

# Credence Goods Markets with Conscientious and Selfish Experts\*

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## Abstract

I study credence goods markets when there are both selfish and conscientious experts. The selfish expert is a profit maximizer. The conscientious expert wants to maximize profit and repair the consumer's problem. There are two classes of equilibria: uniform-price equilibria and nonuniform-price equilibria. A consumer cannot infer the expert's type from his price list in a uniform-price equilibrium but can do that in a nonuniform-price equilibrium. When the fraction of the conscientious expert is small, the selfish expert will be honest about the severity of the consumer's problem. When the fraction of the conscientious expert is large, the selfish expert will cheat the consumer; overcharging the consumer whenever he offers to repair the problem. Finally, more conscientious experts may result in a larger social loss.

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# 1 Introduction

This article examines credence goods markets. A credence good is one whose quality cannot be evaluated by the buyer even after the buyer has consumed it (Darby, 1973). Suppose that the brake in your car is not working properly. A mechanic tells you that your brake fluid reservoir is leaking and recommends you to replace it and refill the brake fluid. Suppose that you accept the offer. Indeed, after the repair, the brake works properly. You never get to find out whether a simple refill could have been sufficient to solve the problem. In addition, you may not be able to verify whether the fluid reservoir has been replaced as promised.

Asymmetric information in credence goods markets allows an expert to exploit a consumer by exaggerating the problem. The existing literature studies market outcomes when experts are pure profit maximizers. In reality, most of us have met experts whose behavior is not consistent with profit maximization. Harvard Medical School asks students to pair with patients. Each medical student follows along on the patient's visits to her specialists. The objective of the exercise is that walking in patients' shoes may teach students to care. Time magazine comments on this, saying, "At Harvard and other medical schools across the country, educators are beginning to realize that empathy is as valuable as any clinical skill."<sup>1</sup> It is hard to believe that every student trained by this doctrine will become a doctor who merely wants to maximize profit. In our academic profession, we all know professors who spend considerable time advising students in the summer. They could have instead worked on their own papers or gone for vacation with families. What profit can they make by sacrificing their time?

Psychologists and sociologists have recognized for a long time that job satisfaction stems not only from financial rewards but also from intrinsic motivations. Herzberg (1959)

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<sup>1</sup>"Teaching Doctors to Care", TIME, May 29, 2006

claims that a worker's motivation is related to two factors: motivators and hygiene. Motivators include achievement, the work itself, recognition, responsibility and advancement. The hygiene elements include salary, company policies, supervision, interpersonal relations and working conditions. Friedlander (1964), Ewen (1966), Wernimont (1966), and Knoop (1994) show that motivators are positively correlated with job satisfaction and have significant influence on work performance.

As behavioral economics progresses, the limitation of the pure self-interested assumption has raised more and more concerns. Various modifications on this assumption have been considered. Lindbeck and Weibull (1988) analyze the strategic and intertemporal interaction between two economic agents who have altruistic concerns for each other's welfare. Rabin (1993) incorporated fairness into game theory. In the fairness equilibria, people want to be nice to those who treat them fairly but punish those who hurt them. Fehr and Schmidt (1999) study the interaction between self-interested agents and agents with a fairness concern. Alger and Ma (2003) analyze an optimal insurance contract when some health care providers are collusive while some are honest about the consumer's treatment cost. Benabou and Tirole (2003) study a worker's extrinsic and intrinsic motivations.

This paper departs from the existing credence goods literature by including both selfish and conscientious types of expert in a market. The selfish expert is a profit maximizer. The conscientious expert's utility comes from profit and repairing the consumer's problem. This assumption has two interpretations. First, an expert may directly get satisfaction from work itself as described by the psychology literature. Second, an expert may obtain satisfaction from work indirectly through a reputation for competence. A newly established car repair shop can build up a reputation of competence by solving consumers' problems at a low price initially and can make a profit in the future through the good reputation.

I adopt the standard credence goods literature's framework and ask the following research questions. How does the presence of a conscientious expert influence the selfish expert's behavior? Can the consumer identify the type of the expert by either price lists or recommendation strategies? Do more conscientious experts always result in a more efficient market equilibrium?

In my model, there is a monopoly expert and a consumer. In line with Wolinsky (1993), Fong (2005) and Emons (1997, 2001), it is assumed that the consumer has either a minor problem or a serious problem, but he does not know which one it is. The novelty of my model is that the expert can be one of two types: the conscientious type or the selfish type. The expert knows his type and posts a price list for the possible repairs. The consumer visits the expert; the expert learns the nature of the problem. Then the expert either refuses to provide a repair or offers to repair the problem at a price chosen from the posted prices. Upon hearing a recommendation, the consumer decides whether to accept the repair offer. If the consumer accepts the repair offer, his problem is solved at the quoted price.

I find two classes of equilibria: uniform-price equilibria and nonuniform-price equilibria. In a uniform-price equilibrium, both types of expert post the same single price; therefore, the consumer cannot distinguish the expert's type by price. The conscientious expert repairs both problems, whereas the selfish expert only repairs the minor problem. When the selfish expert treats the minor problem, he overcharges the consumer; that is, he charges a price higher than the consumer's willingness to pay for the minor problem. The intuition behind the uniform-price equilibria is the following. The single price results in a positive profit for the conscientious expert when the problem is minor and a loss when the problem is serious, but he will repair both problems. If the conscientious expert's profit from repairing the minor problem is high enough, the selfish expert will mimic him by posting the same single price; the selfish expert will then repair the minor

problem but reject the serious problem to avoid a loss.

In a nonuniform-price equilibrium, the consumer can infer the expert's type by the price lists. The conscientious expert posts a single price and repairs both problems. The selfish expert posts different prices. He recommends the high price when the problem is serious; he randomizes between recommending the high price and the low price when the problem is minor. The consumer accepts the low price offer and rejects the high price offer with a positive probability. The conscientious expert's single price is so low that the selfish expert would not post that price even if the consumer accepts it with probability one. The conscientious expert gets a high utility from repairing the problem. Hence, he would not copy the selfish expert's price list, trading off a high acceptance rate for a high profit. The consumer rejects the selfish expert's serious treatment offer with a positive probability to prevent the selfish expert from always misreporting a minor problem as the serious problem.

I select the most profitable equilibrium for both types of expert for comparative statics. This is for two reasons. First, the conscientious expert always repairs the consumer's problem in equilibrium. Besides satisfaction from repairing the problem, he also maximizes profit. Second, a monopolist often has a stronger bargaining power against a consumer and therefore the equilibrium is more likely to be in favor of the monopolist. When the expert is very likely to be selfish, the most profitable equilibrium is a nonuniform-price equilibrium. When the expert is very likely to be conscientious, the most profitable equilibrium is a uniform-price equilibrium.

In a nonuniform-price equilibrium, the expert's type is revealed. Once the consumer can infer the expert's identity, the fraction of the conscientious expert,  $\lambda$ , does not play any role in the nonuniform-price equilibrium. In contrast, the expert's profit in a uniform-price equilibrium increases in  $\lambda$ . This is because when the expert is more likely to be conscientious, upon hearing a recommendation the consumer believes that his problem is

more likely to be serious. Hence, his willingness to pay is higher. When  $\lambda$  is above some threshold, the uniform-price equilibrium is the most profitable equilibrium.

