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Baojun Jiang, Jian Ni, Kannan Srinivasan

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Signaling Through Pricing by Service Providers with Social Preferences

Baojun Jiang

Olin Business School, Washington University in St. Louis, St. Louis, Missouri 63130, baojunjiang@wustl.edu

Jian Ni

Carey Business School, Johns Hopkins University, Baltimore, Maryland 21202, jni@jhu.edu

Kannan Srinivasan

Tepper School of Business, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213, kannans@cmu.edu

In many service markets such as consulting, auto repair, financial planning, and healthcare, the service provider may have more information about the customer's problem than the customer, and different customers may impose different costs on the service provider. In principle, the service provider should ethically care about the customer's welfare, but it is possible that a provider may maximize only its own profit. Moreover, the customer may not know *ex ante* whether the provider is ethical or purely self-interested. We develop a game-theoretic model to investigate pricing strategies and the market outcome in service markets where the provider has two-dimensional private information about her own type (whether ethical or self-interested) and about the customer's condition (whether serious or minor). We show that in a less ethical market, a self-interested provider will charge different prices based on the customer's condition, whereas an ethical provider will charge the same price for both conditions. In contrast, in a more ethical market, both the self-interested and the ethical provider will charge the same uniform price to both types of customers. Interestingly, both market efficiency and the customer's *ex ante* expected surplus might be lower in a more ethical market than in a less ethical one.

Keywords: social preference; signaling; credence goods; pricing; behavioral economics; asymmetric information

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1. Introduction

In the service markets, customers are often uncertain whether the service provider is acting in her own interest or in the interest of the customer.¹ For example, a financial planner's advice on retirement investments, a car mechanic's suggestions for preventive maintenance, and a physician's diagnosis for surgery all create a level of ambiguity in the mind of the customer that cannot be easily resolved. Is the service provider acting in her own best interest or is she taking into careful consideration the best interest of the customer? This is a pervasive and important issue in the massive and diverse service industry.

The above-mentioned services are essentially credence goods, and they exhibit three key characteristics that create a need for careful analysis. First, the service provider may have more information about the customer's problem than the customer does. In each of the above cases, the expert service provider

is likely to have more information about the problem than what the customer knows.

Second, different customers' problems may impose different levels of cost on the service provider, and customers may not know the provider's true costs of resolving an issue. This is very different from the traditional product market, where the product's cost is usually the same across consumers. In the context of services, a provider's cost may be customer specific. Different conditions require different service/effort levels and, hence, impose different costs on the providers.

Third, even though in principle the provider should ethically care about the customer's welfare (e.g., by fiduciary duty or ethical codes of conduct), it is possible that a provider may seek only to maximize her own profit. For example, a mechanic might not always work to maximize the welfare of her customers. Some service providers prescribe more than adequate or necessary levels of care to their customer (De Jaegher and Jegers 2000). Some even stop providing procedures or services that carry a high liability of risk or require a great amount of time and effort, or

¹ For expositional ease, we will refer to a customer as "he" and a service provider as "she."

they simply dump those customers with serious conditions that cost them much more to service (Ansell and Schiff 1987). During the global financial crisis that started in 2007, some investment management companies acted against the customers' interests, and they did not disclose potential conflicts of interest to customers when recommending and carrying out financial transactions—even though their own ethical standards state that their customers' interests always come first. For example, former Goldman Sachs executive Greg Smith said in his open resignation letter in the *New York Times* that “the interests of the client continue to be sidelined in the way the firm operates and thinks about making money” (Smith 2012). Clearly, some service providers—be they mechanics, financial services companies, or physicians—do not always focus on the welfare of their customers as they should, according to ethical standards or business principles. Instead, they may provide services that maximize their own profit while negatively affecting their customers. That service providers might undertake actions not in the customer's best interest is a major and significant problem across a diverse set of markets in the service industry. It is worth noting that often customers may not know *ex ante* whether a provider is ethical or purely self-interested in their service interactions.

We develop a game-theoretic model to investigate the pricing strategies and market outcomes in a credence good market with the aforementioned characteristics where the service provider has two-dimensional private information—one about her own type (whether ethical or self-interested) and the other about the customer's condition (whether minor or serious). As is typical for credence goods, customers face both uncertainties: they do not know if the service provider is ethical or self-interested and are also uncertain about their true condition. Standard economic literature generally assumes that firms maximize their monetary profits. But the existence of social preferences such as conscientious or altruistic behavior is demonstrated by extensive behavior literature; e.g., ethical providers may derive some utility from their customer's welfare besides their own profits (Ho et al. 2006a, b). This explains why some providers keep their promises to serve their customers even though the associated costs may be higher than the price they charge (Vanberg 2008).

Unfortunately, a self-interested provider may mimic an ethical provider when the customer's problem is minor (i.e., more profitable) but reject a customer with serious conditions unless she can charge a high enough price given the high cost of service. More seriously, a self-interested service provider may charge a customer a high price for minor (low-cost) conditions—in essence lying about the customer's

condition. Hence, a customer may reject high-priced services because he knows that the provider may be overcharging him for a minor problem. Both the customer-dumping practice and the customers' self-interested service behavior worry policy makers, hurt consumers, and cause significant social welfare loss. This motivates our research questions: What impact does the presence of the ethical service provider have on the self-interested provider? What equilibrium pricing strategies will different types of providers adopt? How does the level of ethics in the market (i.e., the probability of the provider being ethical) affect pricing and market efficiency? Does a more ethical marketplace necessarily lead to higher market efficiency? We systematically analyze these questions.

We contribute to the literature on credence goods (e.g., Darby and Karni 1973, Dulleck and Kerschbamer 2006, Dulleck et al. 2011, and the references therein). As noted earlier, a credence good is a good whose impact on the consumer's utility is difficult for her to ascertain even after purchase; examples include auto repair, healthcare, and legal services. Two common issues can arise in credence good markets. If the service input is verifiable, there may be problems with under- or overprovision of service by the provider (e.g., Jing 2011). If the service input is not verifiable but the result is, there may be overcharging by the provider (i.e., misreporting of the consumer's need or condition). Our focus is on the latter issue. In this aspect, the work most related to ours is Fong (2005). He provides a theory of cheating by the expert, who has private information about the customer's problem/condition. He shows that cheating can arise either when customers' loss from the same problem may differ or when the same problem may impose different costs on the expert across different customers. In addition to consumer heterogeneity, we introduce different types of service providers based on their social preferences. The provider (i.e., expert) in our framework has private information about her own ethical type as well as about the customer's condition. Thus, in contrast to the single dimension of uncertainty in Fong, we tackle a far more subtle and complex two-dimensional information asymmetry widely present in service markets. In this context, we show that the provider's pricing decision critically depends on the customer's inference about both dimensions of asymmetric information.

Our research contributes to the signaling literature. Most signaling games focus on the pure-strategy separating equilibrium (e.g., Balachander 2001, Desai 2000, Desai and Srinivasan 1995, Moorthy and Srinivasan 1995, Shin 2005, Simester 1995, Soberman 2003). As in Jiang et al. (2011) and Guo and Jiang (2013), we closely examine both pooling and separating equilibria to rationalize the underlying market phenomena;

this also relates to the literature on countersignaling (Feltovich et al. 2002, Mayzlin and Shin 2011). From a theoretical perspective, we study *two-dimensional* private information—the provider has private information about her own type (ethical or self-interested) and about the customer's condition (minor or serious). This is different from Jiang et al., where the third-party seller has one-dimensional private information about demand and also an unobservable service level (to the platform owner)—hidden action—which creates a moral hazard issue. Jiang and Yang (2012) focus on two-dimensional asymmetric information involving experience goods rather than credence goods. Chen and Jiang (2013) examine the dynamic signaling of the quality of experience goods using prices in multiple periods and price commitment. Guo and Jiang (2013) study search goods and show that price and quality serve as a two-dimensional signal of a firm's cost to consumers who have fairness concerns. To the best of our knowledge, our approach of modeling both social preferences and the key characteristics of multidimensional private information in a credence good market has not been tackled before.

