Credence Goods Markets with Conscientious and Selfish Experts

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Abstract

I study credence goods markets when an expert is either selfish or conscientious. A selfish expert is a profit maximizer. A conscientious expert wants to maximize profit and repair the consumer's problem. In a monopoly model, 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. Both classes of equilibria have a social loss from an unresolved serious problem. In a uniform-price equilibrium, the selfish expert refuses to treat the serious problem because the price is too low to cover the treatment cost. In a nonuniform-price equilibrium, the consumer sometimes rejects the serious treatment offer made by the selfish expert because the price is too high. The uniform-price equilibria will be sustained in a competitive market while the nonuniform-price equilibria will collapse in a competitive market.

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1 Introduction

Consider the Check Engine light of your car turns on. It may be triggered by a minor problem like a loose gas cap or it may be triggered by a serious problem in the engine. After diagnosis, a mechanic tells you to replace the engine sensor. If you take his offer, after a repair, the light is off. You never get to know whether tightening your gas cap could have been enough to solve the problem. To make matters worse, you may not be able to verify whether the engine sensor is replaced as promised. This asymmetric information appears not only in automobile repair market but also in health care market, legal consulting market and many other markets. In these markets, a buyer cannot evaluate the quality of a product even after he has consumed it (Darby, 1973). These markets are termed credence goods markets. They are the object of this paper.

Asymmetric information in credence goods markets allows an expert to exploit a consumer by exaggerating the problem. The existing literature has studied various mechanisms preventing a profit maximizing expert from cheating. It has been found that when consumers search among experts (Wolinsky, 1993) or sometimes reject the expensive repair offer (Fong, 2005), an expert will honestly report the nature of the problem for fear of losing consumers. However, these mechanisms are two-edged-swords; both consumer search and consumer rejection result in a social loss. Hence, the promotion of professional morals is very important in credence goods markets. In fact, both the health care industry and the automobile repair industry have their professional ethic code. The question of interest in this paper is what will be the market outcome when some experts are ethical.

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 different interpretations.

First, an expert may be altruistic. 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."[1] It is hard to believe that every student trained by this doctrine will become a doctor who merely wants to maximize profit.

Second, an expert may get satisfaction from work itself. 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) 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.

In this paper I 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 pricing or recommendation strategies? What is the nature of a social loss, if there is any, when there are two types of expert?

In the model, there is a monopoly expert and a consumer. In line with Wolinsky (1993), Fong (2005) , Emons (1997, 2001) and Alger and Salanie (2006), it is assumed that the consumer either has 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

[1] "Teaching Doctors to Care", TIME, May 29, 2006

the possible repairs. The consumer visits the expert. The expert then learns the nature of the problem and 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 resolved at the quoted price.

There are 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.

Uniform-price equilibria are the main finding of this paper. The intuition behind a uniform-price equilibrium 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. Essentially, the selfish expert free rides on the conscientious expert and behaves even more opportunistically than he would have if he were the only expert in the market.

In sharp contrast to Pitchik and Schotter (1987) , Wolinsky (1993) and Fong's (2005) results, in a uniform-price equilibrium the social loss results from a selfish expert's rejection rather than a consumer's rejection. This result fits the anecdotal evidence of dumping in health care markets. The price in health care market is regulated and the fixed price is often blamed for the dumping behavior. The uniform-price equilibrium predicts that dumping may not be avoided even when hospitals can set prices freely.

In a nonuniform-price equilibrium, the consumer can infer the expert's type by his price list. 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 sufficiently low so 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 higher acceptance rate for a higher 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.

In a nonuniform-price equilibrium, the social loss is due to the consumer's rejection. When the consumer can infer the expert's identity from his price list, naturally the selfish expert will just do the best for him as if he were the only type of expert in the market. The selfish expert's equilibrium strategy is similar to that in Pitchik and Schotter (1987) and Fong (2005).

Pitchik and Schotter (1987) study an expert's fraudulent behavior in a setting with exogenously given prices. They find a mixed strategy equilibrium in which the expert randomizes between lying and telling the truth. This equilibrium is similar to any nonuniform-price equilibrium.

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 where the consumer can consult multiple experts by incurring a search cost. He finds that consumer search and reputation concern may reduce an expert's fraudulent behavior. He identifies a specialization equilibrium in which some experts repair a minor problem while others repair a serious problem. 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. The social loss in a uniform-price equilibrium is, however, different from that in Wolinsky. In Wolinksy, consumer search results in a social loss whereas in a uniform-price equilibrium, the selfish expert's rejection of a treatment for the serious problem results in a social loss.