Are more conscientious experts always better in terms of efficiency? To answer this question, the efficiency of the most profitable equilibrium as a function of  $\lambda$  is analyzed. In my model, it is socially efficient to have both problems repaired. In both the nonuniform-price and uniform-price equilibrium regimes the minor problem is always repaired. Any social loss is due to an unsolved serious problem. When  $\lambda$  increases, two effects influence efficiency. On the one hand, the consumer has a higher chance to see the conscientious expert who will always repair the problem. This improves efficiency. On the other hand, when  $\lambda$  increases, the market is more likely to be in the uniform-price equilibrium regime. Here, the selfish expert free rides on the conscientious expert and behaves worse than in the nonuniform-price equilibrium regime. This leads to a larger social loss. Because of the two opposite effects, efficiency is not monotonic in  $\lambda$ . When  $\lambda$  is close to one of the two extremes, 0 and 1, more conscientious experts will result in a smaller social loss. When  $\lambda$  is in a middle range, more conscientious experts may result in a larger social loss.

Pitchik and Schotter (1987) study an expert's fraudulent behavior in a setting with exogenously given prices. They found a mixed strategy equilibrium in which the expert randomizes between lying and telling the truth. Emons (1997, 2001) assumes that consumers can verify whether the recommended service is delivered by the expert. Hence, cheating becomes costly. In his equilibrium, an expert never cheats. In my paper, the consumer cannot verify whether the recommended service is performed and therefore the selfish expert is more tempted to cheat.

Wolinsky (1993) studies market equilibrium in a competitive setting wherein the consumer can consult multiple experts by incurring a search cost. He identifies a specialization equilibrium in which some experts repair a minor problem while others repair a serious problem. In my model, there is a monopolist expert and the consumer does not search.

A uniform-price equilibrium resembles Wolinsky's specialization equilibrium in the sense that the selfish expert only repairs the minor problem and the conscientious expert repairs both problems.

My article is closely related to Fong (2005). The main result in Fong is that the selfish expert never misreports a minor problem as a serious one, but the consumer sometimes rejects the serious treatment offer. The market inefficiency results from the consumer's rejection because the price is so high that it extracts the entire consumer surplus. My paper models both selfish and conscientious experts. In contrast to Fong's result, I identify another source of market inefficiency stemming from the selfish expert's refusal to repair the serious problem. The selfish expert does so because the price is too low to cover the treatment cost for the serious problem. These results contrast strongly against those in Fong (2005).

Other important studies about principal-agent model with multiple types of agents are also related to my article. Alger and Renault (2006) study a principal-agent model when the agent is either honest or opportunistic. An honest agent reports his ability truthfully to the principal while an opportunistic agent may misreport his ability to maximize material payoff. They examine the optimal contract when the agent has two dimensional private information: his type and his ability. My model is different from theirs in the following ways. First, in their model, it is the uninformed party, the principal, moves first by offering a contract to the agent. In my model, it is the informed party, the expert, moves first by offering a price list. Second, the honest agent commits to reporting his ability truthfully to the principal, while the conscientious expert does not commit to being honest about the nature of the consumer's problem.

The rest of the paper is organized as follows. Section 2 introduces the model. Section 3 derives the uniform-price and nonuniform-price equilibria. Section 4 analyzes market efficiency as a function of  $\lambda$ . Section 5 discusses market equilibrium in a competitive

setting. Section 6 concludes.

## 2 The model

### 2.1 Players and payoff functions

There are two players in the model, a monopoly expert and a consumer. The consumer has either a serious problem or a minor problem. The problem is serious with probability  $\alpha$ , with  $\alpha \in (0, 1)$ . Let  $s$  denote the serious problem and  $m$  denote the minor problem. If problem  $i \in \{m, s\}$  is left unresolved, the consumer suffers a loss  $l_i$ , with  $l_m < l_s$ . The consumer's utility of having the problem unrepaired is  $-l_i$ . If he accepts a repair offer at  $p$ , his payoff is  $-p$ .

The expert is either a conscientious type or a selfish type. The selfish expert only cares about profit; his payoff from repairing problem  $i$  at price  $p$  is  $p - r_i$ , where  $r_i$  is the treatment cost for problem  $i$ , with  $r_m < r_s$ . The conscientious expert cares about both profit and the consumer's well being; his payoff from repairing problem  $i$  at price  $p$  is  $p - r_i + kl_i$ , where  $k$  denotes the degree of conscientiousness. When  $k = 0$ , the conscientious expert becomes the selfish expert. As  $k$  increases, the conscientious expert's utility from repairing the problem rises. This paper studies what incentives a few conscientious experts may create for the selfish experts; therefore, the conscientious expert's motive needs to be sufficiently different from that of the selfish expert. Assume that  $k \geq \frac{r_s}{l_s}$ . When  $k \geq \frac{r_s}{l_s}$ , the conscientious expert will repair the serious problem for free. An expert's payoff is zero if he does not repair the problem.

In line with earlier literature, the assumption is that it is efficient to repair both problems, i.e.,  $0 < r_i < l_i, i \in \{m, s\}$ . Let  $E(l) \equiv \alpha l_s + (1 - \alpha)l_m$ . The equilibria under the condition  $E(l) < r_s$  are analyzed in sections 3 and 4. The case of  $E(l) > r_s$  is discussed

in section 5.

## 2.2 Information structure

It is common knowledge that the consumer has a serious problem with probability  $\alpha$ , with  $0 < \alpha < 1$ , and that the expert is a conscientious type with probability  $\lambda$ , with  $0 < \lambda < 1$ . The consumer knows that he has a problem but does not know if it is serious or minor. After diagnosing the problem, the expert learns whether it is serious or minor, but this remains his private information. If the expert repairs the problem  $i \in \{m, s\}$ , the consumer only knows that his problem is solved but does not know which treatment cost  $r_i$  is incurred. Implicitly, I have assumed that the resolution of a problem is a verifiable or contractible event, but the type of repair for the resolution is not.

## 2.3 Extensive form

I consider the following extensive form game.

- Stage 1: Nature decides the severity of the consumer's problem,  $l_i, i \in \{m, s\}$ , and the expert's type, according to the probabilities  $\alpha$  and  $\lambda$  respectively.
- Stage 2: Nature informs the expert of his type; this information is unknown to the consumer. Then the expert posts a price list  $(p_m, p_s)$ , with  $p_m \leq p_s$ .
- Stage 3: The expert observes the severity of the consumer's problem; the severity is unknown to the consumer. The expert either declines to repair the consumer's problem, or offers to treat the consumer at a price taken from his price list  $(p_m, p_s)$ .
- Stage 4: If a price  $p_i$  is offered by the expert, the consumer decides whether to accept the repair offer. If the consumer accepts, he pays the price  $p_i$ , a repair is performed and the problem is resolved.

### 3 The equilibria

To simplify the analysis, the expert is restricted to post only prices that are recommended with a positive probability. An expert will never set a price below  $r_m$  or above  $l_s$ . Any price  $p > l_s$  will be rejected by the consumer. Any price  $p < r_m$  will be accepted by the consumer but will generate a smaller profit than  $p' = p + \epsilon$ , for a sufficiently small  $\epsilon > 0$ . Therefore experts are restricted to posting their prices in the range of  $[r_m, l_s]$ .

One degenerate case of my model is when there is only a selfish expert,  $\lambda = 0$ . This is studied by Fong (2005). This unique equilibrium is presented in Proposition 0.

