verifiability) *An expert cannot charge for the expensive treatment $\overline{c}$ if she has provided the cheap treatment $\underline{c}$.*

Let us now describe the market environment. There is a finite population of $n \geq 1$ identical risk-neutral experts in the credence goods market. Each expert can serve arbitrarily many customers. The experts simultaneously post take-it-or-leave-it prices. Let $\overline{p}^i$ denote the price posted by expert $i \epsilon \{1, ..., n\}$ for the expensive treatment $\overline{c}$, and $\underline{p}^i$ the price posted for the cheap treatment $\underline{c}$. An expert's profit is the sum of revenues minus costs over the customers she treated. By assumption, an expert provides the appropriate treatment if she is indifferent between providing the appropriate and providing the wrong treatment, and this fact is common knowledge among all players.

There is a finite population of $m \geq 1$ risk-neutral consumers in the market. Each consumer incurs a diagnosis cost d per expert he visits independently of whether he is actually treated or not.[9] That is, a consumer who resorts to r experts for consultation bears a total diagnosis cost of rd. The net payoff of a consumer who has been treated by an expert is his gross valuation as depicted in Table 1 minus the price paid for the treatment minus total diagnosis cost. The payoff of a consumer who has not been treated is his reservation payoff, which we normalize to equal zero, minus total diagnosis cost.[10] By assumption, it is always (i.e., even *ex post*) efficient that a

[8] An undercharging incentive only exists if the price of the expensive treatment is such that customers reject a $\overline{c}$ recommendation, and if the price of the cheap treatment exceeds the cost of the expensive one. Such price combinations are not observed in equilibrium.

[9] Provision of treatment without diagnosis is assumed to be impossible. The diagnosis cost d is assumed to include the time and effort cost incurred by the consumer in visiting a doctor, taking the car to a mechanic, etc. It is also assumed to include a fair diagnosis fee paid to the expert to cover her opportunity cost.

[10] Here, the implicit assumption is that the outside option is not to be treated at all.

consumer is treated when he has a problem. That is, $v - \overline{c} - d > 0$. Also, by assumption, if a consumer is indifferent between visiting an expert and not visiting an expert, he decides for a visit, and if a customer who decides for a visit is indifferent between two or more experts he randomizes (with equal probability) among them.

Consumers may differ in their "risk" h of having the major problem and in their gross valuation v. Following the rest of the literature on credence goods we assume in Section 3 that customers are identical. We refer to this as the homogeneity assumption (Assumption H).

Assumption H (Homogeneity) *All consumers have the same probability h of having the major problem, and the same valuation v.*

Regarding the magnitude of economies of scope between diagnosis and treatment there are two different scenarios to consider. If these economies are small, separation of diagnosis and treatment or consultation of several experts may become attractive. With profound economies of scope, on the other hand, expert and customer are in effect tied together once the diagnosis is agreed upon. In Section 4 we take the diagnosis cost d as measure for the magnitude of economies of scope between diagnosis and treatment[11] and discuss conditions under which expert and consumer are in effect tied together. In Section 3 we work with the following short-cut assumption which we refer to as the commitment assumption (Assumption C).

Assumption C (Commitment) *Once the diagnosis is agreed upon, the customer is committed to undergo a treatment by the expert.*

For the considered time and information structure we refer to Figure 1. This figure shows the game tree for the special case where a single expert ($n = 1$) courts a single consumer ($m = 1$). The variables $v, h, \overline{c}$ and $\underline{c}$ are assumed to be common knowledge. At the outset the expert posts prices $\underline{p}$ and $\overline{p}$ for $\underline{c}$ and $\overline{c}$, respectively. The consumer observes these prices and then decides whether to visit the expert or not. If he decides against the visit, he remains untreated yielding a payoff of zero for both players. If he decides for a visit, a random move of nature determines the severity of

[11] Since provision of treatment without diagnosis is assumed to be impossible (see Footnote 9 above) an increase in diagnosis cost means that consulting more than one expert becomes less attractive.

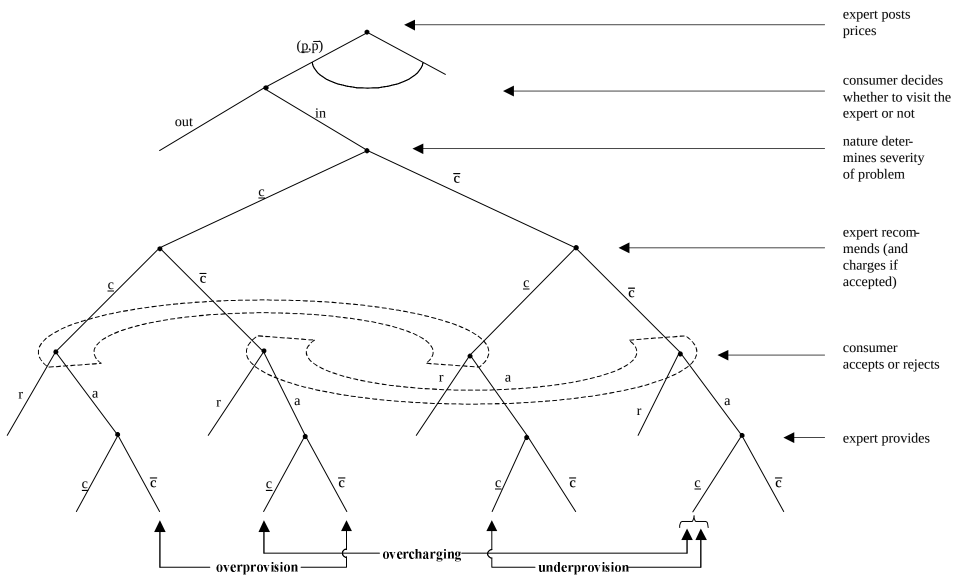

Figure 1: Game Tree for the Credence Goods Problems

his problem.[12] Now the expert diagnosis the consumer. In the course of her diagnosis she learns the customer's problem and recommends either the cheap or the expensive treatment. Next the customer decides whether to accept or reject the recommendation. If he rejects, his payoff is $-d$, while the expert's payoff is zero.[13] Under the commitment assumption (Assumption C) this decision node of the consumer is missing. If the consumer is committed, or if he accepts under the non-commitment assumption, then the expert provides a treatment and charges for the recommended one.[14] Under the verifiability assumption (Assumption V) this decision node is degenerate:

[12]Here note that, from a game-theoretic point of view, there is no difference between a model in which nature determines the severity of the problem at the outset and our model where this move occurs after the consumer has consulted an expert (but before the expert has performed the diagnosis).

[13]We take the convention that each consumer can visit a given expert at most once.

[14]Throughout we assume that an expert's agreement to perform the diagnosis means a commitment to provide a treatment even if treatment-provision is not profitable for the expert. This assumption is not important for our results and we mention in footnotes what changes if the expert is free to send off the customer after having conducted the diagnosis.

the expert simply provides the recommended treatment. Under the liability assumption (Assumption L) this decision node is degenerate whenever the customer has the major problem: then the expert must provide the expensive treatment. The game ends with payoffs determined in the obvious way.

The game tree for the model with many consumers ($m > 1$) and a single expert ($n = 1$) can be thought of as simply having many of these single-consumer games going on simultaneously, with the fraction of consumers with the major problem in the market being h. With more than one expert ($n > 1$) the experts simultaneously post prices $\underline{p}^i$ and $\overline{p}^i$ ($i \in \{1, ..., n\}$) for $\underline{c}$ and $\overline{c}$, respectively. Consumers observe these prices and then decide whether to undergo a diagnosis by an expert or not, and if yes, by which expert. Thus, with $n > 1$ a consumer's decision against visiting a given expert (the "out" decision in the game tree) doesn't mean that he remains untreated: he might simply visit a different expert. Similarly, a consumer's payoff if he rejects a given expert's treatment recommendation depends on whether he visits a different expert or not.

With commitment the game just described is a multi-stage game with observed actions and complete information (i.e., a "game of almost-perfect information"). The natural solution concept for such a game is subgame-perfect equilibrium and we will resort to it in Section 3. Subgame-perfection looses much of its bite in the non-commitment case where the less-informed customer has to decide whether to stay or to leave without knowing whether the better-informed expert has recommended the right or the wrong treatment. To extend the spirit of subgame-perfection to this game of incomplete information, we require that strategies yield a Bayes-Nash equilibrium not only for each proper subgame, but also for continuation games that are not proper subgames (because they do not stem from a singleton information set). That is, we focus on perfect Bayesian equilibria in the non-commitment case.

3 No Problem with Credence Goods

In this section we show that market institutions solve the fraudulent expert problem at no cost if (i) expert sellers face homogeneous customers (Assumption H), (ii) expert and customer are committed to proceed with a treatment once a diagnosis is agreed upon (Assumption C), and (iii) either the type of treatment is verifiable (Assumption V), or a liability rule is in effect (Assumption L), or both. This result is recorded as Proposition 1 below. The proof for this result, as well as the intuition behind it, relies on three observations that are reported as Lemma 1-3.

Lemma 1 discusses the result under the verifiability assumption. With verifiability alone (i.e., without liability) experts charge equal mark-up prices and serve customers honestly as the following result shows.