We also contribute to the behavioral economics literature that studies agents with social preferences, i.e., agents who care about factors other than their own profits (e.g., social outcome, other agents' welfare, perceived fairness). Cui et al. (2007) study how fairness concerns in a conventional channel may affect channel coordination. Guo and Jiang (2013) study a firm's quality and pricing decisions when facing consumers with fairness concerns. Ho and Zhang (2008) employ reference-dependent utility specification to study how the presentation of pricing contracts affects channel outcome. Amaldoss and Jain (2005, 2008) study the impacts of consumers' context dependent or social preferences on strategic firm behavior. Ho and Su (2009) consider peer-induced fairness when agents engage in social comparison. We contribute to this new, active area of research by examining substantively a credence good market in which the provider may be purely self-interested or may ethically care about the customer's well-being. We study how uncertainty about the provider's social preferences affects pricing strategies and market outcomes.

We highlight several key findings from our analysis. First, in a separating equilibrium, in a less ethical market (where the probability of the provider being ethical is low), the self-interested provider posts a differential price menu whereas an ethical provider posts the same price for both serious and minor conditions.² Realizing the possibility of being overcharged for a

minor condition, the customer occasionally rejects the high-priced service from the provider posting differential pricing.

Second, in a more ethical market, in equilibrium, both the ethical and the self-interested provider adopt a uniform pricing strategy—posting only one price for both customer conditions. In this pooling equilibrium, all customers will accept service at the pooling equilibrium price. However, the self-interested provider will dump customers with a serious (high-cost) condition because ex post it is not profitable for her to serve such customers at the pooling equilibrium price.³

Third, and especially interesting, market efficiency (i.e., the ratio of the actual social welfare over the maximum social welfare) may be lower in a more ethical market than in a less ethical market. The intuition lies in the fact that a higher ethical level gives the self-interested provider more incentive to mimic the ethical provider's uniform price menu, which may induce the self-interested provider to switch from differential pricing to uniform pricing. Note that in both situations, customers with minor conditions are always served. In a less ethical market, customers with serious conditions *occasionally* reject the high-priced service offer. But in a more ethical market, *all* customers with serious conditions will be ex post dumped by the self-interested provider who adopts the same uniform pricing strategy as the ethical provider. Therefore, market efficiency may actually be lower in a more ethical market than in a less ethical one. Furthermore, we show that the customer's ex ante surplus may also be lower in a more ethical market than in a less ethical one.

The rest of the paper is organized as follows. In §2, we develop an analytical framework to model the interaction between the service provider and the customer. In §3, we first examine the case when the service cost is less than the consumer's expected loss from the problem. Then we analyze the high service cost case when the social loss rises, derive both differential pricing and uniform pricing equilibria, and compare the implications of corresponding consumer surplus, profit, and social welfare. In §4, we offer concluding thoughts on our paper identifying scope for future research.

2. Model

We model a monopoly service market of the nature we discussed before.⁴ Without loss of generality, we normalize the total number of customers (N) to 1.

³ In practice, dumping a customer may take several forms: the service provider may claim to be fully booked, refer the customer to another provider in a different market/area, or use other means to discourage the customer's seeking service from her.

⁴ A monopoly model in our setting is in fact quite reasonable. Many service markets are monopolies or monopolistically competitive

² "Separating" or "pooling" refers to whether the provider's type is revealed by her pricing decision. The customer's type (condition), however, may not be fully revealed in either type of equilibrium.

The customer has an uncertain condition that needs to be serviced: with probability β , he has a serious condition, and with probability $1 - \beta$, he has a minor condition. A customer with a serious condition—an H -type customer—requires a high service cost C_H from the service provider. A customer with a minor condition—an L -type customer—requires a low service cost $C_L < C_H$ from the service provider. Upon seeing the customer, the service provider will learn about the customer's condition at no cost (i.e., the diagnostic cost is normalized to 0), but this information about the customer's condition is the service provider's private information. The customer does not know *ex ante* the severity of his condition, although he knows the prior probability of his condition being serious or minor. If he does not obtain service, the customer of type i will incur a welfare loss (in the future) denoted by W_i , $i \in \{H, L\}$ with $W_L < W_H$. So if the customer does not receive service from the provider, his *ex ante* expected welfare loss is $E(W) = \beta W_H + (1 - \beta)W_L$. If the customer receives service from the provider, his welfare loss will be completely prevented verifiably after the provider incurs the corresponding service cost C_i . That is, if the customer gets services from the provider, he will know after service that his issue has been restored, but he may not know the provider's actual cost.

There are two types of service providers—ethical (type e) or self-interested (type s). The self-interested service provider maximizes her own monetary profit as in standard economic models, and her utility from serving customer i at price p is $p - C_i$. In this paper, we will use the terms “utility,” “profit,” and “pay-off” interchangeably. The ethical provider cares about both profit and customers' well-being, so her utility from serving customer i at price p is $p - C_i + \alpha W_i$, where a positive constant α denotes the ethical provider's degree of social preference.⁵ The ethical provider's utility from serving a customer increases as α increases.⁶ A provider of either type derives zero

utility if she does not serve the customer. It is common knowledge that the provider is ethical with probability $\gamma \in (0, 1)$ and self-interested with probability $1 - \gamma$. The provider knows her own type whereas the customer knows only the prior probability of each type of provider. Thus, the provider possesses two-dimensional private information—about her own type and about the customer's type.⁷ We focus on the case where the two types of providers are sufficiently different such that the following condition holds:

$$\alpha \geq \max \left\{ \frac{C_H}{W_H}, \frac{C_L}{W_L}, \frac{C_H - C_L}{W_H - W_L} \right\}. \quad (C1)$$

The condition implies that unlike the self-interested provider, the ethical provider has a strong enough social preference that she is willing to offer free service to a customer rather than leave him unserved. Furthermore, for nontrivial analysis, we assume $W_i > C_i$, $i \in \{H, L\}$; i.e., it is socially efficient to service both types of customers.

More formally stated, the game proceeds as follows. Nature determines the customer's type and the provider's type. The customer is of H -type with probability β and L -type with probability $1 - \beta$. With probability γ , the provider is ethical (e); with probability $1 - \gamma$, the provider is self-interested (s). The provider determines with certainty her true type $j \in \{e, s\}$ whereas the customer knows only the prior probability distribution. The provider then posts a price menu, p_{ji} , $i \in \{H, L\}$ with $p_{jH} \geq p_{jL}$, where p_{ji} is for the i -type customer as announced by the provider. The customer observes the posted price menu and subsequently sees the provider. Upon seeing the customer, the provider without cost learns the customer's type and then offers the service to the customer at some price p from her posted menu or dumps/rejects the customer.⁸ Based on the offered price p and the

preferences. Our model results remain qualitatively the same as long as there is a large enough difference between the providers' social preferences.