**Proposition 0.** *When the expert is always selfish ( $\lambda = 0$ ), there always exists a unique Subgame Perfect Equilibrium outcome not involving weakly dominated strategies. In the equilibrium, the expert posts a price list  $(l_m, l_s)$ . He recommends  $l_m$  in state  $m$  and recommends  $l_s$  in state  $s$ . A consumer accepts  $l_m$  with probability one and accepts  $l_s$  with probability  $\frac{l_m - r_m}{l_s - r_m}$ .*

*Proof.* Refer to Proposition 1 in Fong (2005). □

Recall that in this and the next sections, I assume  $E(l) < r_s$ . The condition  $E(l) < r_s$  implies  $r_m < l_m < r_s < l_s$ . The expert can raise  $p_m$  up to  $l_m$ , the consumer's willingness to pay for the minor problem, because any  $p_m$  less than  $l_m$  is accepted regardless of the consumer's belief about the severity of his problem. Raising the price for the serious problem  $p_s$  has two effects. A higher  $p_s$  results in a higher profit margin for repairing the serious problem. Meanwhile, a higher  $p_s$  may trigger a higher rejection rate by the consumer because the consumer knows that the expert has an incentive to misreport the minor problem as the serious problem when  $p_s$  is high. The gain in profit margin dominates the loss of rejection. Hence, the expert will set  $p_s$  to  $l_s$ , the consumer's willingness to pay for the serious problem. In Fong's model, the continuation game after each price

list is a proper subgame. The equilibrium in Proposition 0 gives the selfish expert the highest profit among all the subgames and therefore is the unique subgame-perfect Nash equilibrium.

In Fong's equilibrium, the expert recommends  $l_m$  when the problem is minor and  $l_s$  when it is serious. This no cheating result is driven by the high price  $p_s = l_s$ . When the price for repairing the serious problem,  $p_s$ , is so high that it extracts all the surplus of repairing the serious problem, the consumer will reject this offer completely if the expert lies with an arbitrarily small probability. Rejection by the consumer is the source of inefficiency. However, it is this rejection that disciplines the expert's behavior and supports the equilibrium.

Now the model is studied with both selfish and conscientious types of expert; that is,  $\lambda \in (0, 1)$ . Two classes of equilibrium outcomes are identified: uniform-price equilibrium outcomes and nonuniform-price equilibrium outcomes.

**Proposition 1.** (*Uniform-price Equilibria*). *There is a continuum of equilibrium outcomes in which both types of expert post the same single price. An equilibrium outcome is indexed by  $p \in [l_m, \bar{p}]$ , with  $\bar{p} = \frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + (1-\alpha)}$ . In such an equilibrium, both types of expert post a single price  $p$ . The conscientious expert always offers to repair the problem at price  $p$ . The selfish expert offers to repair the minor problem at price  $p$ ; he declines to repair the serious problem. The consumer always accepts the repair offer  $p$ .*

When both types of expert post the same price list  $p$ , the consumer cannot infer the identity of the expert from a repair offer at  $p$ . Given the expert's equilibrium strategy, the consumer updates his belief about having a serious problem by Bayes' rule after recommended  $p$ ; his expected loss from the problem is  $E(l|p) = \frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + (1-\alpha)}$ . Since  $E(l|p)$  is at least the price charged by the expert, the consumer will accept this repair offer.

A uniform-price equilibrium is supported by the following consumer beliefs after an off-equilibrium repair offer  $p' \neq p$ . If  $p' < p$ , the consumer believes that the expert is conscientious and, accordingly, his problem is serious with probability  $\alpha$ , the prior. If  $p' > p$ , the consumer believes that the expert is selfish. In addition, his belief about the nature of the problem depends on the comparison between  $p'$  and  $r_s$ . If  $p < p' < r_s$ , the consumer believes that his problem is minor; if  $r_s \leq p' \leq l_s$ , he believes that the problem is serious with probability  $\alpha$ .

I call the consumer with such beliefs a pessimist in the sense that he regards the expert as selfish if he is recommended an off-equilibrium price higher than the equilibrium price. The pessimist's beliefs can be justified by the following argument: When the conscientious expert's benefit from repairing the problem is sufficiently large, he will not bear the risk of rejection in exchange for a higher profit by raising the repair offer above  $p$ . In comparison with the conscientious expert, the selfish expert has a stronger incentive to deviate to a price above  $p$ .

The model requires that the consumer's belief about the nature of the problem must be consistent with his belief about the expert's type. A conscientious expert will always repair the consumer's problem. Hence, the consumer will not update his belief about the nature of the problem if he is recommended  $p' < p$ . When  $p'$  is greater than  $p$ , the consumer believes that the expert is the selfish type who will not repair the problem when the quoted price is smaller than the treatment cost. Hence, when  $p'$  is smaller than  $r_s$ , the serious treatment cost, the consumer believes that he has a minor problem. When  $p'$  is at least  $r_s$ , the selfish expert will always offer to repair a problem at  $p'$ . Hence, the consumer's belief about having a serious problem remains the prior,  $\alpha$ .

According to the consumer's off-equilibrium beliefs, he will accept a repair offer below  $p$  and reject a repair offer above  $p$ . The consumer accepts  $p$  in equilibrium. Clearly, he will accept  $p'$  lower than  $p$  if  $p'$  is offered by the conscientious expert. If the consumer is

recommended  $p' \in (p, r_s)$ , his expected loss,  $l_m$ , is smaller than  $p'$ , therefore he will reject such a repair offer. If the consumer is recommended  $p' \geq r_s$ , his expected loss  $E(l)$ , which is less than  $r_s$ , is smaller than  $p'$ . Hence, the consumer will reject this repair offer as well. Given the consumer's optimal strategy after a repair offer  $p'$ , there is no profitable price deviation for both types of expert.

The condition  $E(l) < r_s$  implies that  $p$  is higher than the treatment cost for the minor problem and lower than the treatment cost for the serious problem. The conscientious expert commits to repair the problem even if it turns out to be serious. The selfish expert will decline to treat the serious problem and overcharge the consumer for the minor problem; that is, the selfish expert charges the consumer a price higher than his loss from the minor problem if the problem is indeed minor.

The class of the uniform-price equilibria survive the Cho-Kreps intuitive criterion. The conscientious expert cannot deviate to a higher price and convince the consumer to accept the deviation. Suppose the conscientious expert deviates to  $p' > p$ . The most favorable reaction he can expect from the consumer is to accept  $p'$  with probability one. However, if the consumer accepts  $p'$  with probability one, the selfish expert will also deviate to offering  $p'$ . By the same logic, the selfish expert cannot deviate to a higher price and convince the consumer to accept the price.

The upper bound of the uniform equilibrium price is  $\frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + (1-\alpha)}$ , which increases in both  $\lambda$  and  $\alpha$ . When the expert is more likely to be conscientious or the consumer is more likely to have a serious problem, the expected loss from the problem conditional on the recommendation  $p$  is higher. The consumer's willingness to pay becomes higher accordingly. When  $\lambda$ , the fraction of the conscientious expert, is one, the expert will charge  $E(l)$  and always repair the consumer's problem. This equilibrium is efficient and allows the expert to take away the entire social surplus.

The existence of the conscientious expert creates an incentive for the selfish expert to

cream skim the consumer with a minor problem and dump the consumer with a serious problem. The unsolved serious problem creates a social loss due to the fact that the uniform price is too low for the selfish expert to cover the serious treatment cost. This result is in sharp contrast to Fong's equilibrium. In Fong, it is the consumer who sometimes rejects the serious problem treatment offer and creates a social loss. The rationale behind the consumer's rejection is that the price for the serious problem is so high that if the consumer accepts it with probability one, the selfish expert will always misreport the minor problem as the serious one.

Uniform-price equilibrium outcomes are ranked by efficiency and profitability in Corollary 1 and Corollary 2, respectively.