Lemma 1 *Suppose that Assumptions H (Homogeneity), C (Commitment) and V (Verifiability) hold, and that Assumption L (Liability) is violated. Then, in the unique subgame-perfect equilibrium, each expert posts and charges equal mark-up prices and efficiently serves her customers. Posted (and charged) equilibrium prices satisfy* $\underline{p}-\underline{c}=\overline{p}-\overline{c}=v-d-\underline{c}-h\left(\overline{c}-\underline{c}\right)$ *if a single expert provides the good* $(n=1)$*, and* $\underline{p}-\underline{c}=\overline{p}-\overline{c}=0$ *if there is competition in the credence good market* $(n\geq 2)$*.*

Proof. First note that with verifiability the last two stages of the game coincide; that is, an expert's recommendation (and charging) policy equals her provision policy. If $\overline{p}-\overline{c}>\underline{p}-\underline{c}$ the expert will always recommend and provide the expensive, if $\overline{p}-\overline{c}<\underline{p}-\underline{c}$ the cheap treatment. Only if $\overline{p}-\overline{c}=\underline{p}-\underline{c}$ the expert is indifferent between the two types of treatment and, therefore, behaves honestly. Customers know that and visit the expert whose posted price-vector, together with the implied provision policy, generates the highest positive expected utility.[15] A customer visiting an expert whose posted prices satisfy $\overline{p}-\overline{c}>\underline{p}-\underline{c}$ has an expected utility of $v-\overline{p}-d$. Similarly, a customer visiting a $\overline{p}-\overline{c}<\underline{p}-\underline{c}$ expert obtains an expected utility of $(1-h)\,v-\underline{p}-d$. Finally, the expected utility from visiting an equal mark-up expert is $v-\underline{p}-h\left(\overline{c}-\underline{c}\right)-d$. Experts take consumers' expected utility into account in posting their prices. First, consider the monopoly case. The maximal profit per customer the monopolist can realize with equal mark-up prices is $v-d-\underline{c}-h\left(\overline{c}-\underline{c}\right)$. The maximal obtainable profit with price vectors satisfying $\overline{p}-\overline{c}>\underline{p}-\underline{c}$ is $v-d-\overline{c}$, and the maximal profit with price vectors satisfying $\overline{p}-\overline{c}<\underline{p}-\underline{c}$ is $(1-h)\,v-d-\underline{c}$. Thus, since $v>\overline{c}-\underline{c}$, the expert

[15] The assumption that it is common knowledge among players that experts provide the appropriate treatment whenever they are indifferent plays an important role in Lemma 1 in generating a unique subgame-perfect equilibrium. Without this assumption there exist other subgame-perfect equilibria which are supported by the belief that all experts who post equal mark-up prices - or, that experts who post equal mark-up prices that are too low (in the monopoly case: too high) - deliberately mistreat their customers. We regard such equilibria as implausible and have therefore introduced the common knowledge assumption which acts as a restriction on consumers' beliefs.

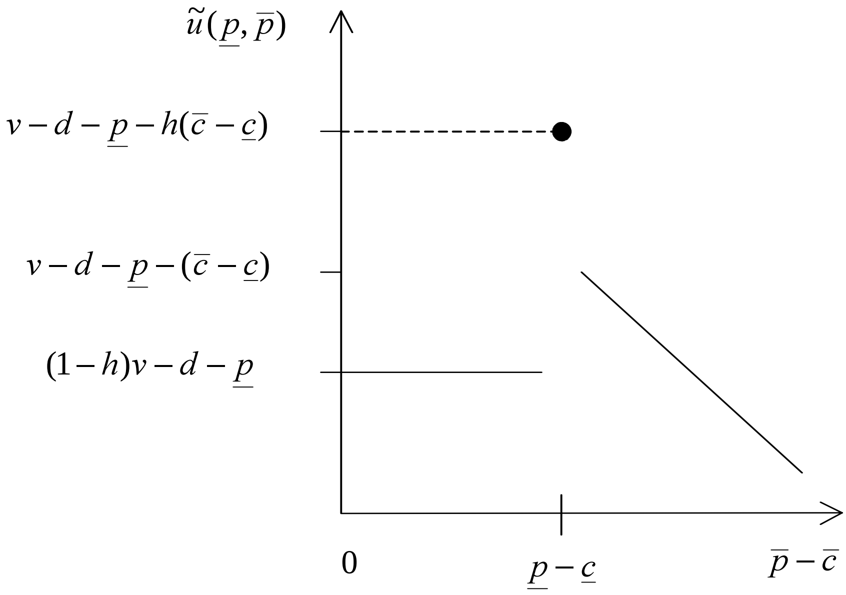

Figure 2: Consumers' Expected Utility with Verifiability

will post the proposed equal mark-up price-vector. Next suppose that $n > 1$. Further suppose that at least two experts post equal mark-up prices. Then these prices satisfy $\overline{p} - \overline{c} = \underline{p} - \underline{c} = 0$ since this is the only equal mark-up price-vector consistent with Bertrand competition. Next suppose that at least one expert posts prices satisfying $\overline{p} - \overline{c} = \underline{p} - \underline{c} = 0$, while at least one other expert posts prices violating the equal mark-up rule. In order to attract customers the deviating expert must either post prices satisfying $\overline{p} \leq \underline{c} + h\left(\overline{c} - \underline{c}\right)$ and $\overline{p} > \underline{p} + \overline{c} - \underline{c}$, or prices satisfying $\underline{p} \leq \underline{c} - h\left(v - \overline{c} + \underline{c}\right)$ and $\underline{p} > \overline{p} + \underline{c} - \overline{c}$. The former price-vector results in a loss of at least $\left(1 - h\right)\left(\overline{c} - \underline{c}\right)$ per customer, the latter in a loss of at least $h\left(v - \overline{c} + \underline{c}\right)$ per customer. Next suppose that no expert posts equal mark-up prices. Then at least one expert can attract all customers and increase her profit by switching to equal mark-up prices. Finally suppose a single expert is able to attract some customers with equal mark-up prices exceeding the proposed equilibrium prices, while all other experts post prices violating the equal mark-up rule. Then one of those other experts has an incentive to switch to an equal mark-up price-vector, leading again to Bertrand competition. ■

Figure 2 depicts the situation under consideration. In this figure the term $\tilde{u}(\underline{p}, \overline{p})$ denotes the expected net payoff of a consumer who resorts to an expert with posted price-vector $(\underline{p}, \overline{p})$. This figure is easily understood by first noting that verifiability solves the problem of overcharging. In other words, the seller cannot claim to have supplied the expensive treatment when she actually has provided the cheap one. Remains the incentive to provide the wrong treatment. Whether an expert has such an incentive depends on her posted prices. With $\overline{p} - \overline{c} > \underline{p} - \underline{c}$ the expert will always recommend and provide the expensive treatment. Consumers know that; that is, they infer experts' behavior from posted prices. Thus, their expected payoff is $v - d - \overline{p}$. Similarly, with posted prices satisfying $\underline{p} - \underline{c} > \overline{p} - \overline{c}$ the expert provides the cheap treatment yielding an expected utility of $(1 - h)v - d - \underline{p}$. Only with equal mark-up prices the expert is indifferent between the two types of treatment and, therefore, behaves honestly. Honest behavior guarantees an expected payoff of $v - d - (1 - h)\underline{p} - h\overline{p}$.

Experts take consumers' expected utility into account in choosing their prices. Thus, they post prices that yield a constant profit independent of the type of treatment sold. In the monopoly case ($n = 1$) the expert has all the market power. Hence, posted prices are such that the entire surplus goes to the expert. With two or more experts, on the other hand, Bertrand competition drives profits down to zero and consumers appropriate the entire surplus.

Equal mark-up prices are common in important credence goods markets, including dental services, automobile and equipment repair and pest control. For more sophisticated repairs, where the customer is normally not physically present during the treatment, verifiability is often secured indirectly through the provision of *ex post* evidence. In the automobile repair market, for instance, it is quite common that broken parts are handed over to the customer to substantiate the claim that replacement, and not only repair, has been performed. Similarly, in the historic car restoration market the type of treatment is usually documented step by step in pictures.

Equal mark-up prices are also often seen in case of expert sellers. Computer stores are an obvious example. Customers can control which quality they receive. If (some) customers behave irrationally in the sense that they care for relative mark-ups rather than expected prices, some (low) qualities will not be sold because the needed - efficiency inducing - mark-up is high compared to costs. Other examples are pricing schemes of travel agents. The mark-up the travel agent charges (the margin plus any bonuses to the agent offered by the provider) is similar for all products.

Lemma 1 facilitates the interpretation of the Emons (1997) result on the provision and pricing strategy of capacity constrained experts. Emons considers a model in which each of a finite number of identical potential experts has a fixed capacity. She becomes an active expert by irreversibly devoting this capacity to the credence goods market. Once she has done this, she can use her capacity to provide two types of treatment at zero marginal cost up to the capacity constraint. One type of treatment uses up more units of capacity than the second. Total capacity over all potential experts exceeds the amount necessary to serve all customers honestly. Emons proposes a symmetric equilibrium in which each potential expert's entry decision is strictly mixed. Thus, active experts may either have to ration their clientele due to insufficient capacity, or they may end up with idle capacity. In the former case they charge prices such that (i) all the surplus goes to the experts and (ii) the price for the more capacity-consuming treatment exceeds the price of the second treatment by such an amount that the profit per unit of capacity consumed is the same for both types of treatment. In the latter case all experts charge a price of zero for both types of treatment. In both cases experts serve customers honestly. This is exactly what our Lemma 1 would predict: If demand exceeds total capacity experts have all the market power ($n = 1$). Thus, all the surplus goes to the experts. Furthermore, with insufficient capacity, equal mark-up prices imply a higher price for the more capacity-consuming treatment since the opportunity cost in terms of units of capacity used is higher. By contrast, if capacity exceeds demand, the opportunity cost of both types of treatment is the same, namely zero. Thus, the price has to be the same for both types of treatment to yield equal mark-ups. Furthermore, with idle capacity, experts have no market power ($n \geq 2$). Thus, prices are zero and customers appropriate the entire surplus. To summarize, our analysis shows that many specific assumptions made by Emons (e.g., that there is a continuum of customers, that capacity is needed to provide treatments, that success is a stochastic function of the type of treatment provided, etc.) are not important for his efficiency result.[16] What is important, however, is that consumers are homogeneous (see Proposition

[16]The only inefficiency that remains in the Emons model is the suboptimal amount of capacity provided in equilibrium. This inefficiency has nothing to do with the credence goods problem, however. It is rather a coordination failure type of inefficiency similar to that arising in the symmetric mixed strategy equilibrium of the grab-the-dollar game prominent in Industrial Organization.

2 below),[17] and that the type of treatment is verifiable (see Proposition 4 below).[18]

Let us turn now to the liability case. Under the liability assumption experts charge a uniform price for both types of treatment and serve customers honestly as the following result shows.