⁷ Instead of using the social preference setting, we can adopt a framework with two types of providers—one is more efficient (with a lower service cost for any customer condition) than the other. In essence, we can absorb the social utility term into the provider's cost and use her cost type (rather than her social preferences) to represent the provider's type. So in the alternative framework, social preferences represent one factor that can lead to differences in the provider's effective cost efficiency. Such an alternative framework and our social preference framework are conceptually equivalent.

⁸ Note that the provider learns the customer's type *after* the customer observes her price menu. This means that the provider cannot post different price menus to different customers in the case of $N > 1$ customers. (We normalized the number of customers to 1.) Our model setting is therefore a much more reasonable framework than the alternative of assuming that the provider learns a customer's type *before* she posts a price menu.

markets. For example, healthcare service providers in rural areas are typically monopolies; there is typically only one clinic or hospital or one dental office in each local rural area. In metropolitan areas, there may be multiple providers, but they provide specialized services that are potentially differentiated in location, style, and technical competence, and they compete mostly monopolistically (Pauly and Satterthwaite 1981).

⁵ An alternative for the ethical provider's utility or payoff function is $p - C_i + \alpha(W_i - p)$; i.e., the ethical provider cares about not merely whether a customer's problem is solved but his surplus. The utility function we have constructed here is in the spirit of Farley (1986), in which service providers are concerned about their customers' well-being rather than surplus.

⁶ Note that a self-interested provider corresponds to $\alpha = 0$. In effect, we use the terminology of “self-interested” and “ethical” to represent two types of providers with different degrees of social

price menu $\{p_{jL}, p_{jH}\}$, the customer updates his beliefs about his type and about the provider's type and decides whether to accept the service at price p . If he accepts, he pays p to the provider, who incurs the service cost corresponding to the customer's true condition, and the customer's welfare loss is prevented (i.e., his problem is solved). The game ends with either service or rejection by the provider or the customer.

The provider's strategy consists of the price menu $\{p_{jL}, p_{jH}\}$ and the price (from the menu) together with the probability at which the provider will offer service to the customer upon learning his position. Note that different equilibria may yield the same market outcome. For example, in one equilibrium, the provider lists two different prices p_{jL} and p_{jH} for different severity conditions but always offers p_{jH} . This equilibrium outcome is equivalent to that of another equilibrium in which the provider lists a single price p_{jH} for both conditions and always offers that. To simplify our analysis and exposition, we restrict the provider to posting only prices that she offers with a positive probability. The customer's strategy is a mapping from a provider's service offer to an accept or reject decision about the service. We analyze perfect Bayesian equilibria, which consist of each type of provider's strategy and payoff, the customer's strategy and payoff, and the customer's beliefs about the provider's type and about his own type.

3. Analysis

For the sake of completeness, in §3.1 we analyze the simple case of $E(W) \geq C_H$. Subsequently, we examine our focal case of $E(W) < C_H$, where the self-interested provider cannot credibly commit to always offering a service at a price $E(W)$ because she will be better off rejecting the H -type customer after learning about his condition.

3.1. Ex Ante and Ex Post Incentives Aligned

We first examine the case of $E(W) \geq C_H$. Under this scenario, the provider's ex ante and ex post incentives to service a customer at the uniform price of $E(W)$ are aligned, i.e., both ex ante and ex post to determining the customer's type, the provider is willing to always offer service at that specified price. We show that the provider's maximum utility is achieved by posting and charging one price, $E(W)$, which leads to all customers' receiving service. This result is easily proved by contradiction. Suppose that there exists a different equilibrium price menu or price offer that gives the provider a higher utility. Then it must be that the provider (regardless of her type) collects from the customer an expected total revenue higher than $E(W)$, which is the amount achieved by offering one price $E(W)$. This implies that at least one type of

customer is paying a price higher than $E(W)$ at equilibrium. So the new equilibrium must be a separating equilibrium, because for a pooling equilibrium, no customer will be willing to pay more than $E(W)$. But for a separating equilibrium, regardless of whether the customer's condition is revealed, the maximum expected revenue that the provider can collect is still equal to $E(W)$, and cannot be any higher. Thus, we have shown that the provider's maximum utility is achieved by posting and charging one price $E(W)$, which leads to the efficient outcome of all customers' receiving service.

3.2. Ex Ante and Ex Post Incentives Misaligned

We now examine our focal case of $E(W) < C_H$, which implies $C_L < W_L < E(W) < C_H < W_H$. Under this condition, the self-interested provider can no longer ex ante credibly commit to always accepting a customer at the uniform price of $E(W)$ because ex post (after determining the customer's type) she is strictly better off not serving the H -type customer. In contrast, because of her social preferences, an ethical provider will derive an overall positive utility from both types of customers at price $E(W)$ and hence will offer such a price to both types of customers if they know that she is the ethical type.

LEMMA 1. *When the provider's type is common knowledge, the ethical provider will post and offer $p_e^* = E(W)$ for both types of customers, whereas the self-interested provider will post a price menu $\{p_{sL}^* = W_L, p_{sH}^* = W_H\}$, then charge W_H to an H -type customer and charge W_L to an L -type customer. The customer accepts the offer of $p_{sL}^* = W_L$ and $p_e^* = E(W)$ with probability 1, and the offer of $p_{sH}^* = W_H$ with probability $\delta^* = (W_L - C_L)/(W_H - C_L)$. Furthermore, the self-interested provider earns a lower profit than the ethical provider (even excluding the social utility component).⁹*

Lemma 1 shows that when the customer knows the provider's type (common knowledge), the ethical provider can still extract the maximum social surplus, achieving the socially optimal result of all customers receiving service. However, because of the lack of credible commitment, the self-interested provider will make a lower profit and fail to achieve the socially optimal result.

It turns out that when the provider's type is observed, the self-interested provider's most profitable uniform pricing strategy is to charge W_L . However, as Lemma 1 shows, the self-interested provider will achieve the highest profit with a differential price menu rather than any uniform price. Interestingly, at equilibrium, the self-interested provider does not

⁹ All proofs not incorporated in the main body of the paper are relegated to the appendix.

cheat (by overcharging customers with a minor condition) even though there are subgames with $p_{sH} < W_H$ in which the provider may cheat and misreport the minor condition as the serious condition. Note also that though the self-interested provider is truth-telling, the customer cannot obtain any higher surplus by deviating (to always accept the high price offer). At the equilibrium price $p_{sH}^* = W_H$, the customer is indifferent between accepting and rejecting service (both result in zero surplus). His probabilistic acceptance strategy eliminates the provider's incentive to deviate, which makes the provider indifferent between offering an L -type customer the price of W_H or W_L .

Next we analyze what happens when the provider's type is not observed by the customer. We first examine the separating equilibria, in which the two types of providers post different price menus from which the customer can infer the provider's true type. We then solve for the pooling equilibria, in which both types of providers post the same price menu.

3.2.1. Separating Equilibria (Differential Pricing).

If the provider's type is not ex ante known to the customer, the ethical provider will not be able to achieve the maximal utility with a uniform price of $E(W)$; at that price, the customer will not accept service. This is because a self-interested provider will offer the service at price $E(W)$ only if the customer has a minor condition. Thus, the customer can infer that, conditional on being offered service at $E(W)$, the probability of his condition being serious must be less than the prior probability β , which implies that he should reject service since $E(W | p = E(W)) < E(W)$.