**Corollary 1.** *Uniform-price equilibrium outcomes are equally efficient.*

Under the condition  $r_i < l_i, i \in \{m, s\}$ , it is socially efficient to have both problems repaired. I measure market inefficiency as the social loss from an unresolved problem. In a uniform-price equilibrium, a minor problem is always repaired whereas a serious problem remains unresolved with probability  $1 - \lambda$ . The social inefficiency of a uniform-price equilibrium is therefore  $\alpha(1 - \lambda)(l_s - r_s)$ . The distinctions among uniform-price equilibria are the distributions of wealth between the consumer and the expert.

**Corollary 2.** *The most profitable uniform-price equilibrium outcome is one in which both types of expert post a single price  $\bar{p} = \frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + (1-\alpha)}$ .*

In a uniform-price equilibrium, both types of expert post the same price  $p$  in  $[l_m, \bar{p}]$ , and the consumer always accepts a repair offer at  $p$ . Clearly, both types of expert's profits reach the maximum at  $\bar{p}$ .

Thus far, the equilibria in which both types of expert post the same price are characterized. Next, I will characterize other equilibria in which different type of expert posts a different price list.

**Proposition 2.** (*Nonuniform-price Equilibria*) *There is a continuum of equilibrium outcomes in which each type of expert posts a different price list. An equilibrium outcome is indexed by  $p_s \in [r_s, l_s]$  and  $p_c \in [l_m, \bar{p}_c]$ , with  $\bar{p}_c = l_m + \frac{\alpha}{1-\alpha}(p_s - r_s)\left(\frac{l_m - r_m}{p_s - r_m}\right)$ . In the equilibrium, the selfish expert posts a price list  $(l_m, p_s)$ . In state  $s$ , the selfish expert offers to repair the problem at  $p_s$ ; in state  $m$ , he offers to repair the problem at  $p_s$  with probability  $\beta = \frac{\alpha(l_s - p_s)}{(1-\alpha)(p_s - l_m)}$ , and repair the problem at  $l_m$  with probability  $1 - \beta$ . The conscientious expert posts a single price  $p_c$ , and always offers to repair the problem at  $p_c$ . The consumer accepts  $l_m$  and  $p_c$  with probability one; he accepts  $p_s$  with probability  $\gamma = \frac{l_m - r_m}{p_s - r_m}$ .*

In a nonuniform-price equilibrium, the expert's identity is revealed by his price list. If recommended a single price  $p_c$ , the consumer knows the expert is conscientious and the consumer believes that his problem is serious with probability  $\alpha$ , the prior. Because the expected loss from the problem,  $E(l)$ , is greater than  $p_c$ , the consumer will always accept a repair offer at  $p_c$ . If recommended a price from the price list  $(l_m, p_s)$ , the consumer knows that he is seeing the selfish expert, who recommends  $p_s$  when the problem is serious and randomizes between recommending  $p_s$  and  $l_m$  with probabilities  $\beta$  and  $1 - \beta$ , respectively, when the problem is minor. Clearly, the consumer is indifferent between accepting and rejecting a repair offer at  $l_m$ . Accepting  $l_m$  with probability one is his best response. The selfish expert's probability of lying,  $\beta$ , makes the consumer indifferent between accepting and rejecting a repair offer at  $p_s$ . Hence, accepting  $p_s$  with probability  $\gamma$  is the consumer's best response.

A nonuniform-price equilibrium is supported by the consumer's beliefs after an off-equilibrium price  $p' \notin \{p_c\} \cup \{(l_m, p_s)\}$  is recommended. If  $p' < p_c$ , the consumer believes that the expert is conscientious with probability one and the problem is serious with probability  $\alpha$ . If  $p' > p_c$ , the consumer believes that the expert is selfish. In addition, he believes that his problem is minor for  $p' \in (p_c, r_s)$  and is serious with probability  $\alpha$  for

$p' \in [r_s, l_s]$ . The justification for the consumer's beliefs after a repair offer  $p' > p_c$  is the same as in the analysis for Proposition 1. According to the consumer's beliefs, his optimal strategy in the continuation game following  $p'$  is to accept  $p' < p_c$  and reject  $p' > p_c$ .

Given the consumer and the conscientious expert's equilibrium strategies, the selfish expert does not have a profitable deviation in price. The conscientious expert's prices,  $p_c$ , is so low that the selfish expert does not want to post  $p_c$  although it is accepted with probability one. Clearly, a price deviation less than  $p_c$  is less profitable than the selfish expert's equilibrium price list,  $(l_m, p_s)$ . A price deviation above  $p_c$  will be rejected and result in zero profit.

In the recommendation stage, the consumer accepts  $p_s$  with probability  $\gamma$ , which makes the selfish expert indifferent between recommending  $p_s$  and  $l_m$  when the problem is indeed minor. Hence, it is the selfish expert's best response to misreport the minor problem as the serious problem with probability  $\beta$ . The selfish expert recommends  $p_s$  when the problem is serious because  $p_s$  is big enough to cover the serious treatment cost,  $r_s$ .

Given the consumer and the selfish expert's strategies, the conscientious expert does not have a profitable deviation. The conscientious expert will not mimic the selfish expert's price list  $(l_m, p_s)$ . A repair offer at  $p_s$  is not attractive for the conscientious expert because it will be rejected with a positive probability. A repair offer at  $l_m$  will be accepted but is less profitable than the conscientious expert's equilibrium repair offer,  $p_c$ . The conscientious expert will not deviate to a price other than the selfish expert's price list. A price deviation  $p'$  less than  $p_c$  will be accepted but is less profitable than  $p_c$ . A price deviation  $p'$  above  $p_c$  will be rejected and result in zero payoff.

The set of nonuniform-price equilibrium outcomes can be reduced by the Cho-Kreps intuitive criterion.

**Corollary 3.** *Nonuniform-price equilibrium outcomes that satisfy the Cho-Kreps intuitive*

criteria are those in which the selfish expert posts  $(l_m, p_s)$ , with  $p_s \in [r_s, l_s]$  and the conscientious expert posts  $p_c = \bar{p}_c = l_m + \frac{\alpha}{1-\alpha}(p_s - r_s)\left(\frac{l_m - r_m}{p_s - r_m}\right)$ .

When the conscientious expert's price is  $\bar{p}_c$ , the selfish expert is indifferent between posting  $(l_m, p_s)$  and  $\bar{p}_c$ . Consider a nonuniform-price equilibrium outcome in which  $p_c < \bar{p}_c$ . The conscientious expert can deviate to posting  $p_c' = p_c + \epsilon$ , with  $\epsilon$  positive but arbitrarily close to zero. If the selfish expert recommends  $p_c'$ , the most favorable response he can expect from the consumer is to accept  $p_c'$  with probability one. Because  $p_c' < \bar{p}_c$ , the selfish expert's highest possible profit from recommending  $p_c'$  is strictly less than his equilibrium profit. Hence, the consumer should be convinced that he is seeing the conscientious expert upon being recommended  $p_c'$  and therefore should accept  $p_c'$  with probability one.

The Cho-Kreps intuitive criterion has reduced the set of nonuniform-price equilibrium outcomes. All remaining nonuniform-price equilibrium outcomes are indexed by  $p_s$ , with  $p_s \in [r_s, l_s]$ . In the following analysis, I characterize the efficiency and profitability of the equilibrium outcomes that have survived the Cho-Kreps intuitive criterion.