Lemma 2 *Suppose that Assumptions H (Homogeneity), C (Commitment) and L (Liability) hold, and that Assumption V (Verifiability) is violated. Then, in any subgame-perfect equilibrium, each expert charges a constant price for both types of treatment and efficiently serves her customers. The price charged in equilibrium is given by $\widetilde{p} = v - d$ if a single expert provides the good ($n = 1$), and by $\widetilde{p} = \underline{c} + h(\overline{c} - \underline{c})$ if there is competition in the credence goods market ($n \geq 2$).*[19] *Posted prices satisfy $\underline{p} \leq \overline{p} = \widetilde{p}$.*

Proof. First observe that with commitment the subgame starting immediately after the price-posting game among experts is a multi-stage game of perfect information and as such can be solved by backward induction. So we start by solving for the expert's optimal provision policy for each possible situation she might face. Under the conditions of Lemma 2, liability prevents undertreatment, and the cost difference $\overline{c} - \underline{c} > 0$ prevents overtreatment. So each expert will efficiently serve her customers. Next consider the recommendation policy. If $\overline{p} > \underline{p}$ then the expert has incentives to overcharge, i.e., to always recommend $\overline{c}$ and charge $\overline{p}$. Only if $\overline{p} = \underline{p}$ the expert has no incentive to charge for the wrong treatment.[20] Customers' beliefs reflect experts' incentives. Thus, they visit the expert with the lowest $\overline{p}$, provided that the lowest $\overline{p}$ is such that $v - \overline{p} - d \geq 0$. The rest is trivial. In the monopoly case ($n = 1$) the expert has all the market power. Thus, she posts $\underline{p} \leq \overline{p} = v - d$. With $n > 1$, the price-posting game is a standard Bertrand game. Thus, $\underline{p} \leq \overline{p} = \underline{c} + h\,(\overline{c} - \underline{c})$ by the usual price-cutting argument. ■

Figure 3 depicts the expected utility of the customer under the conditions of Lemma 2. Here, liability solves the problem of undertreatment, the cost

[17] In the Emons model the inefficiencies described in Subsection 4.1 arrise for *any* n since experts have market power whenever capacity is insufficient to cover demand.

[18] Assumption C is not important for the Emons result as Lemma 8 below shows.

[19] If the expert is not obligated to treat the customer after having conducted the diagnosis the price charged in equilibrium changes to $\widetilde{p} = \overline{c} + \alpha\,[v - d - \overline{c}]$, where $\alpha = 1$ for $n = 1$ and $\alpha = 0$ otherwise. The rest of Lemma 2 remains unaffected.

[20] Throughout we assume that $\overline{p} \geq \underline{p}$. Allowing for $\underline{p} > \overline{p}$ burdens the analysis without changing the qualitative results.

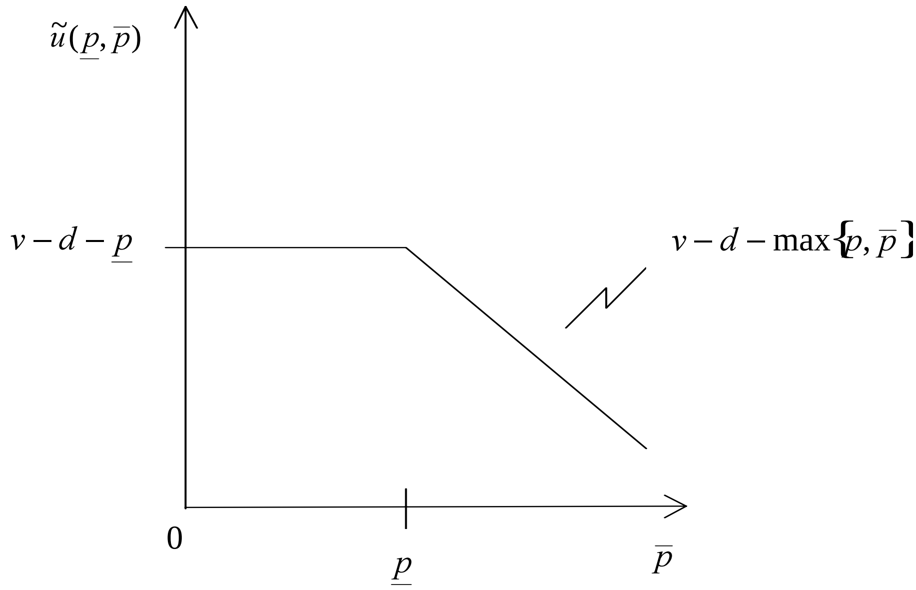

Figure 3: Consumers' Expected Utility with Liability

differential $\overline{c} - \underline{c} > 0$ that of overtreatment. So each expert will efficiently serve her customers. Remains the incentive to overcharge. Such an incentive exists whenever $\overline{p} \neq \underline{p}$. Consumers know that. Thus, their behavior depends on max $\{\underline{p}, \overline{p}\}$ only. Given this, experts cannot gain anything by posting price vectors where $\overline{p} \neq \underline{p}$.

Lemma 2 offers an explanation for the frequently observed fixed prices for expert services in environments where experts have to provide reliable quality because otherwise they are punished by law or by bad reputation. Examples are garages offering car check-ups at a fixed price and health maintenance organizations (HMOs) providing medical service to members at an individualized constant price per treatment. From the analysis it becomes clear that the schemes offered by the HMOs are cheaper than a health insurance system. Under insurance the customer does not care about the price after having paid the insurance premium. With the HMO, the company will make sure that the cheapest sufficient quality will be provided.

Lemma 2 facilitates the identification of the driving forces behind the Taylor (1995) results. Taylor studies a fairly elaborate model of a durable credence good which may be in one of three states: health, disease, or failure.

The good begins in the state of health, passes over to the state of disease and from there either to the state of failure, or, if efficiently treated, back to the state of health. The amount of time spent in each of the first two states is governed by an exponential distribution. When the good enters the state of failure it remains there forever. The main problem for the owner of the good is that he never discovers whether the good is healthy or diseased. An expert, on the other hand, can observe this by performing a diagnostic check. If the check reveals the good to be diseased she can perform the necessary treatment. Taylor shows that if experts post treatment prices *ex ante* then they essentially offer fair insurance against the presence of disease by charging a fixed price equal to the expected treatment cost, exactly as our Lemma 2 would predict. However, in the Taylor model this insurance solution is not efficient since the good needs also maintenance by the owner for survival. If the owner opts for low maintenance then the maintenance cost per unit of time is low, but the good is later more expensive to treat when it becomes diseased. Obviously, in this set up fixed prices are inefficient since they provide poor incentives for owners to perform maintenance. Taylor proposes two alternative ways to solve this problem: *Ex post* contracts where experts commit to treatment prices only after having learned the owner's level of care, and multi-period contracts for settings with repeated interactions between an owner and an expert. These solutions would dominate the simple fixed price rule in our setup too, if we assumed that the good needs costly maintenance and that the owner's level of care is revealed to the expert in the diagnostic check as is assumed by Taylor.

To summarize, our simple framework shows that many specific details of the sophisticated Taylor model are not important for his results. What is important, however, is that a liability rule protects consumers from obtaining insufficient treatment (without liability experts would never cure the good, except for the prospect of repeat business), and that the type of treatment is not verifiable (otherwise equal mark up prices would provide incentives for maintenance).

Let us now consider the case where both, the liability and the verifiability assumption hold. In this case $\overline{p} \leq \underline{p} + (\overline{c} - \underline{c})$ is sufficient to induce nonfraudulent behavior as the following result shows.

Lemma 3 *Suppose that Assumptions H (Homogeneity), C (Commitment), L (Liability) and V (Verifiability) hold. Then, in any subgame-perfect equilibrium, each expert posts and charges prices yielding a lower* ($\leq$) *mark up* *for the more expensive treatment and efficiently serves her customers. Posted (and charged) equilibrium prices satisfy* $\underline{p} + h(\overline{p} - \underline{p}) = v - d$ *and* $\overline{p} - \overline{c} \leq \underline{p} - \underline{c}$ *if a single expert provides the good* ($n = 1$), *and* $\underline{p} + h(\overline{p} - \underline{p}) = \underline{c} + h(\overline{c} - \underline{c})$ *and* $\overline{p} - \overline{c} \leq \underline{p} - \underline{c}$ *if there is competition in the credence goods market* ($n \geq 2$).

Proof. The proof is similar to that of Lemma 1, the only difference being that the liability rule prevents the expert from profiting by providing the cheap treatment when the expensive one is needed. ■

With liability and observability undertreatment and overcharging are both unattractive. The incentive to overtreat customers is eliminated by posting prices yielding a (weakly) lower mark-up for the expensive treatment.

Lemmas 1 - 3 can be summarized to the following result.

Proposition 1 *Under Assumptions H (Homogeneity), C (Commitment), and either L (Liability) or V (Verifiability) or both, market institutions solve the fraudulent expert problem at no cost.*

4 Various Degrees of Inefficiencies and Fraud in the Credence Goods Market

In this section we characterize the inefficiencies that might arise if at least one of the conditions of Proposition 1 is violated. We begin with the homogeneity assumption (Assumption H).

4.1 Heterogeneous Consumers: Inefficient Rationing and Inefficient Treatment of some Consumer Groups

Without exception the formal literature on credence goods assumes that consumers are homogeneous. In this subsection we show that new inefficiencies may arise if this assumption (our Assumption H) is violated. To show this we use a simple example where $n = 1$ and where consumers differ in their risk of needing the expensive treatment. More precisely, we assume that consumer $j \in \{1, .., m\}$ has the major problem with probability h_j, and the minor problem with probability $(1 - h_j)$. Consumers' types (i.e., the probabilities h_j) are drawn independently from the same cumulative distribution function $F(\cdot)$, with differentiable strictly positive density $f(\cdot)$ on $[0, 1]$.

$F(\cdot)$ is common knowledge, but a consumer's type is the consumer's private information.[21] If a customer gets the appropriate treatment he obtains a type-independent gross utility of v, and if not one of zero, exactly as in our basic model.[22] To show the effect of heterogeneous customers, we rule out overcharging by assuming the type of treatment to be verifiable (Assumption V).

Our first result deals with a setting in which the expert cannot price discriminate among consumers. Without price discrimination the expert chooses equal mark-up prices such that some consumers do not consult her even though serving them would be efficient. This is nothing but the familiar monopoly-pricing inefficiency: The monopolistic expert would like to appropriate as much of the net gain from treatment as possible but, because of asymmetric information, runs the risk of losing some consumers in order to get a higher price from the remaining ones. We record the monopoly pricing result in Lemma 4.

Lemma 4 *Suppose that Assumptions C (Commitment) and V (Verifiability) hold, and that Assumptions H (Homogeneity) and L (Liability) are violated. Further suppose that a single expert* $(n = 1)$ *who cannot price-discriminate among customers serves the market, and that consumers differ in their risk of needing the expensive treatment. Then, in the unique subgame-perfect equilibrium, the expert posts and charges equal mark-up prices* $\left(\overline{p} - \overline{c} = \underline{p} - \underline{c}\right)$ *such that (i) high risk consumer types decide to remain untreated* $(\overline{p} > v - d)$*, and (ii) all other types visit the expert* $\left(\underline{p} < v - d\right)$ *and get the appropriate treatment.*

Proof. From the proof of Lemma 1 we know that, for given net utilities for the consumers, the monopolist's profit is highest with an equal mark-up price vector. Thus, the monopolist will choose such a vector and she will provide the appropriate treatment to all of her customers. With an equal mark-up price vector the monopolistic expert is interested in two variables only,

[21] Car owners know how they treat their vehicles and the associated risk of needing certain repairs, auto mechanics know only the distribution. Similarly, patients know their eating and smocking habits and the associated risk of getting certain diseases, doctors only the distribution.