LEMMA 2. *The ethical provider is better off offering uniform pricing with some price $p \geq W_L$ compared with offering any differential pricing menu $\{p_L, p_H\}$ with $p_L < p_H$, regardless of whether the customer believes that she is ethical.*

Lemma 2 shows that the ethical provider prefers uniform pricing to differential pricing regardless of whether or not the customer believes that she is ethical. That is, even if the customer believes (falsely) that the provider is self-interested, the ethical provider still prefers offering uniform pricing to offering a differential price menu. This is a result of the ethical provider's high opportunity cost for losing an L -type customer when he rejects a high-priced offer with a positive probability.

LEMMA 3. *In a separating equilibrium,*

(a) *The self-interested provider posts the price menu $\{p_{sL}^*, p_{sH}^*\}$, where $p_{sL}^* = W_L$ and $p_{sH}^* = W_H$. She always offers price p_{sH}^* to an H -type customer and price p_{sL}^* to an L -type customer.*

(b) *The ethical provider posts a single price p_e^* for both severity conditions, where $p_e^* \in [W_L, \hat{p}_e]$ with $\hat{p}_e = W_L + (\beta(W_H - C_H)(W_L - C_L))/((1 - \beta)(W_H - C_L)) < E(W)$; she offers service at p_e^* to both types of customers.*

(c) *The customer always accepts services at offered prices of p_{sL}^* or p_e^* from the respective price menus above but accepts p_{sH}^* only with probability $\delta^* = (W_L - C_L)/(W_H - C_L)$.*

Lemma 3 shows that in any separating equilibrium, the self-interested provider adopts a differential pricing strategy and the ethical provider selects a uniform pricing strategy. The usual strict belief system (i.e., any deviation from p_e^* comes from a self-interested provider) supports these separating equilibria, at which the customer can infer the provider's true type from the posted price menu. The ethical provider posts a single price p_e^* , whereas the self-interested provider posts a differential price menu $\{W_L, W_H\}$. Note that, to the self-interested provider, the separating outcome is the same as depicted in Lemma 1. To the ethical provider, however, the posted separating price is less than her first-best price when her type is known; i.e., $p_e^* < E(W)$. This is because she has to ensure that p_e^* is low enough to prevent the self-interested provider from making a profitable deviation. Such p_e^* convinces the customer that she is an ethical provider and that her offer to serve all customers at p_e^* is a credible commitment, and the customer will thus accept such an offer with probability 1. Interestingly, at equilibrium, the self-interested provider does not cheat (i.e., offer the high price W_H to an L -type customer) because the customer will accept the high-priced offer with a probability that makes the provider indifferent between offering the high (W_H) and the low price (W_L) to an L -type customer. In equilibrium, the customer is also indifferent between accepting and rejecting the high-priced offer since the resulting surplus is zero either way.¹⁰

Lemma 3 provides a continuum of perfect Bayesian equilibria depending on the customer's off-equilibrium beliefs. We show here that any separating equilibrium with $p_e^* < \hat{p}_e$ can be eliminated by the intuitive criterion (Cho and Kreps 1987). Suppose that the provider deviates from p_e^* to some $p_e \in (p_e^*, \hat{p}_e)$. This posted uniform price is still equilibrium-dominated for the self-interested provider, regardless of what the customer believes about the provider's type.¹¹

¹⁰ If regulatory agencies for some industries impose a price ceiling for the high price $p_{sH} < W_H$, this means that at equilibrium we will no longer have $p_{sH}^* = W_H$. Our model suggests that the self-interested provider will indeed cheat with some positive probability, i.e., misreport a minor condition and charge the L -type customer the high price with some positive probability (the expression for this probability ρ conditional on p_{sH} is given in the proof of Lemma 1).

¹¹ In the proof of Lemma 3, we show that the self-interested provider will not deviate to any uniform price less than \hat{p}_e .

Therefore, the customer should not believe that the provider who voluntarily made such a deviation can be the self-interested type with any positive probability. Consequently, the ethical provider indeed prefers deviating to such a price as long as the customer believes that such deviation cannot come from the self-interested provider. That is, the equilibrium involving any $p_e^* < \hat{p}_e$ fails the intuitive criterion. It is easy to verify that $p_e^* = \hat{p}_e$ is the only separating outcome that survives the intuitive criterion (the off-equilibrium belief is that any deviation to a uniform price higher than \hat{p}_e comes from either type of providers). Clearly, among all separating equilibria, the one with $p_e^* = \hat{p}_e$ also gives the ethical provider the highest payoff. We will focus on this refined separating outcome for the rest of the paper. We summarize the analysis as follows.

PROPOSITION 1. *The unique separating equilibrium that survives the intuitive criteria (out of all the equilibria in Lemma 3) corresponds to $p_e^* = \hat{p}_e$ and is the ethical provider's most profitable separating equilibrium.*

In a separating equilibrium, the self-interested provider's profit is the following:

$$\begin{aligned} \pi_s^{\text{sep}}(p_{sH}^*, p_{sL}^*) \\ = \beta \frac{W_L - C_L}{W_H - C_L} (W_H - C_H) + (1 - \beta)(W_L - C_L). \end{aligned} \quad (1)$$

From Proposition 1, the ethical provider sets $p_e^* = \hat{p}_e$, and her payoff is

$$\begin{aligned} \pi_e^{\text{sep}}(p_e^*) = W_L + \frac{\beta(W_H - C_H)(W_L - C_L)}{(1 - \beta)(W_H - C_L)} \\ + [\beta(\alpha W_H - C_H) + (1 - \beta)(\alpha W_L - C_L)]. \end{aligned} \quad (2)$$

Simple algebra shows that the ethical provider's equilibrium payoff, $\pi_e^{\text{sep}}(p_e^*)$, increases in β . In contrast, the self-interested provider's payoff decreases in β .

COROLLARY 1. *Under the separating equilibrium, the self-interested provider's profit decreases in β , whereas the ethical provider's profit increases in β .*

Moreover, neither provider's profit depends on γ , the level of ethics (the probability of the provider being ethical). Under the separating equilibrium, the ethical provider accepts both types of customers, and the customer accepts with certainty any service offer at a price of $p_{sL}^* = W_L$ or p_e^* . Thus, the expected welfare loss under the separating equilibrium, denoted by W_{sep} , comes only from the customer's probabilistic rejection of the self-interested provider's high-priced offer of p_{sH}^* . We can easily compute W_{sep} :

$$\begin{aligned} W_{\text{sep}} &= (1 - \gamma)\beta(1 - \delta^*)(W_H - C_H) \\ &= (1 - \gamma)\beta \frac{W_H - W_L}{W_H - C_L} (W_H - C_H). \end{aligned} \quad (3)$$

Clearly, the maximum social welfare (i.e., the total customer welfare loss prevented net of the provider's cost) is $W_{\text{max}} = \beta(W_H - C_H) + (1 - \beta)(W_L - C_L)$. We define market efficiency ε as the ratio of the actual social welfare over the maximal social welfare: $\varepsilon \equiv (W_{\text{max}} - W_{\text{sep}})/W_{\text{max}}$.

COROLLARY 2. *In the separating equilibrium, market efficiency increases in the level of ethics in the market (γ), though neither type of provider's payoff depends on γ .*

Corollary 2 shows that, as expected, the level of ethics in the market does not affect the provider's payoff, but it does influence market efficiency. In particular, market efficiency increases as the probability of a provider being ethical increases.

3.2.2. Pooling Equilibria (Uniform Pricing). We now examine pooling equilibria and characterize the uniform pricing equilibria in Proposition 2.