**Corollary 4.** *In the continuum of nonuniform-price equilibrium outcomes, the most profitable equilibrium outcome coincides with the most efficient equilibrium outcome. In the equilibrium, the selfish expert posts a price list  $(l_m, l_s)$ . He recommends  $l_m$  when the problem is minor and recommends  $l_s$  when it is serious. The conscientious expert posts a single price  $\bar{p}_c$  and always recommends  $\bar{p}_c$ . The consumer accepts  $\bar{p}_c$  and  $l_m$  with probability one; he accepts  $l_s$  with probability  $\gamma^* = \frac{l_m - r_m}{l_s - r_m}$ .*

The selfish expert's equilibrium strategies are the same as in Fong (2005) (See Proposition 0). In a nonuniform-equilibrium outcome, the selfish expert's profit is

$$\pi_s(l_m, p_s) = \alpha(p_s - r_s)\left(\frac{l_m - r_m}{p_s - r_m}\right) + (1 - \alpha)(l_m - r_m).$$

Under the assumption  $E(l) < r_s$ ,  $\pi_s$  increases in  $p_s$ . This is because as the selfish expert raises  $p_s$ , the gain in profit margin dominates the loss of rejection.

The conscientious expert always repairs the problem in a nonuniform-price equilibrium. Hence, his rank of the equilibrium outcomes is also determined by the profit. The conscientious expert's profit is

$$\pi_c(\bar{p}_c) = \bar{p}_c - [\alpha r_s + (1 - \alpha)r_m].$$

Because  $\bar{p}_c$  increases in  $p_s$ ,  $\pi_c(\bar{p}_c)$  increases in  $p_s$  as well. Therefore, both types of expert's payoffs reach the maximum at  $p_s = l_s$ .

In a nonuniform-price equilibrium outcome, the conscientious expert always repairs the problem. The social loss results from the consumer's rejection of the serious treatment recommendation,  $p_s$ , offered by the selfish expert. The social loss of a nonuniform-price equilibrium outcome is

$$W \equiv (1 - \lambda)[\alpha(l_s - r_s) + (1 - \alpha)\beta(l_m - r_m)](1 - \gamma),$$

where  $\beta$  is the selfish expert's probability of recommending  $p_s$  when the problem is minor and  $\gamma$  is the consumer's probability of accepting  $p_s$ . Substituting  $\beta = \frac{\alpha(l_s - p_s)}{(1 - \alpha)(p_s - l_m)}$  and  $\gamma = \frac{l_m - r_m}{p_s - r_m}$  by their equilibrium values yields

$$W = \frac{(1 - \lambda)\alpha[p_s(l_s - r_s - l_m + r_m) + l_m r_s - l_s r_m]}{p_s - r_m}.$$

The derivative of  $W$  with respect to  $p_s$  is  $-\frac{\alpha(1 - \lambda)(l_m - r_m)(r_s - r_m)}{(p_s - r_m)^2}$ , which is negative. Hence, the most efficient equilibrium outcome is the one in which  $p_s = l_s$ .

When  $p_s$  increases, two conflicting forces are working on efficiency. When  $p_s$  gets bigger, the consumer will reject  $p_s$  more often; hence, the serious problem is less likely

to be resolved. This leads to a larger social loss. However, when  $p_s$  is higher, the selfish expert is less likely to misreport the minor problem as the serious problem. Therefore, the minor problem has a higher chance to be resolved. The efficiency gain from the minor problem exceeds the efficiency loss from the serious problem; consequently, the efficiency increases in  $p_s$ . The social loss of a nonuniform-price equilibrium results from the interaction between the consumer and the selfish expert. In equilibrium, the selfish expert takes the entire social surplus from repairing the problem when the repair offer is accepted. Hence, the efficiency of an equilibrium outcome is aligned with the profitability of the equilibrium outcome.

## 4 Are more conscientious experts always better?

Are more conscientious experts always better in terms of efficiency? To answer this question, I need to select an equilibrium outcome as a benchmark to see how the efficiency changes with the fraction of the conscientious expert,  $\lambda$ . The Cho-Kreps intuitive criterion does not help with selecting among the multiple equilibria. I select the most profitable equilibrium outcome as the benchmark for two reasons. First, the conscientious expert always repairs the problem in equilibrium. Hence, like the selfish expert, the conscientious expert prefers the most profitable equilibrium. Second, a monopolist often has stronger bargaining power over a consumer. The equilibrium outcome is more likely to be in favor of the expert.

**Corollary 5.** *When  $\lambda \in (0, \bar{\lambda})$ , with  $\bar{\lambda} = \left[ \frac{(l_s - l_m)(l_s - r_m)}{(l_s - r_s)(l_m - r_m)} - \alpha \right]^{-1}$ , the most profitable equilibrium outcome is the nonuniform-price equilibrium outcome described in Corollary 2. When  $\lambda \in (\bar{\lambda}, 1]$ , the most profitable equilibrium outcome is the uniform-price equilibrium outcome described in Corollary 4. When  $\lambda = \bar{\lambda}$ , the expert's profit in Corollary 2 is equal to his profit in Corollary 4.*

To select the most profitable equilibrium outcome, it is sufficient to compare the expert's profit in Corollary 2, the most profitable uniform-price equilibrium, and Corollary 4, the most profitable nonuniform-price equilibrium.

In a nonuniform-price equilibrium, the consumer can identify the expert's type from his price list. Once the expert's identity is revealed, the fraction of the conscientious expert,  $\lambda$ , does not play any role in the equilibrium. Therefore, the profit of the expert in Corollary 4 does not depend on  $\lambda$ . In contrast, the expert's profit in Corollary 2 increases in  $\lambda$ . This is because in the uniform-price equilibrium, when the expert is more likely to be conscientious, the consumer's probability of having a serious problem upon being recommended a repair offer is higher; hence, his willingness to pay is higher. When  $\lambda$  is smaller than some threshold  $\bar{\lambda}$ , the expert's profit in Corollary 4 is higher than in Corollary 2. When  $\lambda$  is greater than the threshold  $\bar{\lambda}$ , his profit is higher in Corollary 2 than in Corollary 4. Figure 1 plots both types of expert's profits in the uniform-price and nonuniform-price equilibria as a function of  $\lambda$ .

Next, the efficiency of the most profitable equilibrium as a function of  $\lambda$  is analyzed.

**Proposition 3.** *The market efficiency is not monotonic in  $\lambda$ .*

Recall that market inefficiency is measured as the social loss from an unresolved problem. When  $\lambda$  is less than  $\bar{\lambda}$ , the market is in the nonuniform-price regime. The social loss is  $W = \alpha(1 - \lambda)(1 - \gamma^*)(l_s - r_s)$ , which results from the consumer's rejection of the serious treatment offered by the selfish expert. When  $\lambda$  is above  $\bar{\lambda}$ , the market is in the uniform-price regime. The social loss is  $W = \alpha(1 - \lambda)(l_s - r_s)$ , which results from the selfish expert's rejection of the treatment for the serious problem.

In both regimes, the minor problem is always repaired and the social loss is due to an unresolved serious problem. In the nonuniform-price regime, the serious problem is unresolved with probability  $(1 - \gamma^*)$ , with  $0 < \gamma^* < 1$ , if the consumer is seeing the selfish

expert. In the uniform-price regime, the serious problem is unresolved with probability one if the consumer is seeing the selfish expert. Not surprisingly, the social loss decreases in  $\lambda$  when  $\lambda < \bar{\lambda}$ . It jumps up at  $\lambda = \bar{\lambda}$  and decreases again in  $\lambda$  when  $\lambda > \bar{\lambda}$ . Note when  $\lambda \in (\bar{\lambda}, \lambda^*)$ , where  $\lambda^* = \gamma^*$ , the social loss is higher in a market with conscientious experts than in a market without conscientious experts. Figure 2 plots the social loss as a function of  $\lambda$ .