[22] Similar results can be derived under the assumption that each customer is characterized by a vector (h_j, v_j), and that the types of different consumers are independently drawn from the same two-dimensional distribution.

in the magnitude of the mark-up and in the number of visiting consumers. The result then follows from the observation that the expert's problem is nothing but the familiar monopoly pricing problem for demand curve $D(\underline{p}) = mF[(v - \underline{p} - d)/(\overline{c} - \underline{c})]$ and net revenue per customer $\underline{p} - \underline{c}$. ■

For our next result we allow the expert to (second degree) price discriminate among consumers. That is, we let the monopolistic expert post a menu of price vectors; consumers observe the menu and then decide under which vector, if any, they wish to be served.

Under standard conditions, second degree discriminatory pricing reduces the monopoly-pricing inefficiency. In the present model with credence goods, a new inefficiency appears.

Lemma 5 *Suppose that the general conditions of Lemma 4 hold, except that the expert can now price discriminate among consumers (rather than being restricted to a single price vector only). Then, in any subgame-perfect equilibrium, the expert posts two price vectors, one with equal mark-ups, and one with a higher mark-up for the expensive treatment.*[23] *Both vectors attract customers and in total all consumers are served. Types served under the former vector always get the appropriate treatment, those served under the latter always get the expensive treatment, sometimes inefficiently.*

Proof. See the Appendix. ■

Under the conditions of Lemma 5 the expert posts two price vectors, an equal mark-up vector to skim-off low risk consumers and a less profitable vector with a higher mark-up for the more expensive treatment to serve the rest. The equal mark-up in the vector posted under the conditions of Lemma 5 is strictly higher than that in the vector of Lemma 4. This follows from the observation that the expert's trade-off is between increasing the mark-up charged from the types in the segment of served customers and losing some types to the unprofitable segment of not served consumers in the latter case, while the trade-off here is between increasing the mark-up charged from the types served under the more profitable equal mark-up vector and losing some types to the segment of customers served under the less profitable second vector. So, some types that always get the appropriate treatment under the conditions of Lemma 4, get (with strictly positive probability) the wrong treatment when the expert can price discriminate among consumers. Thus,

[23]The menu may contain some redundant price vectors too, i.e., some vectors that attract no consumers.

there is a trade-off between increasing the number of treated consumers and serving the treated customers efficiently. Overall efficiency might increase or decrease with price discrimination depending on the shape of the distribution function $F(\cdot)$, the valuation v (net of diagnosis costs d, of course) and the cost differential $\bar{c} - \underline{c}$. An increase in efficiency is more likely the smaller is the net valuation $v - d$, the larger is the cost differential $\bar{c} - \underline{c}$, and the higher is the weight on the tails of the distribution. This is because a small $v - d$, a large $\bar{c} - \underline{c}$, and a high weight on the lower end of the distribution increases the efficiency gain from treating more consumers, while a low weight on the middle of the distribution reduces the efficiency loss from mistreating customers.

The result that the number of served customers increases with price discrimination and that the equilibrium with price discrimination involves some consumers being overtreated carries over to a setting in which the type set is discrete, with the qualification that the increase in the number of served customers is not necessarily strict in that case, since all types might already get served under the conditions of Lemma 4. It also extends to a setting where consumers differ in their valuation v, but have the same probability h of needing the more expensive treatment. It does not carry over to a model with a two-dimensional type space, however, as the (discrete) example below shows. In this example some types that always get the appropriate treatment under the conditions of Lemma 4, remain unserved when the expert can price discriminate among consumers; other types that are also efficiently served when the expert can post a single price vector only, are undertreated under the conditions of Lemma 5: If the expert can post a single price vector only, she serves all consumers with equal mark-up prices. With prices discrimination she uses an equal mark-up vector to skim off high valuation/high risk consumers, and a price vector with a higher mark-up for the cheap treatment to undertreat low valuation/low risk consumers. Medium valuation/high risk consumers remain unserved with price discrimination although treating them would be efficient.

Example: There is an arbitrary number m of consumers. Each consumer $j \in \{1, ...m\}$ is characterized by his two-dimensional type (h_j, v_j). Consumers' types are independently drawn from an equal probability distribution on the discrete support $\{(0.9, 1.7), (0.6, 1.0), (0.9, 1.2)\}$. There are no diagnosis costs ($d = 0$). The cost of the expensive treatment is one ($\bar{c} = 1$), and the cost of the cheap treatment is zero ($\underline{c} = 0$). If the expert can post a single price vector only, then she serves all consumers with equal mark-up prices $(\underline{p}, \overline{p}) = (0.3, 1.3)$. With this policy she earns an expected profit of 0.3 per consumer. If the expert can price discriminate among consumers then she increases her expected profit to 0.4 per consumer by posting two price vectors, the equal mark-up vector $(\underline{p}, \overline{p}) = (0.8, 1.8)$, and a second vector with $\underline{p} = 0.4 > \overline{p} - (\overline{c} - \underline{c})$. High valuation/high risk consumers are served efficiently under the equal mark-up vector, low valuation/low risk consumers mistreated under the second vector, and medium valuation but high risk consumers remain unserved.[24]

Before proceeding notice that the inefficiencies of Lemmas 4 and 5 disappear if experts have no market power. With $n > 1$, price-competing experts provide both types of treatment at marginal cost leaving no leeway for inefficiencies of any kind. Here note, that the relevant condition is not $n = 1$, but rather that experts have market power in providing treatments. In a model in which capacity is required to serve customers (cf. e.g. Emons 1997 and 1989) experts have market power (independently of n) whenever tight capacity constraints hamper competition. Similarly, consumer loyalty, travel costs together with location, search costs, collusion and many, many other factors might give rise to market power.

We summarize the results of this subsection to the following proposition.

Proposition 2 *Subgame-perfect equilibria exhibiting inefficient rationing and / or inefficient treatment of some consumer groups might exist if Assumption H (Homogeneity) is violated and if experts have market power.*

[24]Here is an alternative example involving overtreatment of consumers: Same details as in the example in the main text except that consumers' types are now independently drawn from an equal probability distribution on the support $\{(0.2, 1.2), (0.1, 2.2), (0.9, 2.3)\}$. If the expert can post a single price vector only, then she serves all consumers with equal mark-up prices $(\underline{p}, \overline{p}) = (1.0, 2.0)$. With this policy she earns an expected profit of 1 per consumer. If the expert can price discriminate among consumers then she can increase her expected profit to 3.4/3 per consumer by posting two price vectors, the equal mark-up vector $(\underline{p}, \overline{p}) = (2.1, 3.1)$, and a second vector with $\overline{p} = 1.3 > \underline{p} + (\overline{c} - \underline{c})$. Medium valuation/low risk consumers are served efficiently under the equal mark-up vector, high valuation/high risk consumers mistreated under the second vector, and low valuation/ medium risk consumers remain unserved.

4.2 No Commitment: Overcharging and Duplication of Search and Diagnosis Costs

In this subsection we drop the commitment assumption. Under certain conditions this gives rise to two different types of equilibria, overcharging equilibria and specialization equilibria. In both, the credence good problem manifests itself in inefficiently high search and diagnosis costs as some consumers end up visiting more than one expert and being diagnosed more than once. We begin with the overcharging scenario.

Lemma 6 ***(i)*** *Suppose that Assumptions H (Homogeneity) and L (Liability) hold, and that Assumptions C (Commitment) and V (Verifiability) are violated. Further suppose that there is some competition in the credence goods market* ($n \geq 2$)*, that economies of scope between diagnosis and treatment are relatively low* ($d < (\overline{c} - \underline{c})(1 - h)$)*, and that a (legal) rule is in effect requiring experts to choose the price for the expensive treatment from a given range of cost-covering prices* ($\overline{p} \in [\overline{c}, \overline{c} + d]$)*.*[25] *Then there exists a symmetric weak perfect Bayesian equilibrium in which experts overcharge customers (with strictly positive probability). In this equilibrium experts post prices satisfying* $\underline{p} = \underline{c} + \Delta$ *and* $\overline{p} = \overline{c} > \underline{c} + \Delta$*. Experts always recommend the expensive treatment if the customer has the major problem, and they recommend* $\overline{c}$ *with probability* $o \in (0, 1)$ *if the customer has the minor problem. Consumers make at least one, at most two visits. Consumers at their first visit always accept a* $\underline{c}$ *recommendation, and they accept a* $\overline{c}$ *recommendation with probability* $a \in (0, 1)$ *and reject it with probability* $(1 - a)$*. Consumers who reject, visit a second (different) expert, and on that visit they accept both recommendations with certainty. A customer who accepts to be treated always gets the appropriate treatment.*

(ii) *The strategy profile sketched in part (i) of this lemma ceases to form part of weak perfect Bayesian equilibrium if experts are completely free in choosing prices.*

Proof. See the Appendix. ■

In the overcharging equilibrium of Lemma 6 liability solves the problem of undertreatment and the cost differential $\overline{c} - \underline{c}$ that of overtreatment. Remains

[25] If experts are not committed to treat their customers after having conducted a diagnosis, then a lower bound for the price of the expensive treatment ($\overline{p} \geq \overline{c}$) emerges endogeneously. So only the upper bound for prices ($\overline{p} \leq \overline{c} + d$) is required in this case to prove part (i) of the lemma.

the temptation to overcharge consumers. Experts do not overcharge their customers all the time (but only with strictly positive probability) because recommending the cheap treatment guarantees a positive profit of $\underline{p} - \underline{c} = \Delta > 0$ for sure, while recommending the expensive treatment when only the cheap one is required is like playing in a lottery yielding a payoff of $\overline{p} - \underline{c} > \Delta$ if the consumer accepts, and zero otherwise. By construction, the expected payoff under the lottery equals Δ, making the expert exactly indifferent between recommending honestly and overcharging.