My article is 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).

In a fixed price setting, Marty (1999) studies a two period model when there are both selfish and honest experts. He finds that the existence of honest experts reduces selfish experts' fraudulent behavior. In sharp contrast with Marty, my model shows that the selfish expert may free ride on the conscientious expert and behaves even more opportunistically than he would have if he were the only expert in the market.

Other studies about with multiple types of agents are also related to my article. Alger and Renault (2007) 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, who moves first by offering a contract to the agent. In my model, it is the informed party, the expert, who moves first by offering a price list. Second, in their model the honest agent commits to reporting his ability truthfully to the principal, while the conscientious expert does not commit to being honest about 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 discusses market equilibrium in a competitive setting. Section 5 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 α, 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 price 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, I assume 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 4.

2.2 Information structure

It is common knowledge that the consumer has a serious problem with probability α, with $0 < \alpha < 1$, and that the expert is a conscientious type with probability λ, 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 α and λ 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

Different equilibria may yield the same equilibrium outcome. For example, in one equilibrium, the expert posts two different prices (p_m, p_s) and always recommends p_s. This equilibrium outcome is equivalent to the equilibrium outcome of another equilibrium in which the expert posts a single price p_s and always recommends it. To simplify the analysis, the expert is restricted to post only prices that are recommended with a positive probability. Consequently, the conscientious expert always posts a single price in an equilibrium. Under the assumption $k > \frac{r_s}{l_s}$, the conscientious expert will never recommend a price which will be rejected with a positive probability. Suppose he posts two different prices (p_m, p_s), where $p_m < p_s$. If the consumer always accepts both prices, the conscientious expert will always recommend the high price, p_s, because he wants to maximize profit besides repairing the problem.

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 yield a smaller profit than $p' = p + \epsilon$, for a sufficiently small $\epsilon > 0$. Therefore there is no loss of generality restricting experts to posting their prices in the range of $[r_m, l_s]$.

Recall that the following analysis is under the assumption $E(l) < r_s$. This implies $r_m < l_m < r_s < l_s$. In this section, two classes of equilibrium outcomes are identified: uniform-price equilibrium outcomes and nonuniform-price equilibrium outcomes. I first characterize the uniform-price equilibrium in Proposition 1.

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* $p \in [l_m, \overline{p}]$, *with* $\overline{p} = \frac{\alpha\lambda l_s + (1-\alpha) l_m}{\alpha\lambda + (1-\alpha)}$. *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 being 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 α, the prior. If $p' > p$, the consumer believes that the expert is selfish. In addition, 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 α.

The consumer with such beliefs is 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 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, α.

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 because he believes that it 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, r_m, and lower than the treatment cost for the serious problem, r_s. The conscientious expert repairs 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.

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 λ and α. 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 λ, 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 and Wolinsky's results wherein the consumer's equilibrium strategy results in a social loss. In Fong, the consumer 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. In Wolinksy, when search cost is low, a consumer rejects the first serious repair offer and searches for another expert. Consumer search prevents an expert from lying but results in a social loss.

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 unform-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* $\overline{p} = \frac{\alpha\lambda l_s + (1-\alpha) l_m}{\alpha\lambda + (1-\alpha)}$.

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

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* $p_c \in [l_m, \overline{p_c}]$, *with* $\overline{p_c} = l_m + \frac{\alpha}{1-\alpha}(p_s - r_s)(\frac{l_m - r_m}{p_s - r_m})$. *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 believes that his problem is serious with probability α, 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.

The selfish expert posts two different prices (l_m, p_s). When p_s is smaller than l_s, both the selfish expert and the consumer play a mixed strategy in equilibrium. If the selfish expert is always honest, that is, he recommends l_m when the problem is minor and p_s when it is serious, the consumer will accept both l_m and p_s. Then the selfish expert will deviate to always recommending p_s. If the selfish expert always recommends p_s, the consumer will always reject p_s because his willingness to pay is lower than the offer. Then, the selfish expert has a profitable deviation to recommending l_m when the problem is minor. Hence, in equilibrium, when the problem is minor, the selfish expert misreports the minor problem as the serious problem with probability β, and the consumer accepts p_s with probability γ. In the extreme case, when $p_s = l_s$, the selfish expert is always honest but the consumer still rejects the more expensive offer, l_s, with a positive probability to prevent the expert from lying. The selfish expert's equilibrium strategy in the extreme case is the same as that in Fong's model.