## 5 Discussion

In sections 3 and 4, I have analyzed equilibria under the assumption  $E(l) < r_s$ . Under the alternative assumption,  $E(l) \geq r_s$ , there is a unique equilibrium which is efficient. In the equilibrium, both types of expert post a single price  $E(l)$  and always recommend to repair the problem at this price; the consumer will accept  $E(l)$  with probability one. When  $E(l) < r_s$ , a social loss rises in either uniform-price or nonuniform-price equilibria. This is because the selfish expert cannot credibly commit to always repairing the consumer's problem at  $E(l)$ . Although committing to repairing both problems at  $E(l)$  allows the selfish expert to extract the maximum possible social surplus, ex post he always refuses to repair the serious problem at  $E(l)$ . When  $E(l) \geq r_s$ , the selfish expert's ex ante and ex post incentives are aligned and, therefore, the equilibrium is efficient.

In the monopoly setting, there is always a social loss resulting from the interaction between the consumer and the selfish expert. Will the social loss disappear in a competitive setting? Consider a market with a continuum of experts. The fraction of conscientious experts is  $\lambda$  and the fraction of selfish experts is  $1 - \lambda$ . Take the same game structure and allow experts to compete in price lists before a consumer's visit. Assume the condition  $E(l) < r_s$  holds and the search cost is high so that the consumer does not search again after being recommended a treatment offer by an expert. I require a conscientious expert

to break even ex ante.

The nonuniform-price equilibria cannot be sustained in a competitive market. In a nonuniform-price equilibrium, the consumer surplus from a repair by a conscientious expert is higher than a selfish expert. Therefore, in a market with many experts, if the consumer can infer an expert's type, he will never visit selfish experts. The nonuniform-price equilibria collapse.

A uniform-price equilibrium outcome may survive under some parameter configurations. For example, when  $0 < \alpha < \min\{\frac{r_s - l_m}{l_s - l_m}, \frac{l_m - r_m}{r_s - r_m}\}$  and  $\frac{(1-\alpha)(r_s - r_m)}{l_s - \alpha r_s - (1-\alpha)r_m} < \lambda < 1$ , there is a uniform-price equilibrium outcome. In the equilibrium, each expert posts a single price equal to the expected treatment cost  $\alpha r_s + (1 - \alpha)r_m$ . Let  $E(r)$  denote  $\alpha r_s + (1 - \alpha)r_m$ . A conscientious expert always recommends this price to a consumer. A selfish expert recommends this price to a consumer when his problem is minor and refuses to treat the consumer when the problem is serious. A consumer always accept a repair offer at  $E(r)$ .

The condition  $0 < \alpha < \min\{\frac{r_s - l_m}{l_s - l_m}, \frac{l_m - r_m}{r_s - r_m}\}$  ensures that price  $E(r)$  is smaller than  $l_m$ . Hence, a consumer will always accept this repair offer. The driving force behind this equilibrium is similar as in the monopoly setting. In a competitive setting, a selfish expert might want to undercut his price to  $p' < E(r)$ . Doing so will signal that he is selfish but he might gain from attracting more consumers. If a consumer visits this deviating selfish expert, he will enjoy a lower price when his problem is minor. But the consumer will suffer from a higher rejection rate if the problem is serious. When there are enough conscientious experts, say,  $\frac{(1-\alpha)(r_s - r_m)}{l_s - \alpha r_s - (1-\alpha)r_m} < \lambda < 1$ , a consumer will never visit an expert who posts a price lower than  $E(r)$ . Hence, a selfish expert will not deviate to a lower price. In this equilibrium, there is still a social loss equal to  $\alpha(1 - \lambda)(l_s - r_s)$ .

The result that only the uniform-price equilibrium outcomes might survive in a competitive market implies that price dispersion across problems may decrease in the intensity of competition. Empirical test about this prediction might be interesting.

## 6 Conclusion

In this paper, I study credence goods markets with selfish and conscientious experts. I identify two classes of equilibria: uniform-price equilibria and nonuniform-price equilibria.

In uniform-price equilibria, the consumer cannot infer the expert's type from a price list. The consumer's problem will always be repaired if he is treated by a conscientious expert. If he is treated by a selfish expert instead, only the minor problem will be resolved; the serious problem will be rejected by the selfish expert because the price is too low to cover the treatment cost.

In nonuniform-price equilibria, the consumer can infer the expert's type from the posted price lists; the conscientious expert posts a single price for different repairs whereas the selfish expert posts two different prices. The problem will be always resolved if the expert is conscientious. If the expert is selfish, the minor problem will be repaired with probability one but the serious problem will be left unresolved with a positive probability. This is because the serious treatment offer is so expensive that the consumer will sometimes reject it.

Market efficiency does not always increase with the fraction of the conscientious expert. A high fraction of the conscientious expert may induce a free-riding problem; that is, the selfish expert may overcharge the consumer with a minor problem and dump the consumer with a serious problem. When the efficiency loss caused by the selfish expert exceeds the efficiency gain contributed by the conscientious expert, more conscientious experts reduce efficiency.

I have examined a static model with two types of expert. My future research may be a study of a dynamic model. In a multiple-period setting, the selfish expert has a reputation concern which may discipline his current behavior. It may be interesting to study the selfish expert's pricing and recommendation strategies in different periods.

## APPENDIX

*Proof of Proposition 1.* The proof is divided into 4 steps. Step 1 proves that given the expert's strategy described in Proposition 1, the consumer will always accept the repair offer. Step 2 describes the consumer's equilibrium strategy following a price deviation. Step 3 proves that given other players' strategies, the selfish expert's strategy described in Proposition 1 is optimal. Step 4 shows that given other players' strategies, the conscientious expert's strategy is optimal.

Step 1. Upon being recommended a repair offer at  $p \in [l_m, \frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + (1-\alpha)}]$ , the consumer's belief of having a serious problem is  $\Pr(l_i = l_s | p) = \frac{\Pr(p|l_i=l_s)\Pr(l_i=l_s)}{\Pr(p|l_i=l_s)\Pr(l_i=l_s) + \Pr(p|l_i=l_m)\Pr(l_i=l_m)}$ , where  $\Pr(p|l_i = l_s)$  and  $\Pr(p|l_i = l_m)$  stand for the probability that the consumer is recommended a repair offer at  $p$  in state  $s$  and  $m$ , respectively. According to Proposition 1, in state  $s$ , only the conscientious expert offers to repair the problem at  $p$ ; in state  $m$ , both types of expert offer to repair the problem at  $p$ . Therefore,  $\Pr(p|l_i = l_s) = \lambda$ , the probability of a conscientious expert, and  $\Pr(p|l_i = l_m) = 1$ . Consequently, if recommended  $p$ , the consumer has a serious problem with probability  $\Pr(l_i = l_s | p) = \frac{\alpha\lambda}{\alpha\lambda + (1-\alpha)}$ . If the problem is left unsolved, the consumer's expected loss is therefore  $\frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + (1-\alpha)}$ . Because price  $p$  is at most  $\frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + (1-\alpha)}$ , the consumer will accept it.