The overcharging equilibrium sketched in part (i) of Lemma 6 is essentially the equilibrium outlined by Pitchik and Schotter (1989) for a setting with exogenously given payoffs. Wolinsky (1993) argues that the equilibrium might also exist with flexible prices if sufficiently few experts compete for customers. Lemma 6 shows that the overcharging configuration of part (i) continues to form part of a weak perfect Bayesian equilibrium if experts have some freedom in choosing prices, but that it ceases to form part of such an equilibrium if prices are fully flexible.[26]

The "equilibrium with fraud" discussed by Darby and Karni (1973) resembles a purified version of the overcharging equilibrium of Lemma 6. In their (in large parts verbal) analysis "...increasing the amount of services prescribed on the basis of the diagnosis, increases the probability of entering the customer's critical regions for going elsewhere [....] Taking this consideration into account, the firm will carry fraud up to the point where the expected marginal profit is zero" (p. 73). Adapting Lemma 6 to an environment where consumers are heterogeneous with respect to their search cost would yield an equilibrium with these properties. The analogy is not perfect, however, as the problem discussed by Darby and Karni is that of overtreating, and not that of overcharging customers. Overtreatment can only pose problems if the customer can observe and verify the type of treatment he gets (our Assumption V), since, if he can not, overcharging is always more profitable. But, with verifiability and flexible prices there are no equilibria exhibiting fraud, as Lemma 8 below shows. In other words, to support the Darby and Karni (1973) configuration with fraud as an equilibrium, payoffs again need to be exogenously fixed, as they are in their environment.

Overcharging equilibria with the essential features as outlined in Lemma 6 cease to exist if experts are free in choosing prices. With fully flexible

[26]See Mas-Colell et al. (1995) for the definition of *weak perfect Bayesian equilibrium.* Myerson (1991) calls the same concept a *weak sequential equilibrium.*

prices, a continuum of experts, and low economies of scope between diagnosis and treatment the only perfect Bayesian equilibria that survive when Assumptions H and L hold, while Assumptions C and V are violated are specialization equilibria similar to the one outlined in the next lemma. This has been shown by Wolinsky (1993).[27]

Lemma 7 *Suppose that Assumptions H (Homogeneity) and L (Liability) hold, and that Assumptions C (Commitment) and V (Verifiability) are violated. Further suppose that there is enough competition in the credence goods market* ($n \geq 4$) *and that economies of scope between diagnosis and treatment are relatively low* ($d < (\overline{c} - \underline{c})(1-h)$)*.*[28] *Then there exists a perfect Bayesian equilibrium exhibiting specialization. In this equilibrium some experts (at least two) post prices given by* $\underline{p} = \underline{c}$ *and* $\overline{p} > \overline{c} + d$ *(we call such experts "cheap experts"), and some other experts (again at least two, "expensive experts") post prices given by* $\underline{p} \leq \overline{p} = \overline{c}$*. Cheap experts always recommend the appropriate treatment, expensive experts always the expensive one. Consumers first visit a cheap expert. If this expert recommends* $\underline{c}$ *the customer agrees and gets* $\underline{c}$*. If the cheap expert recommends* $\overline{c}$ *the customer rejects and visits an expensive expert who treats him efficiently.*

Proof. See the Appendix. ■

In the specialization equilibrium of Lemma 7 liability solves (again) the problem of undertreatment and the cost differential $\overline{c} - \underline{c}$ that of overtreatment. The incentive to overcharge customers is eliminated because cheap experts lose their customers if they recommend the expensive treatment.

Note that the condition for the strategies described in Lemma 1 to form part of a perfect Bayesian equilibrium even if the commitment assumption (Assumption C) is not imposed and even if $n \geq 4$ is exactly that the restriction imposed by Lemma 7 on d is violated; that is, the diagnosis cost d must exceed $(1-h)(\overline{c} - \underline{c})$. To verify this, notice that a deviation that might jeopardize the equilibrium of Lemma 1 must have $\underline{p} < \underline{c} + h(\overline{c} - \underline{c})$ and $\overline{p} \geq \overline{c} + d$. The expected cost to a consumer who visits the devia-

[27]In the Wolinsky (1993) model, where experts commit to an unobservable recommendation policy at the price-posting stage of the game, an additional restriction on beliefs is required to prove the result. In the present model, that requirement is implied by the notion of perfect Bayesian equilibrium.

[28]If experts are not committed to treat their customers after having conducted the diagnosis, the condition $d < (\overline{c} - \underline{c})(1-h)$ changes to $d < (\overline{c} - \underline{c})(1-h)/h$.

tor first, and, if recommended the expensive treatment, resorts to a non-deviating expert is $d + \underline{p} + h\left[\underline{c} - \underline{p} + h(\overline{c} - \underline{c}) + d\right]$. Consulting only a non-deviating expert, on the other hand, costs $d + \underline{c} + h(\overline{c} - \underline{c})$. Thus, to attract customers, the deviator must post a price vector with a $\underline{p}$ such that $d + \underline{c} + h(\overline{c} - \underline{c}) \geq d + \underline{p} + h\left[\underline{c} - \underline{p} + h(\overline{c} - \underline{c}) + d\right]$, which is equivalent to $\underline{p} \leq \underline{c} + h\left[(\overline{c} - \underline{c}) - d/(1-h)\right]$. But, if $d > (1-h)(\overline{c} - \underline{c})$, then such a price vector doesn't cover cost, and so no deviation is profitable.

The equilibrium outlined in Lemma 7 is essentially the specialization equilibrium of Wolinsky (1993), the only difference being that experts can reject to provide a treatment after having conducted the diagnosis in the Wolinsky model while they cannot reject in our present framework.[29] What drives the Wolinsky result is the combination of two assumptions, the assumption that consumers are neither able to observe the type of treatment they need nor the type they get (our Assumption V is violated), and the assumption that experts are liable for providing the cheap treatment when the expensive one is needed (our Assumption L holds).[30] Specialization equilibria cease to exist if Assumption L is violated, and they also cease to exist if Assumption V holds. We postpone the discussion of the case where neither liability nor verifiability holds to the next subsection and record the rest of the result as Lemma 8.

Lemma 8 *Suppose that prices are flexible, that consumers are homogeneous (Assumption H) and that the type of treatment is verifiable (Assumption V). Then the equilibria summarized in Lemma 1 (for the case where Assumption L is violated) and Lemma 3 (for the case where Assumption L holds) remain the only perfect Bayesian equilibria even if Assumption C is violated.*

Proof. The proof is similar to that of Lemma 1 and therefore omitted. ■

For obvious reasons, perfect Bayesian equilibria exhibiting specialization and perfect Bayesian equilibria in which experts overcharge customers also

[29] Glazer and McGuire (1996) characterize a similar equilibrium for a setting in which there are (by assumption) two types of experts, safe ones who can successfully serve all consumers, and risky ones whose treatment might fail. The focus of their work is on optimal referral from risky to safe experts after risky experts' diagnosis of a consumer's problem.

[30] Wolinsky (1993) doesn't explicitly impose the liability assumption. This assumption is implicit in his specification of consumer payoffs, however.

cease to exist if a single expert serves the market.[31]

We summarize the results of this subsection to the following proposition.

Proposition 3 *Perfect Bayesian equilibria exhibiting specialization and perfect Bayesian equilibria in which experts overcharge their customers might exists if Assumption C (Commitment) is violated.*

4.3 Neither Liability Nor Verifiability: The Credence Goods Market Breaks Down

In this subsection we consider an environment resembling a hidden action version of Akerlof's (1970) lemons model: consumers can neither observe the type of treatment they get (Assumption V is violated), nor punish the expert if they realize *ex post* that the type of treatment they received is not sufficient to solve their problem (Assumption L is violated too). Under these adverse conditions experts always provide the cheap treatment independently of whether the customer has the minor or the major problem.

Proposition 4 *Suppose that Assumption H (Homogeneity) holds, and that Assumptions V (Verifiability) and L (Liability) are violated. Then there is no perfect Bayesian equilibrium in which experts serve customers efficiently. If consumers valuation v is sufficiently high ($\underline{c}+d \leq (1-h)v$), then each expert charges a constant price (given by $\widetilde{p} = (1-h)v - d$ if a single expert provides the good, and by $\widetilde{p} = \underline{c}$ if there is competition in the credence goods market) and always provides the cheap treatment. If the consumers' valuation is too low ($\underline{c} + d > (1-h)v$) then the credence goods market ceases to exist.*

Proof. Obvious and therefore omitted. ■

Under the conditions of Proposition 4 consumers are neither able to observe the type of treatment they need, nor the type they get. Also, a consumer who observes *ex post* that the type of treatment he received is not sufficient to solve his problem, has no means to punish the expert. Given this, and given the cost differential $\overline{c} - \underline{c} > 0$, the expert(s) always provide(s) the cheap (and charge(s) for the expensive) treatment. Consumers anticipate this and consult an expert only if $\overline{p}$ is such that getting the cheap treatment

[31] Since the uniform price charged by the monopolistic expert under the conditions of Lemma 1 does not exceed consumers' gross utility v, they will not quit even if not committed, for their only alternative is to remain without any treatment.

at this price for sure increases their expected utility. If there is no $\overline{p} \geq \underline{c}$ that attracts customers, no trade takes place and the credence goods market ceases to exist.

The assumption that one treatment is more expensive than the second one is important for the negative result in Proposition 4. Without this assumption (that is, if $\overline{c} = \underline{c}$) expert(s) have no incentive to mistreat customers and therefore behave honestly. This helps to explain the Emons (2001) results. In his 2001 contribution Emons investigates the same basic model as in the 1997 paper (see our discussion in Section 3). That is, again capacity is required to provide treatments to homogeneous consumers, and once a given capacity level has been installed both types of treatment can be provided at zero marginal cost up to the capacity constraint. Again, one type of treatment uses up more units of capacity than the second. Also, there is no liability rule in effect that protects consumers from getting an inappropriate cheap treatment. The major difference between the two Emons contributions is (i) that the2001 article considers a credence good monopolist while the earlier paper is about competing experts, and (ii) that the 2001 article distinguishes between the cases of verifiable and unverifiable treatment, and between observable and unobservable capacity while the earlier paper deals only with the case of verifiable treatment together with observable capacity. The major result of Emons (2001) is that for three out of the four possible constellations the monopolist always behaves honestly. Only when capacity and treatment are both unobservable no trade takes place.