PROPOSITION 2. *Under a pooling equilibrium, both types of providers post the same price $p^* \in [\hat{p}_e, \hat{p}]$ for different customer conditions, where $\hat{p} = (\beta\gamma W_H + (1 - \beta)W_L)/(\beta\gamma + (1 - \beta))$.*

(a) *The self-interested provider accepts the L-type customer at price p^* but dumps the H-type customer.*

(b) *The ethical provider accepts any customer at price p^* .*

(c) *The customer always accepts a service offer at p^* from the provider's uniform price menu.*

These uniform pricing pooling equilibria are supported by different off-equilibrium beliefs. Below is the belief system that supports all equilibria (both pooling and separating) and that survives the refinement by the intuitive criterion: The provider is self-interested if she posts any differential menu. The provider is ethical if she posts a uniform menu with $p \leq \hat{p}_e$. If $p > \hat{p}_e$, the posterior distribution of the provider type is the same as the prior.

Note that conditional on the customer accepting the service offer, both types of providers have the same incentives to maximize their monetary profits. Therefore, different from Spence's (1973) job market signaling model, the single-crossing property does not hold in our setting; as we show below, the intuitive criterion cannot eliminate the pooling equilibria from Proposition 2. Note that it is the ethical provider that has an incentive to reveal her true type to the customers. From Lemmas 2 and 3, we find that the ethical provider has no profitable deviation to any differential price menu, even if the customer believes she is the ethical type. In addition, if the ethical provider deviates to any price $p < p^*$, she will also make a strictly lower profit than her equilibrium profit, even if doing so convinces the customer that she is ethical. This is because at the current price p^* , all customers already accept the provider's service offer since $E(W | p^*) = (\beta\gamma W_H + (1 - \beta)W_L)/(\beta\gamma + (1 - \beta)) \geq p^*$, and a lower price will not increase the number

of customers that she serves. Finally, any deviation $p > p^*$ by the ethical provider is also not a deviation that is equilibrium-dominated for the self-interested provider under all possible beliefs. Thus, our pooling outcomes survive the intuitive criterion.

If the provider is always ethical ($\gamma = 1$), she will charge a price of $E(W)$ and will always serve all customers. This equilibrium is socially efficient and allows the provider to extract the entire social surplus. When the self-interested provider exists, she has an incentive to mimic the ethical provider to profit from the L -type customer but dump the H -type customer since $p^* < E(W) < C_H$. In practice, for example, the provider can dump the high-cost customers by claiming that her schedule has been fully booked. The self-interested provider's dumping of H -type customers results in a net welfare loss and hence socially suboptimal market inefficiency.

COROLLARY 3. *All the pooling equilibria are equally efficient, and the provider's most profitable equilibrium corresponds to that with $p^* = \hat{p}$.*

As γ increases, the customer's willingness to pay for service increases, and the self-interested provider's incentive to mimic the ethical provider also increases. The provider's profit increases in the equilibrium price since the customer always accepts offered service in pooling equilibria. As Corollary 3 indicates, the provider's most profitable pooling equilibrium is when the belief corresponds to $p^* = \hat{p}$. Recall that it is socially efficient to have both types of customers served; the market inefficiency in the pooling equilibria comes from the welfare loss of the self-interested provider's customer dumping. Though the ethical provider serves any customer at the equilibrium price, the self-interested provider always dumps the H -type customers ex post, so all pooling outcomes have the same market efficiency. In a pooling equilibrium, the L -type customer is always served, whereas the H -type customer will be rejected for service with probability $1 - \gamma$ (dumped by the self-interested provider). The welfare loss and the corresponding market efficiency are therefore

$$W_{\text{pool}} = (1 - \gamma)\beta(W_H - C_H) \quad \text{and} \quad \varepsilon = 1 - \frac{W_{\text{pool}}}{W_{\text{max}}},$$

respectively, which are the same across all pooling equilibria, even though the division of the social surplus between the customer and the provider may vary.

Let us first examine the provider's profit under the most profitable pooling equilibrium, where both types of providers post a uniform price $p^* = \hat{p}$. Since the

self-interested provider accepts only the L -type customer and dumps any H -type customer, her profit is

$$\begin{aligned} \pi_s^{\text{pool}} &= (1 - \beta)(p^* - C_L) \\ &= (1 - \beta) \frac{\beta\gamma(W_H - C_L) + (1 - \beta)(W_L - C_L)}{\beta\gamma + (1 - \beta)}. \end{aligned} \quad (4)$$

The self-interested provider's pooling profit increases in the level of ethics (γ), because the customer's willingness to pay increases with γ .

In contrast, the ethical provider serves both H -type and L -type customers, and her payoff is

$$\begin{aligned} \pi_e^{\text{pool}} &= \frac{\beta\gamma W_H + (1 - \beta)W_L}{\beta\gamma + (1 - \beta)} \\ &\quad - [\beta(C_H - \alpha W_H) + (1 - \beta)(C_L - \alpha W_L)]. \end{aligned} \quad (5)$$

3.3. Separating vs. Pooling

We now examine equilibrium selection (or "realization") between the two different types of equilibria, and we analyze the relative market efficiency across markets with different levels of ethics (the probabilities of the provider being ethical). For a class of signaling games, both the undefeated equilibrium and the lexicographically maximum sequential equilibrium (Mailath et al. 1993) correspond to the same equilibrium, one under which the "high type" (in our case, the ethical type) will make at least as much profit as she can under pooling. The intuitive rationale comes from the fact that the high type has an incentive to reveal her type whereas the "low type" (in our case, the self-interested type) wants to mask herself. Thus, if the high type prefers pooling over separating, then a separating equilibrium can be realized only by adopting an "unnatural" or "unreasonable" belief system, which we want to refine away. In this paper, we adopt this outcome-based refinement approach for further equilibrium selection. With that said, the main goal of our research is to show the possibility of the interesting results rather than the uniqueness of the refined equilibrium.

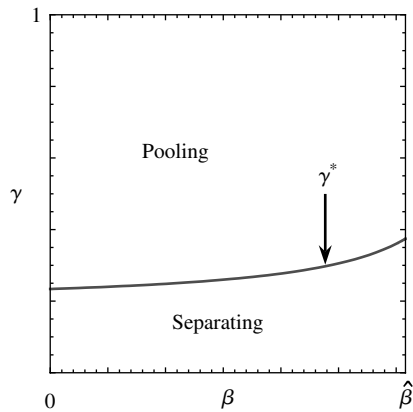
3.3.1. The Role of the Level of Ethics. In the unique separating equilibrium, the customer can identify the provider's type from her posted price menu. From Proposition 1, the self-interested provider's separating profit is (1). The ethical provider's separating payoff at $p_e^* = \hat{p}_e$ is given by (2).

Comparing the provider's profit under differential pricing with that under uniform pricing for both types of providers ((5) versus (2) and (4) versus (1), respectively), we find that the provider's profit is greater under the pooling outcome than under the separating outcome for both types of providers when the same condition holds:

$$\gamma > \gamma^* = \left[\frac{(W_H - C_L)(W_H - W_L)}{(W_L - C_L)(W_H - C_H)} - \frac{\beta}{1 - \beta} \right]^{-1}. \quad (6)$$

Proposition 3 immediately follows.

Figure 1 Equilibrium Outcome in (β, γ) Parameter Space



Note. The upper bound ($\hat{\beta}$) for valid β parameter values in our model is determined by the assumption $E(W) < C_H$, which requires $\beta < (C_H - W_L)/(W_H - W_L)$.