Step 2. Now I characterize the consumer's equilibrium strategy in the continuation game following a deviation  $p' \neq p$ . If recommended  $p' \in (p, l_s)$ , the consumer believes with probability one that he is seeing a selfish expert. In addition, he believes that his problem is minor for  $p' \in (p, r_s)$  and is serious with probability  $\alpha$  for  $p' \in [r_s, l_s]$ . If recommended  $p' \in [r_m, p)$ , the consumer believes that he is seeing a conscientious expert and he has a serious problem with probability  $\alpha$ . Based on these beliefs, the consumer will only accept a repair offer  $p' \in [r_m, p)$ . Accepting a repair offer  $p' \in (p, r_s)$  will result in a loss  $l_m - p'$ ; under assumption  $E(l) < r_s$ , accepting a repair offer  $p' \in [r_s, l_s]$  will also result in a loss

$E(l) - p'$ .

Step 3. The selfish expert.

(i) In the continuation game following  $p$ , the selfish expert will make a repair offer at  $p$  only in state m. The assumption  $E(l) < r_s$  implies  $\frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + (1-\alpha)} < r_s$ . Since  $p$  is at most  $\frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + (1-\alpha)}$ ,  $p < r_s$ . Therefore, the selfish expert will decline to repair the problem at  $p$  in state s. Clearly,  $p$  is higher than the minor problem's treatment cost,  $r_m$ , and therefore the selfish expert will recommend  $p$  in state m.

(ii) The selfish expert will post a uniform price list  $p \in [l_m, \frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + (1-\alpha)}]$ . Any deviation  $p' < p$  is not profitable: given that the consumer accepts  $p$  with probability one, offering a price  $p' < p$  will not increase the acceptance probability but will reduce profit. Any deviation  $p' > p$  will be rejected and result in zero profit.

Step 4. The conscientious expert.

(i) When  $k \geq \frac{r_s}{l_s}$ , the conscientious expert has a positive payoff in both states by repairing the problem at  $p$ . Therefore, he will always offer to repair the problem at  $p$ .

(ii) The conscientious expert will post  $p \in [l_m, \frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + (1-\alpha)}]$ . The argument is similar as that in (ii) of step 3. A deviation  $p' < p$  cannot improve acceptance probability but will result in a lower profit. A deviation  $p' > p$  will be rejected by the consumer and result in zero payoff. Q.E.D.

*Proof of Proposition 2.* The proof is divided into 4 steps. Step 1 shows that given the expert's strategy specified in Proposition 2, the consumer's strategy in Proposition 2 is optimal. Step 2 specifies the consumer's beliefs and equilibrium strategy after a price deviation. Step 3 shows that given other players' strategies, the selfish expert's strategy is optimal. Step 4 shows that given other players' strategies, the conscientious expert's strategy is optimal.

Step 1. The consumer's equilibrium response.

(i) The consumer's loss from the problem is at least  $l_m$ . His surplus from accepting a repair offer at  $l_m$  is nonnegative. Hence accepting price  $l_m$  is the consumer's best response.

(ii) Next, suppose that the consumer is offered a repair at  $p_s \in [r_s, l_s]$ . According to the selfish expert's strategy in Proposition 2, in state  $s$ , he offers to repair the problem at  $p_s$  with probability one, and in state  $m$ , offers to repair the problem at  $p_s$  with probability  $\beta$ . Using Bayesian updating, the consumer infers that he has a serious problem with probability

$$\Pr(l_i = l_s | p_s) = \frac{\Pr(p_s | l_i = l_s) \Pr(l_i = l_s)}{\Pr(p_s | l_i = l_s) \Pr(l_i = l_s) + \Pr(p_s | l_i = l_m) \Pr(l_i = l_m)},$$

which says  $\Pr(l_i = l_s | p_s) = \frac{\alpha}{\alpha + \beta(1-\alpha)}$ . So if the problem is left unresolved, the consumer's expected loss is  $\frac{\alpha l_s + \beta(1-\alpha)l_m}{\alpha + \beta(1-\alpha)}$ . After substitution by  $\beta$ , this expected loss is equal to  $p_s$ . The consumer is indifferent between accepting or rejecting  $p_s$ . Therefore, accepting  $p_s$  with probability  $\gamma = \frac{l_m - r_m}{p_s - r_m}$  is a best response.

(iii) Finally, suppose that the consumer is offered a repair price  $p_c$ . According to the conscientious expert's strategy in Proposition 2, the consumer retains the prior belief,  $\alpha$ , of having a serious problem. When the problem is left unresolved, the consumer's expected loss is  $E(l)$ . The assumption  $E(l) < r_s$  implies that  $l_m + \frac{\alpha}{1-\alpha}(p_s - r_s)(\frac{l_m - r_m}{p_s - r_m}) < E(l)$ . Because  $l_m + \frac{\alpha}{1-\alpha}(p_s - r_s)(\frac{l_m - r_m}{p_s - r_m})$  is the upper bound of  $p_c$ , the consumer will accept  $p_c$  with probability one.

Step 2. The consumer's equilibrium strategy after a price deviation.

Now I characterize the consumer's equilibrium strategy in the continuation game following a price deviation  $p' \notin \{(l_m, p_s)\} \cup \{p_c\}$ . If  $p' < p_c$ , the consumer believes that the expert is conscientious with probability one and the problem is serious with probability

$\alpha$ . If  $p' > p_c$ , the consumer believes that the expert is selfish. In addition, he believes that his problem is minor for  $p' \in (p_c, r_s)$  and is serious with probability  $\alpha$  for  $p' \in [r_s, l_s]$ . Given his beliefs, the consumer's optimal strategy in the continuation game following  $p'$  is to accept  $p' < p_c$  and reject  $p' > p_c$ .

Step 3. The selfish expert's equilibrium strategy.

(i) Given other players' strategies, the selfish expert will post a price list  $(l_m, p_s)$ ,  $p_s \in [r_s, l_s]$ .

First, I show that the selfish expert will not mimic the conscientious expert's price list. The selfish expert's equilibrium payoff is

$$u_s(l_m, p_s) = \alpha(p_s - r_s) \left( \frac{l_m - r_m}{p_s - r_m} \right) + (1 - \alpha)(l_m - r_m).$$

If he mimics the conscientious expert's price list  $p_c \in [l_m, l_m + \frac{\alpha}{1-\alpha}(p_s - r_s) \left( \frac{l_m - r_m}{p_s - r_m} \right)]$ , the selfish expert will recommend  $p_c$  only in state m since  $p_c < r_s$  (step 1 (iii) has shown this). The highest payoff for the selfish expert from  $p_c$  is  $u_s(p_c) = (1 - \alpha)(p_c - r_m)$ . The condition  $p_c \leq l_m + \frac{\alpha}{1-\alpha}(p_s - r_s) \left( \frac{l_m - r_m}{p_s - r_m} \right)$  implies  $u_s(l_m, p_s) \geq u_s(p_c)$ .

Next I show that the selfish expert will not post a price  $p' \notin \{(l_m, p_s)\} \cup \{p_c\}$ . By step 2, a repair price at  $p' < p_c$  will be accepted. However, such a price deviation is less profitable than the selfish expert's equilibrium price list. A repair price at  $p' > p_c$  will be rejected and result in zero profit.

(ii) Given other players' strategies, the selfish expert's recommendation strategy in the continuation game following  $(l_m, p_s)$  is optimal.

In state s, repairing the problem at  $p_s$  results in a nonnegative profit  $(p_s - r_s)\gamma = (p_s - r_s) \left( \frac{l_m - r_m}{p_s - r_m} \right)$ ; whereas, repairing the problem at  $l_m$  results in a loss  $l_m - r_s$ .