Efficiency with homogeneous consumers and verifiable treatments is exactly what one would expect given our Lemma 8. What is more intriguing is that Emons obtains efficiency even in one of the non-verifiability cases. The intuition for this result is as follows. With observable capacities the expert can publicly pre-commit to a technology (i.e., to a capacity level) that allows her to provide the right treatment to all consumers at zero marginal cost ($\overline{c} = \underline{c} = 0$). Consumers observe capacity, and since they know that there is nothing the monopolist can do with her technology but to provide honest services, they trust the expert and get honest treatment. By contrast, with unobservable capacities the expert has no pre-commitment technology at hand, and the credence goods market breaks down.[32] To summarize, our

[32] In the Emons paper the credence good market breaks down even if consumers' gross valuation v is high. The reason is the Emons assumption that not only the type of treatment is unobservable, but also whether treatment has been provided at all or not. Under this assumption the expert's capacity investment is zero irrespective of consumers'

analysis shows that many specific assumptions made by Emons (e.g., that capacity is needed to provide treatments, that success is a stochastic function of the type of treatment provided, etc.) are not important for his findings. What is important, however, for the positive part of his result is that consumers are homogeneous; with heterogeneous customers the effects described in Subsection 4.1 above would emerge and inefficiency obtain.

The equilibrium of Proposition 4 is rather extreme and one is tempted to argue in favor of public intervention, e.g. the introduction of a legal rule that makes the expert liable for providing an inappropriate inexpensive treatment. In reality, liability rules are far from being perfect mechanisms, however. Problems arise, e.g., in cases in which it is hard to prove that the treatment provided was not sufficient to solve the problem. For instance, a toothache needn't prove that necessary treatment was not provided, and proving to have a toothache is by itself hard, if not impossible. Liability rules may also fail to do their job when there is consumer moral hazard *ex post*. Is there a way out? In practice, experts might be kept honest by their need to maintain reputation (if bad reputation spreads, reputation considerations might mitigate the problem even if consumers are expected to buy only once), or by their desire to retain customers who are expected to need a treatment repeatedly.[33]

5 Conclusions

Previous work has fostered the impression that the equilibrium behavior of experts and consumers in the credence goods market delicately depends on the details of the model. By contrast, the present paper has shown that the results for the majority of the specific models can be reproduced in a very simple unifying framework.

Our analysis suggests that market institutions solve the fraudulent expert problem at no cost if (i) expert sellers face homogeneous customers, (ii) there exist large economies of scope between diagnosis and treatment, and (iii) either the type of treatment is verifiable, or a liability rule is in effect

valuation v. If only the type of treatment were unobservable, as is the case in the present paper, and if v were high enough, then the expert would install a capacity level that allows her to sell $\underline{c}$ to all consumers, exactly as one would expect from our Proposition 4.

[33] To our best knowledge Wolinsky (1993) is the only paper in the credence goods literature that studies the reputation mechanism. Wolinsky assumes liability, however.

protecting consumers from obtaining an inappropriate inexpensive treatment.

We have shown that inefficient rationing and inefficient treatment of some consumer groups may arise if condition (i) fails to hold, that equilibria involving overcharging of customers or duplication of search and diagnosis costs may result if condition (ii) is violated, and that the credence goods market may break down altogether if condition (iii) doesn't hold.

Our model might be considered restrictive in several respects. It rests on the assumption that there are only two possible types of problem and only two types of treatment, that treatment costs are observable, that posted prices are take-it-or-leave-it prices, that experts can diagnose a problem perfectly, and so on. This is certainly a justified criticism. Nevertheless our simple model is sufficient to derive most results of that class of models that have been the focus of research in the credence goods literature.[34] Thus, our simple model provides a useful benchmark for the development of more general frameworks which allow for an assessment of the robustness of the results.

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6 Appendix

Proofs of Lemmas 5, 6, and 7 follow.

Proof of Lemma 5 First note that any arbitrary menu of price vectors can be represented by (at most) three variables, by the lowest $\overline{p}$ from those vectors in the menu which have $\overline{p} > \underline{p} + (\overline{c} - \underline{c})$ (we denote the lowest $\overline{p}$ in this class by $\overline{p}^l$), by the lowest $\underline{p}$ from those vectors in the menu which have $\underline{p} > \overline{p} - (\overline{c} - \underline{c})$ (we denote this $\underline{p}$ by $\underline{p}^l$), and by the lowest equal mark-up Δ from all equal mark-up vectors in the menu (denoted by Δ^l). To see this, divide the vectors in the menu in the mentioned three groups, i.e., in the group of $\overline{p} > \underline{p} + (\overline{c} - \underline{c})$ vectors, the group of $\underline{p} > \overline{p} - (\overline{c} - \underline{c})$ vectors, and the group of $\overline{p} - \overline{c} = \underline{p} - \underline{c}$ vectors. A consumer who decides for a vector in the first group has (by the arguments in the proof of Lemma 2) an expected utility of $v - \overline{p} - d$; thus, he chooses the vector with the lowest $\overline{p}$, and all other vectors in the group can safely be ignored since they attract no customers.[35] Similarly, the expected utility under a $\underline{p} > \overline{p} - (\overline{c} - \underline{c})$ vector is $(1-h)\,v - \underline{p} - d$, and all vectors in the group but the one with the lowest $\underline{p}$ can be ignored since they are redundant. Finally, the expected utility under a vector with equal mark-ups of Δ is $v - \underline{c} - h(\overline{c} - \underline{c}) - \Delta - d$ and all vectors in the equal mark-up group but the one with the lowest Δ can be ignored. A first implication of this observation is that successful price discrimination requires that some types are mistreated with strictly positive probability. Why? Since at least two vectors must attract a positive measure of consumers and since only one of the two can be an equal mark-up vector. A second implication is that each menu of price vectors partitions the type-set into (at most) three subintervals (delimited by cut-off values $\widehat{h}$ and $\widetilde{h}$, with $0 \leq \widehat{h} \leq \widetilde{h} \leq 1$) such that (i) the optimal strategy of types in $[0, \widehat{h})$ is to choose the vector characterized by $\underline{p}^l$, (ii) the optimal strategy of types in $[\widehat{h}, \widetilde{h}]$ is to decide for the Δ^l vector, and (iii) the optimal strategy of types in $(\widetilde{h}, 1]$ is either to choose $\overline{p}^l$, or to remain untreated.[36] This follows from the fact that the expected utility under both, the Δ^l and the $\underline{p}^l$ vector, is strictly decreasing in h while the utility under $\overline{p}^l$ is a constant, and from $v > \overline{c} - \underline{c}$ (implying that the $\underline{p}^l$-function is steeper than the Δ^l function). Here, note that we allow for $\widetilde{h} = 1$ (all consumers are served and no consumer chooses $\overline{p}^l$), for $\widehat{h} = \widetilde{h}$ (no consumer is attracted by Δ^l), and for $\widehat{h} = 0$ (no consumer is attracted by $\underline{p}^l$). Price discrimination requires, however, that at lest two of the three relations hold as strict inequalities. Our strategy is now to show first that an optimal price-discriminating menu cannot have $\widehat{h} = \widetilde{h}$ (that is, there must be an equal mark-up vector which attracts a strictly positive measure of types), to show then that $\widehat{h} = 0$ whenever $\widehat{h} < \widetilde{h}$ (that is, the expert has never an incentive to post a menu where both an equal mark-up vector and a $\underline{p} > \overline{p} - (\overline{c} - \underline{c})$ vector attract types), and to show in the end that the expert has indeed always a strict incentive to cover a strictly positive interval $(\widetilde{h}, 1]$ by a $\overline{p}^l$ (that is, by a $\overline{p} > \underline{p} + (\overline{c} - \underline{c})$ vector). To see that $\widehat{h} < \widetilde{h}$, suppose to the contrary that $\widehat{h} = \widetilde{h}$. Then $\widehat{h} > 0$, since $\widehat{h} = \widetilde{h} = 0$ is incompatible with price-discrimination. But such a menu is strictly dominated, since the $\underline{p}^l$ vector can always be replaced

[35] Neither the consumer nor the expert cares about the associated $\underline{p}$. All vectors in the group that have the same $\overline{p}$ can therefore be thought off as being a single vector without any loss in generality.

[36] The borderline types $\widehat{h}$ and $\widetilde{h}$ are indifferent between the strategies of the types in the adjacent intervals (whenever such intervals exist).

by a vector with equal mark-ups of $\Delta = \underline{p}^l - \underline{c} + \widehat{h}(v - \overline{c} + \underline{c})$; the latter attracts exactly the same types as the replaced one and yields a strictly higher profit. To see that $\widehat{h} = 0$ whenever $\widehat{h} < \widetilde{h}$, suppose to the contrary that $0 < \widehat{h} < \widetilde{h}$. Then the expert's profit is strictly increased by removing all $\underline{p} > \overline{p} - (\overline{c} - \underline{c})$ vectors from the menu. This follows from the observation that all types in $[0, \widehat{h})$ switch to Δ^l when all $\underline{p} > \overline{p} - (\overline{c} - \underline{c})$ vectors are removed from the menu (by the monotonicity – in h – of the expected utility under Δ^l), and from the fact that the expected profit per customer is strictly higher under Δ^l than under $\underline{p}^l$ whenever $0 < \widehat{h} < \widetilde{h}$, since $\Delta^l \leq \underline{p}^l - \underline{c}$ is incompatible with the shape of expected utilities ($\Delta^l \leq \underline{p}^l - \underline{c}$ implies that $v - \underline{c} - h(\overline{c} - \underline{c}) - \Delta^l - d > (1 - h)\, v - p^l - d$ for all $h > 0$ contradicting $\widehat{h} > 0$.) Thus, $\widehat{h} = 0 < \widetilde{h} \leq 1$. So, if price discrimination is observed in equilibrium it is performed via a menu that contains two price vectors, one with equal mark-ups, and one with a higher mark-up for the more expensive treatment.[37] We now show that the expert has always a strict incentive to post such a menu. Consider the equal mark-up price vector posted by the expert under the conditions of Lemma 4. With this one-vector menu all types in $[0, \widetilde{h})$ have a strictly positive expected utility under the equal mark-up vector and therefore opt for it. Type $\widetilde{h}$ is also treated since he is indifferent and since indifferent types choose to be served, by assumption. Types in $(\widetilde{h}, 1]$ would have a strictly negative expected utility under Δ^l and, therefore, decide not to visit the expert. Now, suppose the monopolist posts a menu consisting of two vectors, the one chosen under the conditions of Lemma 4 and a second with $\overline{p} = v - d$ and $\underline{p} < \overline{p} - (\overline{c} - \underline{c})$. This vector guarantees each type an expected utility equal to the reservation utility of 0. Thus, all types in $(\widetilde{h}, 1]$ will opt for it since they are indifferent. Also, all types in $[0, \widetilde{h}]$ still choose the equal mark-up vector since $v - \underline{c} - h(\overline{c} - \underline{c}) - \Delta^l - d \geq v - \overline{p}^l - d = 0$ for $h \leq \widetilde{h}$ (with strict inequality for $h < \widetilde{h}$). Hence, since $\overline{p} = v - d > \overline{c}$ (the strict inequality follows from our assumption that it is *ex ante* efficient to treat all types), and since all types in $[0, 1]$ have strictly positive probability, the expert's expected profit is increased. Furthermore, the expert can do even better by increasing Δ^l. This follows from the observation that the expert's trade-off under the conditions of Lemma 4 is between increasing the mark-up charged from the types in the segment of served customers and losing some types to the unprofitable segment of not served consumers, while