PROPOSITION 3. *There exists γ^* such that the separating equilibrium is realized when $\gamma < \gamma^*$, and the pooling outcome is realized when $\gamma > \gamma^*$.*

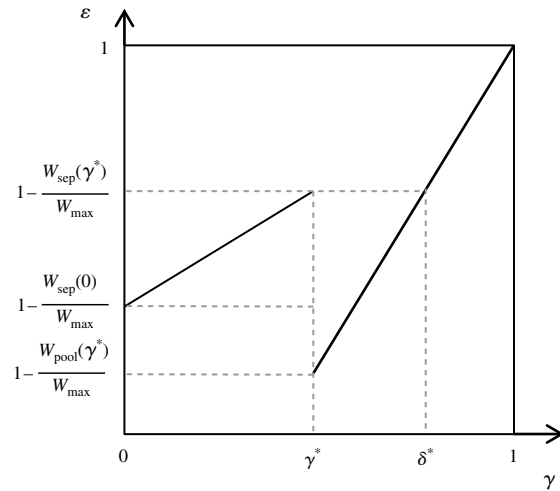
Intuitively, if consumers believe that the probability of the provider being ethical is high, the self-interested provider will more likely pose as an ethical provider by posting the same uniform price. Note also that, as illustrated in Figure 1, γ^* increases (i.e., pooling is less likely) as β increases. If the self-interested provider mimics the ethical provider (by posting a relatively low uniform price), she will dump all H -type customers. So as the number of H -type customers increases, the self-interested provider is less likely to mimic the ethical provider and will make more profit with differential pricing because only some H -type customers will reject service when quoted the high price.

3.3.2. Market Efficiency and Customer Welfare.

Now we examine how total welfare and market inefficiency depend on the level of ethics in the market. As discussed earlier, it is socially efficient to have both types of customers served since the provider's cost is smaller than the customer's potential loss.

Under both types of equilibria, the ethical provider posts and offers a uniform price and both types of customers are served. That is, any welfare loss or market inefficiency comes from the self-interested provider. Under the pooling equilibrium, the self-interested provider will dump the H -type customer ex post. So the welfare loss under pooling is $W_{\text{pool}} = (1 - \gamma)\beta(W_H - C_H)$. Under the separating equilibrium, the self-interested provider will use a differential price menu and offers to serve both types of customers. However, the customer occasionally rejects the high-priced service out of concerns about the provider's misreporting incentive. The welfare loss

Figure 2 Effect of γ on Market Efficiency (ε)



under the separating equilibrium is computed as $W_{\text{sep}} = (1 - \gamma)\beta((W_H - W_L)/(W_H - C_L))(W_H - C_H)$. Figure 2 illustrates how the level of ethics affects market efficiency (ε). Intuitively, one may expect that the higher the level of ethics in the market, the higher the market efficiency. However, we find that this is not necessarily the case. Proposition 4 formally proves that market efficiency may be lower in a more ethical market than it is in a less ethical market.

PROPOSITION 4. *Market efficiency may be lower in a more ethical market than in a less ethical one.*

As Figure 2 shows, within the parameter region for each equilibrium regime, market efficiency increases. Interestingly, at $\gamma = \gamma^*$, there is an efficiency gap between the differential pricing (separating) equilibrium and the uniform pricing (pooling) equilibrium. The intuition lies in the fact that a higher ethical level (γ) gives the self-interested provider more incentive to mimic the ethical provider's uniform price menu, which may induce the self-interested provider to switch from differential pricing to uniform pricing. Note that in both situations, the L -type customer is always serviced and the ethical provider also always services the H -type customer, so the market inefficiency is due to the H -type customer in the case of a self-interested provider. In a more ethical market (under uniform pricing), the self-interested provider always dumps the H -type customer; in a less ethical market (under differential pricing), the self-interested provider will have her high-priced offer accepted by the H -type customer with some positive probability. Therefore, market efficiency may actually be lower in a more ethical market than in a less ethical one.

Next we examine how the customer is affected by the level of ethics in the market. Let us compute the customer's ex ante expected surplus $E[CS]$ (before

seeing the service provider) compared with his status quo of seeking no service. If $\gamma < \gamma^*$, $E[CS] = \gamma[E(W) - p_e^*]$ by noting that at the separating equilibrium the customer gets no surplus when facing a self-interested doctor. When $\gamma > \gamma^*$, at the pooling equilibrium, the H -type customer is dumped by the self-interested provider, so $E[CS] = \gamma[E(W) - p^*] + (1 - \gamma) \cdot (1 - \beta)(W_L - p^*)$. Since $p^* > p_e^* > W_L$, clearly, the customer's ex ante surplus is lower when $\gamma > \gamma^*$ than when $\gamma < \gamma^*$; Proposition 5 follows.

PROPOSITION 5. *The customer is worse off in a more ethical market with $\gamma > \gamma^*$ than in a less ethical one with $\gamma < \gamma^*$.*

The customer's ex ante surplus in the less ethical market is lower mainly because in the less ethical market, the ethical provider reduces her uniform price enough to separate herself from the self-interested provider. In a very ethical market, however, the ethical provider will no longer incur the signaling cost to prove her type; the pooling uniform price is much higher. If we examine the customer ex post surplus, we find that the H -type customer actually benefits as γ increases but the L -type customer is worse off. In essence, because of the information asymmetry, the L -type customer subsidizes the H -type customer. As γ increases, the L -type customer subsidizes the H -type customer to a greater degree via the ethical provider's uniform pricing under both types of equilibria.

4. Conclusion

In this paper, we have examined the economic and social implications of the particular characteristics of many service markets such as consulting, financial planning, and healthcare. In such markets, the service provider may have more information about the customer's problem than the customer, and different customers' problems may impose different levels of cost on the service provider. In principle, the service provider should ethically care about the customer's welfare (e.g., by fiduciary duty or ethical codes of conduct), but it is possible that a provider may maximize only its own profit. For example, a provider may not always take into consideration the welfare of her customers. Some health service providers prescribe more than adequate or necessary levels of care to customers; some even stop providing procedures or services that carry a high liability risk or require a great amount of time and effort. Some simply dump those customers with serious conditions that cost them more to service and focus on the most profitable customers. Furthermore, the customer may not know ex ante whether the service provider is ethical or purely self-interested. We have introduced

a game-theoretic model to investigate pricing strategies and the market outcome in such a services market where the service provider has two-dimensional private information—about her own type (whether ethical or self-interested) and about the customer's condition (whether serious or minor).

Our analysis shows several key findings. First, in a less ethical market, a unique separating equilibrium survives the intuitive criterion, and at that equilibrium the self-interested provider adopts differential pricing whereas an ethical provider will post the same price for both conditions. Realizing the possibility of being overcharged for a minor condition, the customer will occasionally reject the service offer when asked to pay a high price by a provider using differential pricing. Thus, in the case of a self-interested provider, a customer with a serious condition may not be able to obtain any service with some positive probability.

Second, in a more ethical market, the ethical provider still posts and charges one price for both customer conditions, but the self-interested provider will mimic the ethical provider's pricing strategy to achieve a pooling equilibrium. Under the pooling equilibrium, no customers of either severity condition will reject service at the equilibrium price. However, the self-interested provider will dump customers with a serious condition because it is not profitable for her to serve such customers at the pooling equilibrium price.