In state m, the selfish expert is indifferent between offering to repair the problem at

$l_m$  and at  $p_s$ . The repair offer  $l_m$  is accepted with probability one and results in a positive payoff  $l_m - r_m$ . The repair offer  $p_s$  is accepted with probability  $\gamma$  and results in a payoff  $(p_s - r_m) \cdot \gamma = l_m - r_m$ .

Step 4. The conscientious expert's equilibrium strategy.

(i) Given other players' strategies, the conscientious expert will post a single price  $p_c \in [l_m, l_m + \frac{\alpha}{1-\alpha}(p_s - r_s)(\frac{l_m - r_m}{p_s - r_m})]$ .

First I show that the conscientious expert will not mimic the selfish expert's price list. The conscientious expert's equilibrium payoff is  $u_c(p_c) = p_c + \alpha(kl_s - r_s) + (1-\alpha)(kl_m - r_m)$ . If the conscientious expert mimics the selfish expert's price list  $(l_m, p_s)$ , the highest payoff he can obtain is  $u_c(l_m, p_s) = l_m + \alpha(kl_s - r_s) + (1-\alpha)(kl_m - r_m)$ ; this is because when  $k$  is sufficiently big (more precisely  $k \geq \frac{r_s}{l_s}$ ), the conscientious expert will bear a financial loss to repair the consumer's problem. Clearly,  $u_c(p_c) \geq u_c(l_m, p_s)$ .

I now show that the conscientious expert will not post a price  $p' \notin \{(l_m, p_s)\} \cup \{p_c\}$ . By step 2, a price  $p' < p_c$  will be accepted, but is less profitable than  $p_c$ . A price  $p' > p_c$  will be rejected and result in zero payoff.

(ii) In the continuation game following  $p_c$ , the conscientious expert will always offer to repair the problem at  $p_c$ . Again, when  $k$  is sufficiently big ( $k \geq \frac{r_s}{l_s}$ ), repairing the problem at  $p_c$  results in a positive payoff in both states. Q.E.D.

*Proof of Corollary 5.* In Corollary 2, the selfish expert's profit is  $\pi_s = (1-\alpha)(p - r_m)$ , with  $p = \frac{\alpha\lambda l_s + (1-\alpha)l_m}{\alpha\lambda + 1 - \alpha}$ . The conscientious expert's profit is  $\pi_c = p - [\alpha r_s + (1-\alpha)r_m]$ .

In Corollary 4, the selfish expert's profit is

$$\pi_s = \alpha(l_s - r_s) \frac{l_m - r_m}{l_s - r_m} + (1-\alpha)(l_m - r_m).$$

The conscientious expert's profit is

$$\pi_c = l_m + \frac{\alpha(l_s - r_s)(l_m - r_m)}{(1 - \alpha)(l_s - r_m)} - [\alpha r_s + (1 - \alpha)r_m].$$

Both types of expert's profits in Corollary 2 are higher than that in Corollary 4 if and only if  $\alpha < \frac{r_s - l_m}{l_s - l_m}$  and  $\lambda > \frac{1}{\frac{(l_s - l_m)(l_s - r_m)}{(l_s - r_s)(l_m - r_m)} - \alpha}$ . The condition  $\alpha < \frac{r_s - l_m}{l_s - l_m}$  is automatically satisfied under the assumption  $E(l) < r_s$ . Q.E.D.

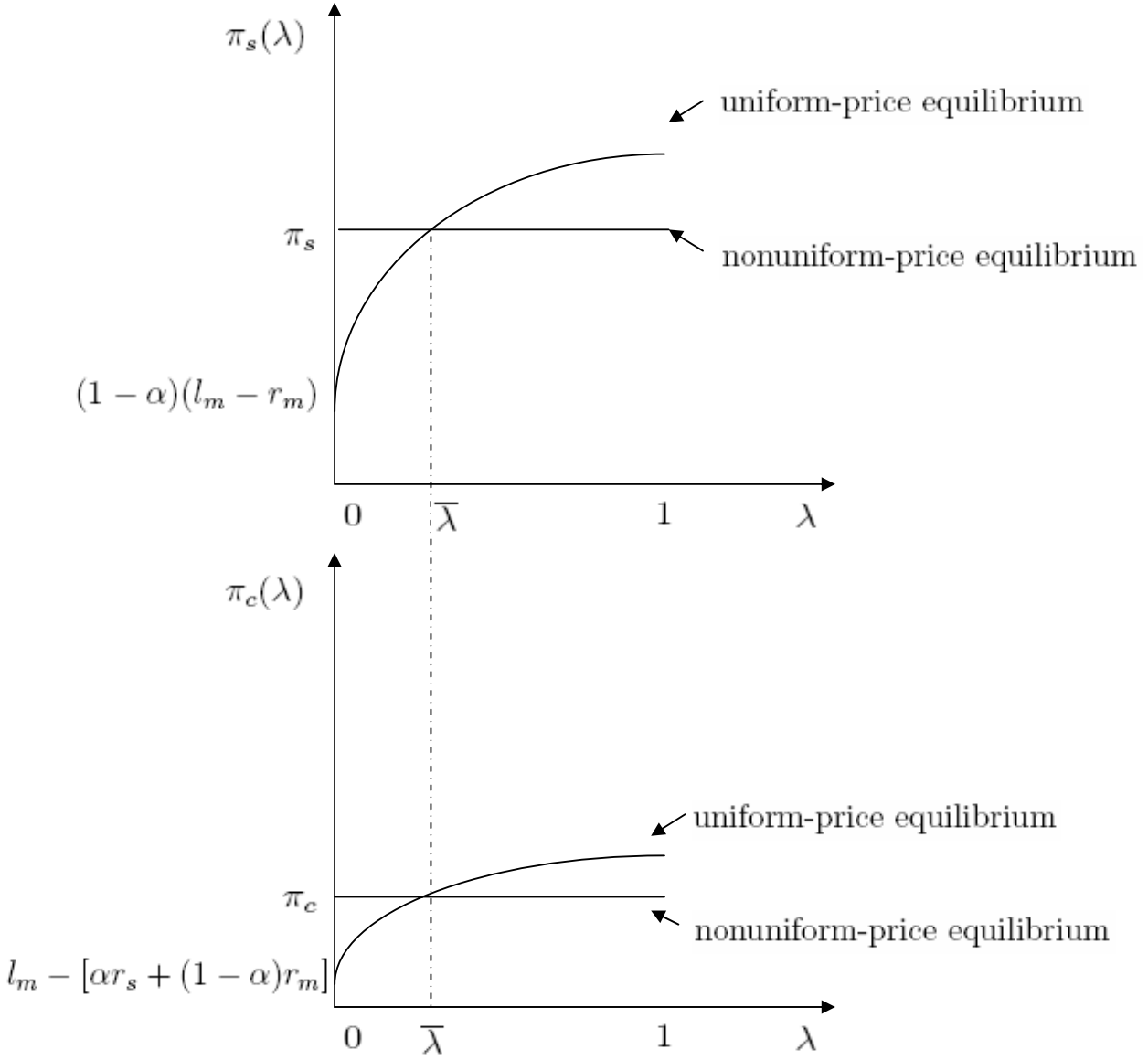
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Figure 1



$$\pi_s = \alpha(l_s - r_s) \frac{l_m - r_m}{l_s - r_m} + (1 - \alpha)(l_m - r_m)$$

$$\pi_c = l_m + \frac{\alpha(l_s - r_s)(l_m - r_m)}{(1 - \alpha)(l_s - r_m)} - [\alpha r_s + (1 - \alpha)r_m]$$

Figure 2