A nonuniform-price equilibrium is supported by the consumer's beliefs after an off-equilibrium price $p' \notin \{p_c\} \bigcup \{(l_m, p_s)\}$ is recommended. If $p' < p_c$, the consumer believes that the expert is conscientious with probability one and the problem is serious with probability α. 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 α 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 . The conscientious expert's prices, p_c, is so low that the selfish expert does not want to post p_c even if it is accepted with probability one. Clearly, a price deviation $p' \neq p_c$ is not profitable.

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. A price deviation $p' \neq (l_m, p_s)$ is not profitable as well.

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 criterion 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* $p_c = \overline{p_c} = l_m + \frac{\alpha}{1-\alpha}(p_s - r_s)(\frac{l_m - r_m}{p_s - r_m})$.

When the conscientious expert's price is $\overline{p_c}$, the selfish expert is indifferent between posting (l_m, p_s) and $\overline{p_c}$. Consider a nonuniform-price equilibrium outcome in which $p_c < \overline{p_c}$. The conscientious expert can deviate to posting ${p_c}' = p_c + \epsilon$, with ϵ 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 ${p_c}' < \overline{p_c}$, 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.

When p_s increases, the selfish expert misreports the minor problem as the serious one less frequently and the consumer rejects p_s more frequently. When the serious repair offer becomes more expensive, a small probability of lying may trigger a full rejection from the consumer. Thus the selfish expert becomes more cautious. As p_s increases, the consumer knows that the selfish expert has a larger incentive to misreport the minor problem as the serious problem. Hence, he will reject the serious treatment offer more often.

The conscientious expert's price $\overline{p_c}$ increases in γ, the consumer's acceptance rate of the serious repair offer, and $\frac{\alpha}{1-\alpha}$, the odds ratio for the serious problem to happen. When the consumer accepts the serious repair offer more frequently or the problem is more likely to be serious, the selfish expert's profit from posting (l_m, p_s) is higher. This allows the conscientious expert to charge a higher price.

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 $\overline{p_c}$ and always recommends $\overline{p_c}$. The consumer accepts $\overline{p_c}$ 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 in the most profitable nonuniform-price equilibrium are the same as in Fong. In Fong's model, there is only one selfish expert who posts a price list before seeing the consumer. His model has a proper subgame after each price list. Therefore the selfish expert chooses the most profitable price list (l_m, l_s) in the unique SPNE outcome.

In a nonuniform-equilibrium outcome, the selfish expert's profit is

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

Under the assumption $E(l) < r_s$, π_s increases in p_s. 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, π_s reaches the maximum at $p_s = l_s$.

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

$$\pi_c(\overline{p_c}) = \overline{p_c} - [\alpha r_s + (1-\alpha) r_m].$$

Because $\overline{p_c}$ increases in p_s, $\pi_c(\overline{p_c})$ 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 β is the selfish expert's probability of recommending p_s when the problem is minor and γ 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 influence 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 Discussion

In sections 3, 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 λ 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.

5 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 a uniform-price equilibrium, the selfish expert free rides on the conscientious expert and behaves even more opportunistically than he would have if he were the only expert in the market.

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.

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 α 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 α. 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 β. 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 β, 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, α, 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 $p' \notin \{(l_m, p_s)\} \bigcup \{p_c\}$. If $p' < p_c$, the consumer believes that the expert is conscientious with probability one and the problem is serious with probability

α. 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 α 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

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

If he mimics the conscientious expert's price list $p_c \in [l_m, l_m + \frac{\alpha}{1-\alpha}(p_s - r_s)(\frac{l_m - r_m}{p_s - r_m})]$, 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 $p_c \leq l_m + \frac{\alpha}{1-\alpha}(p_s - r_s)(\frac{l_m - r_m}{p_s - r_m})$ implies $u_s(l_m, p_s) \geq u_s(p_c)$.

Next I show that the selfish expert will not post a price $p' \notin \{(l_m, p_s)\} \bigcup \{p_c\}$. 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 $(p_s - r_s)\gamma = (p_s - r_s)(\frac{l_m - r_m}{p_s - r_m})$; 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 γ and results in a payoff $(p_s - r_m).\gamma = l_m - r_m$.

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 $p' \notin \{(l_m, p_s)\} \bigcup \{p_c\}$. 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.

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