Third, and especially interesting, market efficiency may be lower in a more ethical market than in a less ethical one. This is because a higher ethical level gives the self-interested provider more incentive to mimic the ethical provider's uniform price menu, which may induce the self-interested provider to switch from differential pricing to uniform pricing. Since the L -type customers are always served, the market inefficiency is due to the H -type customers. In a less ethical market, H -type customers may occasionally reject services when facing the self-interested provider's differential pricing. However, in a more ethical market, all H -type customers will be dumped by the self-interested provider, who adopts a uniform pricing strategy to mimic the ethical provider. Thus, market efficiency may actually be lower in a more ethical market. We find that a higher level of ethics may lead to a lower level of customer surplus. We caution the reader that the public policy implications of our results on market efficiency and consumer surplus have to be interpreted within the context of abstraction from additional critical factors that may affect the results. Specifically, note that we do not model competition, the consumers' adverse reactions to the unethical provider, or repeated interactions; incorporating them might alter the key findings.

To the best of our knowledge, our paper is the first to explore both social preferences and the two-dimensional informational asymmetry in the credence good market that we have characterized. Our analysis applies to many service industries, including auto mechanical services; financial services; professional, legal, and management consulting services; and some industries in the healthcare sector where service interactions are at an arm's length and mostly transactional (e.g., specialist or discretionary services, such as cosmetic treatment or surgery) and where prices are easily available and insurance or government programs have less impact (e.g., in developing economies).

Our current study offers several avenues for future research. First, we have focused on monopoly and monopolistically competitive markets. If we take a reduced-form approach to provider competition, the self-interested providers will still have incentives to mimic the ethical providers, and both nontrivial pooling and separating outcomes should exist as long as price competition is not so severe as to reduce all providers' profits to zero. In other words, as long as the competitive market is a differentiated duopoly or oligopoly, the key framework of our model remains relevant. In such competitive settings, we expect our main results to qualitatively hold under some conditions for symmetric equilibria. We also intuit that it is more likely that high-cost customers will receive service in a competitive market. Consumer search behaviors can also be examined by extending Wolinsky (1993) to incorporate our framework. We will leave that for future research. Second, it may also be fruitful to examine information sharing between early customers and later customers. We do not explicitly model such a dynamic model because it is extremely complex, but we can make reasonable conjectures. We can allow for word of mouth to be partially effective in reducing uncertainty in the market. (Note that Angie's List, for example, helps customers identify service providers likely to be of higher quality or more ethical, but it does not completely resolve the uncertainty. There remains significant variance in the ratings.) Thus, word-of-mouth effects can be seen as eliminating from the market unethical service providers who do not hesitate to rip off customers. Abstracting this idea in a model, word of mouth can be seen as making the market appear more ethical, because in these dynamic, multiperiod contexts, the self-interested provider's mimicking incentives become stronger. An interesting scenario may arise if we also allow for dynamic pricing. After word of mouth reveals the provider's type to later customers, both providers may adopt differential pricing in the future period, since the self-interested provider can no longer pool with the ethical provider. One can

study the welfare implications and the strategic incentives for earlier customers to share information with later customers. Third, it may be interesting to investigate the customer's or customer's search behaviors or incentives to acquire information in a competitive services market with the same characteristics that we have studied. Finally, we have focused on the overcharging issue in credence good markets, but when some part of the service input is verifiable, there can also be an important issue of under- and overprovision of service. We leave it to future research to explore any new insights from a more comprehensive framework with both overcharging and under- or overprovision of services.

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Appendix

PROOF OF LEMMA 1. Since the provider's type is common knowledge, we simply need to discuss the two cases separately. Let us start with the case of the ethical provider. From assumption (C1), the ethical provider's utility for servicing a customer of type i at price p is $U_{ei} = p - C_i + \alpha W_i \geq p \geq 0$. Thus, the ethical provider's ex ante and ex post incentives to service the customer at price p are aligned. Following the same argument in §3.1, the ethical provider's optimal strategy is to post and offer $p_e^* = E(W)$ for both conditions, and the customers always accept the offer p_e^* .

Now we consider the case of the self-interested provider. Suppose that the self-interested provider posts a single price p for both conditions. Clearly, if $p > E(W)$, no customer will accept the price offer because the customer's ex ante expected loss with no service is $E(W)$. If $W_L < p \leq E(W)$, the provider will offer service only to an L -type customer because the provider will get negative profit from an H -type customer (since $p < C_H$). The customer who receives such a price offer knows that he must have a minor condition and will thus reject the offer (since $p > W_L$). The customer will accept service only if $p \leq W_L$. Thus, the self-interested provider's most profitable uniform price is W_L , and the corresponding profit is $(1 - \beta)(W_L - C_L)$.

Now we consider the self-interested provider's most profitable differential price menu $\{p_{sL}, p_{sH}\}$ where $p_{sL} < p_{sH}$. The proof for this special case is similar to that in Fong (2005). Note that $p_{sL} \leq W_L$ must hold because otherwise no customer—with only prior information about his condition—will accept the price offer (by similar arguments to the above). In addition, $p_{sH} \leq W_H$ because otherwise no customer will accept service at p_{sH} . The self-interested provider

will offer only prices that will at least cover her cost; i.e., $p_{sL} \geq C_L$ and $p_{sH} \geq C_H$. In summary, the self-interested provider's optimal price menu must satisfy $C_L \leq p_{sL} \leq W_L$ and $C_H \leq p_{sH} \leq W_H$.

Note that the self-interested provider will always offer p_{sH} to an H -type customer, because she will incur a loss charging p_{sL} to an H -type customer. However, when seeing an L -type customer, the self-interested provider may cheat and offer p_{sH} rather than p_{sL} . If the provider *always* offers p_{sH} to an L -type customer (as well as to an H -type customer), then the (uninformed) customer will certainly reject the high-priced offer since p_{sH} is larger than his expected loss. Let ρ be the probability that the self-interested provider will offer p_{sH} to an L -type customer. Let δ be the probability that the customer will accept the offer p_{sH} . At equilibrium (of the subgame following the posting of a differential price menu), the provider should be indifferent between offering p_{sH} and offering p_{sL} to an L -type customer. Thus, $\delta = (p_{sL} - C_L)/(p_{sH} - C_L)$. Similarly, the customer should also be indifferent between accepting and rejecting the high-priced offer p_{sH} . Thus, $p_{sH} = E(W | p_{sH}) = W_H \Pr(H | p_{sH}) + W_L \Pr(L | p_{sH})$, where " $| p_{sH}$ " means conditional on being offered the price p_{sH} from the differential price menu:

$$\begin{aligned} \Pr(H | p_{sH}) &= \frac{\Pr(p_{sH} | H) \Pr(H)}{\Pr(p_{sH} | H) \Pr(H) + \Pr(p_{sH} | L) \Pr(L)} \\ &= \frac{\beta}{\beta + \rho(1 - \beta)}, \end{aligned}$$

$$\Pr(L | p_{sH}) = 1 - \Pr(H | p_{sH}) = \frac{\rho(1 - \beta)}{\beta + \rho(1 - \beta)}.$$