[37]The menue might contain some redundant vectors too, which can safely be ignored, however.

the trade-off here is between increasing the mark-up charged from the types in the segment of customers served under the more profitable equal mark-up vector and losing some types to the segment of customers served under the less profitable $\overline{p} > \underline{p} + (\overline{c} - \underline{c})$ vector. ■

Proof of Lemma 6 For the behavior described in part (i) of the lemma to potentially form part of a *(weak) perfect Bayesian equilibrium* the probabilities o and a, and the mark up Δ must satisfy

$$d = (\overline{c} - \underline{c} - \Delta)\frac{(1-o)\,o\,(1-h)}{h + (1-h)\,o} \tag{1}$$

and

$$\Delta = (\overline{c} - \underline{c})\frac{a + o\,(1-a)}{1 + o\,(1-a)}. \tag{2}$$

The first of these two equations guarantees that consumers who get a $\overline{c}$ recommendation are indifferent between accepting and rejecting: If they reject, they incur an additional diagnosis cost of d for sure. Their benefit is to pay less for the treatment on their second visit with probability $[(1-o)\,o\,(1-h)]/[h + (1-h)\,o]$ because they have the minor problem with probability $[o\,(1-h)]/[h + (1-h)\,o]$ given that the expert has recommended $\overline{c}$. The second equation guarantees that experts are indifferent between recommending $\underline{c}$ and recommending $\overline{c}$ when the consumer has the minor problem: Recommending the cheap treatment guarantees a profit of $\underline{p} - \underline{c} = \Delta > 0$ for sure, while recommending the expensive treatment when only the cheap one is required is like playing in a lottery yielding a payoff of $\overline{p} - \underline{c} > \Delta$ with probability $[a + o\,(1-a)]\,/[1 + o\,(1-a)]$, and zero otherwise. This probability takes into account that a fraction $1/[1 + o\,(1-a)]$ of customers is on their first visit (and hence, is accepting the $\overline{c}$ recommendation with probability a), while the remaining fraction $o\,(1-a)\,/[1 + o\,(1-a)]$ is on their second visit (accepting the $\overline{c}$ recommendation for sure).[38] So, if prices are exogenously fixed at $(\underline{p}, \overline{p}) = (\underline{c} + \Delta, \overline{c})$, and if Δ is such that the probabilities a and

[38] A consumer who is indifferent between accepting and rejecting a $\overline{c}$ recommendation on his first visit will accept the $\overline{c}$ recommendation on his second visit because the probability of needing the minor treatment is lower on the second than on the first visit.

o satisfying equations (1) and (2) above are in $(0,1)$, [39] then the behavior described in the lemma is part of a situation in which experts' strategies are sequentially rational given consumers' strategies, consumers' strategies are sequentially rational given experts' strategies and their own beliefs, and consumers' beliefs are derived from experts' strategies using Bayes' rule.[40] In other words, with fixed prices the described behavior forms part of a perfect Bayesian equilibrium (henceforth *PBE*). To show that this behavior continues to form part of a *weak PBE* even if experts are free to choose $\underline{p}$ while $\overline{p}$ can vary within the range specified in part (i) of the lemma we have to specify out-of-equilibrium beliefs and strategies that support the equilibrium. Let k denote the expected cost to the customer if he follows the proposed equilibrium strategy; that is, $k = (1-h)(1-o)\underline{p} + [h + (1-h)o]\overline{p} + d = (\underline{c} + \Delta) + (\overline{c} - \underline{c} - \Delta)[h + (1-h)o] + d$. Similarly, let π denote the profit per customer if experts follow the proposed equilibrium strategy; that is, $\pi = (1-h)[1 + o(1-a)]\Delta$. Suppose that consumers' beliefs are correct at the proposed price vector and that consumers who get a treatment recommendation under a different price vector believe (i) that the expert will provide the appropriate treatment independently of her treatment-recommendation; (ii) that the expert's recommendation (and charging) policy is honest iff her posted prices satisfy $\underline{p} \leq d + (1-o)(\underline{c} + \Delta) + o\overline{c}$ and $\overline{p} \in [\overline{c}, \overline{c} + d)$; and (iii) that the expert always recommends $\overline{c}$ and that they have the minor problem if the expert recommends $\underline{c}$, in any other case. Further suppose that consumers visiting a deviating expert accept a $\underline{c}$ recommendation iff her $\underline{p}$ satisfies $\underline{p} \leq d + (1-o)(\underline{c} + \Delta) + o\overline{c}$, and that they accept a $\overline{c}$ recommendation iff her posted prices satisfy either $\underline{p} \leq d + (1-o)(\underline{c} + \Delta) + o\overline{c}$ and $\overline{p} \leq \overline{c} + d$, or $\underline{p} > d + (1-o)(\underline{c} + \Delta) + o\overline{c}$ and $\overline{p} \leq k$. Also suppose that deviating experts always recommend (and charge for) the expensive treatment.[41] Finally

[39] Here note that for any $(\overline{c}, \underline{c}, d, h)$ with $d < (\overline{c} - \underline{c})(1-h)$ there exists a Δ such that both a and o are in $(0,1)$.

[40] Consumer participation is assured by the assumption that $v > \overline{c} + d$.

[41] Here note that for out-of-equilibrium price-vectors satisfying $\underline{p} \leq d + (1-o)(\underline{c} + \Delta) + o\overline{c}$ and $\overline{p} \in [\overline{c}, \overline{c} + d]$, the proposed beliefs are not consistent with the proposed equilibrium strategies. Sequential rationality and *full* consistency of beliefs at *all* information sets (*full PBE*) would require that for all out-of-equilibrium price-vectors with these properties (i) the expert recommends $\overline{c}$ if the customer has the major problem and that she randomizes between recommending $\underline{c}$ and recommending $\overline{c}$ if he has the minor problem (and that the randomization is such that a customer who gets a $\overline{c}$ recommendation is indifferent between accepting and rejecting), and (ii) the consumer accepts a $\underline{c}$ recommendation and that he accepts a $\overline{c}$ recommendation with a strictly positive probability that keeps the

suppose that consumers' visiting strategy prescribes not to visit a deviating expert, and that experts' price-posting strategy prescribes not to deviate to a price vector different from the proposed one. First observe that consumers' acceptance strategies are indeed optimal given their beliefs: If a single expert deviates the proposed price vector is still available since at least two experts post this vector in equilibrium. The expected cost to the consumer under that vector is k with prior beliefs, it reduces to $d + (1 - o)(\underline{c} + \Delta) + o\overline{c}$ if the consumer believes to need the cheap treatment for sure, and it increases to $\overline{c} + d$ if the consumer believes to need the expensive treatment for sure. Given this, consumers' acceptance strategies are indeed optimal given their beliefs. Next observe that it is indeed optimal for a deviating expert to always recommend the expensive treatment, either because the expensive treatment is accepted with certainty and $\overline{p} \geq \overline{c}$, or because both types of treatment are rejected anyway. Given deviating experts' recommendation policy and $\overline{p} \geq \overline{c}$, consumers obviously prefer to ignore any deviating expert. This establishes that no deviation to an alternative price vector will attract any customers and so (and since $\pi > 0$) no deviation will occur.

To verify part *(ii)* of the lemma consider a deviation to a price vector $(\underline{p}, \overline{p})$ with $\underline{p} \in (\underline{c}, d + (1 - o)(\underline{c} + \Delta) + o\overline{c})$ and $\overline{p} > \overline{c} + d$. First observe that a consumer served under such a price vector will accept a $\underline{c}$ recommendation and reject a $\overline{c}$ recommendation for any belief that he might have. This follows from the fact that the only alternative price vector available if a single expert deviates is $(\underline{p}, \overline{p}) = (\underline{c} + \Delta, \overline{c})$ and that the cost to the consumer under that vector is $d + (1 - o)(\underline{c} + \Delta) + o\overline{c}$ if the consumer believes to need the cheap treatment for sure while it is $\overline{c} + d$ if the consumer believes to need the expensive treatment for sure. Given consumers' acceptance behavior, sequential rationality for the expert requires that her recommendation policy is honest. This follows from $\underline{p} > \underline{c}$ (so that it is indeed optimal to recommend $\underline{c}$ to a consumer with the minor problem) and $\underline{p} < \overline{c}$ (so that it is never optimal to recommend $\underline{c}$ to a consumer who needs $\overline{c}$), where the latter inequality is implied by consumers' indifference between accepting and rejecting a $\overline{c}$ recommendation under $(\underline{p}, \overline{p}) = (\underline{c} + \Delta, \overline{c})$ and by $\underline{p} < d + (1 - o)(\underline{c} + \Delta) + o\overline{c}$. Given deviating experts' recommendation- and consumers' acceptance-behavior, the expected cost to a first-time consumer who plans to visit the deviator is $\widehat{k} = d + (1 - h)\underline{p} + h(d + \overline{c})$: with

expert indifferent between recommending $\underline{c}$ and recommending $\overline{c}$ whenever the customer has the minor problem.

probability $(1-h)$ the consumer has the minor problem and gets treated for the price $\underline{p}$ by the deviator; with probability h he has the major problem, the deviator recommends $\overline{c}$, the consumer rejects, visits a non-deviator and gets the right treatment for the price $\overline{c}$. So, if $\widehat{k} < k$ then the deviator attracts all first-time consumers and serves them at an expected profit of $\widehat{\pi} = (1-h)(\underline{p} - \underline{c})$ per customer. The inequality $\widehat{k} < k$ is equivalent to $\underline{p} < \underline{c} + \Delta + o(\overline{c} - \underline{c} - \Delta) - dh/(1-h)$, which (using the indifference equations (1) and (2) above) is again equivalent to $\underline{p} < \underline{c} + \Delta + do/[(1-o)(1-h)]$. Now suppose the deviating expert sets $\underline{p} = \underline{c} + \Delta + do/[(1-o)(1-h)] - \epsilon$, which ϵ strictly positive but smaller than $do/[(1-o)(1-h)]$. Then she attracts all consumers and, thus, makes an expected profit $\widehat{\pi}m > (1-h)\Delta m$. The expected profit per expert in the proposed symmetric overcharging equilibrium is $\pi m/n = (1-h)[1+(1-a)o]\Delta m/n$ which is strictly less than $(1-h)2\Delta m/n$ implying that $\widehat{\pi}m < \pi m/n$ even for $n=2$. This establishes that the *weak PBE* sketched in part (i) of the lemma ceases to exist if experts are completely free in choosing prices since a profitable deviation always exists. ■

Proof of Lemma 7 To show that the proposed strategies are part of a *(full) PBE* we have to specify reasonable out-of-equilibrium beliefs and strategies that support the equilibrium. Let k denote the expected cost to the customer if he follows the proposed equilibrium strategy; that is, $k = d + (1-h)\underline{c} + h(\overline{c} + d)$. Suppose that consumers believe (i) that experts always provide the appropriate treatment independent of their original treatment-recommendation; (ii) that an expert's recommendation (and charging) policy is honest if her posted prices satisfy either $\underline{p} = \overline{p} \leq \underline{c} + d$, or $\overline{p} > \overline{c} + d$ and $\underline{p} < \overline{c}$; (iii) that the expert always recommends $\underline{c}$, and that they have the major problem if the expert recommends $\overline{c}$, if $\overline{p} > \overline{c} + d$ and $\underline{p} > \overline{c}$; (iv) that the expert recommends $\overline{c}$ if the customer has the major problem and that she randomizes between recommending $\underline{c}$ and recommending $\overline{c}$ if he has the minor problem (and that the randomization is such that a customer who gets a $\overline{c}$ recommendation is indifferent between accepting and rejecting) whenever $\overline{p} \in (k, \overline{c} + d)$ and $\underline{p} < \underline{c} + d$; and (v) that the expert always recommends $\overline{c}$, and that they have the minor problem if the expert recommends $\underline{c}$, in any other case. Further suppose that customers who visit an expert who has posted a price-vector where $\overline{p} > \overline{c} + d$ and $\underline{p} > \overline{c}$ accept a $\underline{c}$ recommendation if $\underline{p} \leq k$ and reject it otherwise, and that customers who visit other experts accept a $\underline{c}$ recommendation if $\underline{p} \leq \underline{c} + d$ and reject it otherwise.

Also suppose that new customers (first time visitors) who visit an expert who has posted a price vector satisfying $\overline{p} < k$ accept a $\overline{c}$ recommendation with certainty; that new customers who visit an expert who has posted a price vector satisfying $\overline{p} \in (k, \overline{c} + d)$ and $\underline{p} < \underline{c} + d$ accept a $\overline{c}$ recommendation with a strictly positive probability that keeps the expert indifferent between recommending $\underline{c}$ and recommending $\overline{c}$ whenever the customer has the minor problem; and that new customers who visit other experts reject a $\overline{c}$ recommendation with certainty. Finally suppose that consumers on their second visit accept a $\overline{c}$ recommendation whenever $\overline{p} \leq \overline{c} + d$. Now assume that consumers choose the proposed visiting strategy provided no deviating expert offers either $\underline{p} < \underline{c}$ and $\overline{p} > \overline{c} + d$, or $\overline{p} < \overline{c}$, and that experts behave in accordance with consumers' beliefs. First observe that customers beliefs reflect experts' incentives: Under the conditions of Lemma 7, liability prevents undertreatment and the cost difference $\overline{c} - \underline{c} > 0$ prevents overtreatment. So each expert will always provide the appropriate treatment if the customer agrees to proceed after the diagnosis. An expert might, however, recommend the wrong treatment. The expert recommends honestly if $\overline{p} < \underline{c} + d$ and $\underline{p} = \overline{p}$, and if $\overline{p} > \overline{c} + d$ and $\underline{p} < \overline{c}$, either since both recommendations are accepted and have the same price (in the former case), or since consumers prefer to leave after a $\overline{c}$ recommendation and recommending the cheap treatment to a customer who has the major problem is not profitable (in the latter case); the expert always recommends $\underline{c}$ if $\overline{p} > \overline{c} + d$ and $\underline{p} > \overline{c}$, since a $\overline{c}$ recommendation is always rejected and since the price of the cheap treatment exceeds the cost of the expensive one; the expert recommends $\overline{c}$ if the consumer has the major problem and she randomizes between recommending $\underline{c}$ and recommending $\overline{c}$ if he has the minor problem whenever $\overline{p} \in (k, \overline{c} + d)$ and $\underline{p} \in (\underline{c}, \underline{c} + d)$ since the $\underline{c}$ recommendation is always accepted while the $\overline{c}$ recommendation is rejected with such a probability that she is exactly indifferent between both recommendations (by construction); and the expert recommends the expensive treatment in all other cases, either because the expensive treatment is accepted with certainty and $\overline{p} > \underline{p}$, or because both types of treatment are rejected anyway. Next observe that customers' strategies are optimal given their beliefs: First consider consumers' acceptance strategies. If a single expert deviates the proposed equilibrium offers are still available since at least two experts make each offer. Thus, the above described acceptance strategies are optimal given consumers' beliefs. Next consider new consumers' visiting strategy. If no expert deviates the relevant alternatives are (i) to visit a cheap expert first and to reject the $\overline{c}$ recommendation as proposed, or (ii) to visit an expensive expert first and to accept the $\overline{c}$ recommendation. The former strategy has an expected cost of $d+(1-h)\,\underline{c}+h\,(\overline{c}+d)$, the latter a cost of $\overline{c}+d$, while the benefit is the same. Since $(\overline{c}-\underline{c})\,(1-h)\,/h > (\overline{c}-\underline{c})\,(1-h) > d$ the former cost is strictly lower and customers' visiting strategy is optimal if no expert deviates. Given that the equilibrium offers are still available if a single expert deviates, and given the above specified beliefs, no customer has an incentive to visit a deviating expert if her posted prices do not satisfy either $\underline{p} < \underline{c}$ and $\overline{p} > \overline{c}+d$, or $\overline{p} < \overline{c}$. Finally observe that no expert has an incentive to deviate: Deviations to prices satisfying $\underline{p} < \underline{c}$ and $\overline{p} > \overline{c}+d$ are unattractive since only the $\underline{c}$ recommendation is accepted. Deviations to price vectors where $\underline{p} \geq \underline{c}$ and $\overline{p} \geq \overline{c}$ are unattractive since they attract no customers. Price vectors where $\overline{p} < \overline{c}$ are unprofitable too, if they only attract customers who first visit a cheap expert, and, if recommended the expensive treatment, resort to the deviator. The expected cost to the customer of this latter strategy is $d+\underline{c}+h\,(\widehat{p}+d-\underline{c})$, where $\widehat{p}$ is the price posted by the deviator for the expensive treatment. Going directly to the deviator and accepting her recommendation, on the other hand, costs at most $\widehat{p}+d$. Thus, in order to avoid being visited only by consumers with the major problem, the deviation must satisfy $d+\underline{c}+h\,(\widehat{p}+d-\underline{c}) > d+\widehat{p}$, which is equivalent to $\widehat{p} < \underline{c}+dh/\,(1-h)$. To cover expected treatment cost the price $\widehat{p}$ must also satisfy $\widehat{p} \geq \underline{c}+h\,(\overline{c}-\underline{c})$. But, $\underline{c}+h\,(\overline{c}-\underline{c}) > \underline{c}+dh/\,(1-h)$, since $(1-h)\,(\overline{c}-\underline{c}) > d$. This proves that no deviation by an expert is profitable. ■

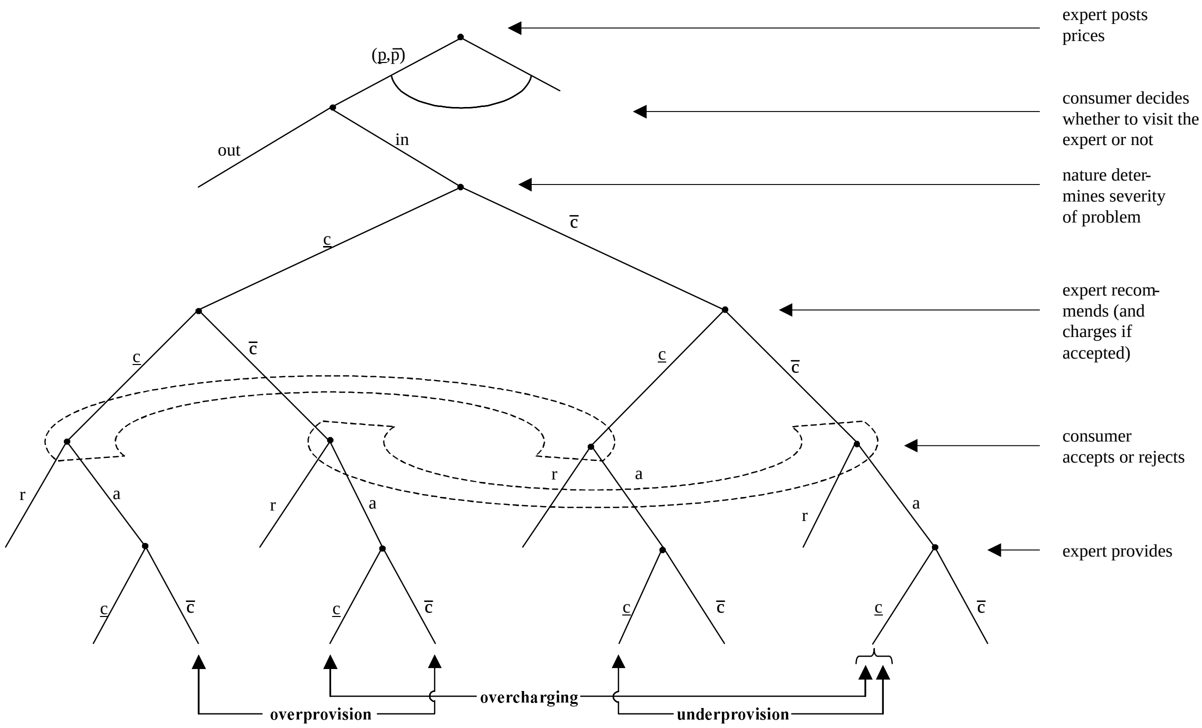

Figure 4: (=Figure 1) Game Tree for the Credence Goods Problems