Thus, the provider should set

$$p_{sH} = E(W | p_{sH}) = \frac{\beta W_H}{\beta + \rho(1 - \beta)} + \frac{\rho(1 - \beta) W_L}{\beta + \rho(1 - \beta)},$$

from which we easily obtain

$$\rho = \frac{\beta(W_H - p_{sH})}{(1 - \beta)(p_{sH} - W_L)}.$$

The self-interested provider's total expected profit is given by $\pi_s(\{p_{sL}, p_{sH}\}) = \beta\delta(p_{sH} - C_H) + (1 - \beta)\rho\delta(p_{sH} - C_L) + (1 - \beta)(1 - \rho)(p_{sL} - C_L)$. Substituting the expressions for ρ and δ , we can simplify the self-interested provider's profit to

$$\pi_s(\{p_{sL}, p_{sH}\}) = \frac{\beta(p_{sL} - C_L)(p_{sH} - C_H)}{p_{sH} - C_L} + (1 - \beta)(p_{sL} - C_L).$$

Note that this profit function is a strictly increasing function in p_{sL} and p_{sH} when $C_L \leq p_{sL} \leq W_L$ and $C_H \leq p_{sH} \leq W_H$. Thus, in these relevant price ranges, the optimal prices are $p_{sL}^* = W_L$ and $p_{sH}^* = W_H$, and the maximum profit is $\pi_s^*(\{p_{sL}^*, p_{sH}^*\}) = (\beta(W_L - C_L)(W_H - C_H))/(W_H - C_L) + (1 - \beta)(W_L - C_L)$, which is clearly larger than her maximum profit from uniform pricing that we found earlier. At this equilibrium, $\rho^* = 0$ and $\delta^* = (W_L - C_L)/(W_H - C_L)$. And finally, this profit is clearly smaller than the ethical provider's profit (even excluding the social preference component):

$$\begin{aligned} \pi_e^*(p_e^*) &= E(W) - [\beta C_H + (1 - \beta)C_L] \\ &= \beta(W_H - C_H) + (1 - \beta)(W_L - C_L). \quad \square \end{aligned}$$

PROOF OF LEMMA 2. First, let us consider the case in which the customer (mistakenly) believes that the ethical provider is a self-interested provider. Suppose that the ethical provider posts a price menu based on customer conditions: $\{p_L, p_H\}$ with $p_L \leq W_L$, $p_H \leq W_H$, and $p_L < p_H$. We want to find the ethical provider's best differential menu and show that it results in a lower payoff than if she uses some uniform price even given that the customer has misidentified her as self-interested. With the differential menu, the customer will accept the high-priced offer $p_H \leq W_H$ with probability $\delta = (p_L - C_L)/(p_H - C_L)$. Let ρ be the probability that the ethical provider offers p_H to an L -type customer; i.e., $\rho = \Pr(p_H | L)$. Similar to our analysis in Lemma 1, we find

$$\begin{aligned} \Pr(H | p_H) &= \frac{\Pr(p_H | H) \Pr(H)}{\Pr(p_H | H) \Pr(H) + \Pr(p_H | L) \Pr(L)} = \frac{\beta}{\beta + \rho(1 - \beta)}, \\ \Pr(L | p_H) &= 1 - \Pr(H | p_H) = \frac{\rho(1 - \beta)}{\beta + \rho(1 - \beta)}. \end{aligned}$$

Thus, to maximize her payoff, the ethical provider should set

$$p_H = E(W | p_H) = \frac{\beta W_H}{\beta + \rho(1 - \beta)} + \frac{\rho(1 - \beta) W_L}{\beta + \rho(1 - \beta)},$$

from which we easily obtain

$$\rho = \frac{\beta(W_H - p_H)}{(1 - \beta)(p_H - W_L)}.$$

The ethical provider's total expected payoff is therefore computed by

$$\begin{aligned} \pi_e(\{p_L, p_H\}) &= \beta\delta(p_H - C_H + \alpha W_H) + (1 - \beta)\rho\delta(p_H - C_L + \alpha W_L) \\ &\quad + (1 - \beta)(1 - \rho)(p_L - C_L + \alpha W_L). \end{aligned}$$

Substituting the expressions for ρ and δ , we can simplify the ethical provider's payoff function to

$$\begin{aligned} \pi_e(\{p_L, p_H\}) &= \frac{\beta(p_L - C_L)(p_H - C_H + \alpha W_H)}{p_H - C_L} + (1 - \beta) \\ &\quad \cdot (p_L - C_L + \alpha W_L) - \beta\alpha W_L \frac{(W_H - p_H)(p_H - p_L)}{(p_H - W_L)(p_H - C_L)}, \end{aligned}$$

which is a monotonic increasing function in p_L and p_H . Thus, given that the customer has mistakenly identified her as self-interested, the ethical provider's best differential price menu is $\{p_H = W_H, p_L = W_L\}$.

Next we compute the ethical provider's payoff with the uniform price of W_L , assuming again the customer misidentifies her as self-interested:

$$\pi_e(W_L) = W_L - [\beta(C_H - \alpha W_H) + (1 - \beta)(C_L - \alpha W_L)].$$

It is easy to show that

$$\begin{aligned} \pi_e(W_L) - \pi_e(\{p_H = W_H, p_L = W_L\}) &= \frac{\beta(W_H - W_L)(\alpha W_H - C_H + C_L)}{(W_H - C_L)} > 0. \end{aligned}$$

Obviously, the ethical provider's *optimal* uniform price p (under the mistaken unfavorable belief) yields a payoff of at least what she gets using the particular uniform price of W_L (under the same belief); i.e., $\pi_e(p) \geq \pi_e(W_L)$. Thus, we

have shown that there exists some $p \in [W_L, E(W)]$ such that $\pi_e(p) - \pi_e(p_H = W_H, p_L = W_L) > 0$, and we conclude that the ethical provider strictly prefers some uniform pricing strategy over any differential pricing strategy in the case in which the customer (mistakenly) believes that she is a self-interested provider.

Now let us consider the second case in which the customer (correctly) believes that the provider is of the ethical type. So if the ethical provider posts a menu $\{p_L, p_H\}$ with $p_L < p_H$, the customer will accept the offer $p_H \leq W_H$ with probability $\delta = (p_L - C_L + \alpha W_L)/(p_H - C_L + \alpha W_L)$. Hence, the ethical provider's payoff becomes

$$\pi_e(\{p_L, p_H\}) = \frac{\beta(p_L - C_L + \alpha W_L)(p_H - C_H + \alpha W_H)}{p_H - C_L + \alpha W_L} + (1 - \beta)(p_L - C_L + \alpha W_L).$$

It is straightforward to show that with assumption (C1), the ethical provider's payoff above is a decreasing function in p_H , which implies that the maximum payoff occurs when $p_H \rightarrow p_L$. That is, there always exists a uniform pricing strategy that strictly dominates any differential pricing menu for the ethical provider. So the ethical provider again prefers uniform pricing. \square

PROOF OF LEMMA 3. By Lemma 2, the ethical provider prefers some uniform pricing strategy $p \geq W_L$ to any differential pricing menu, whether or not the customer believes that she is ethical. Thus, at the separating equilibrium, the ethical provider will choose some uniform price $p_e^* \geq W_L$ and offer it to any customer, who will then accept the service offer as long as $p_e^* \leq E(W)$.

By Lemma 1, if the self-interested provider's type is known to customers, her most profitable price menu is the differential menu $\{p_{sL}^* = W_L, p_{sH}^* = W_H\}$. At the separating equilibrium, the self-interested provider's type will be correctly inferred by the customers, and thus at such an equilibrium, the self-interested provider should adopt that differential price menu and the customer's acceptance strategy is as already discussed in Lemma 1. We must show that the self-interested provider cannot profitably deviate to the ethical provider's strategy; that is, $\pi_s^{\text{sep}}(p_{sH}^*, p_{sL}^*) \geq \pi_s'(p_e^*)$, where $\pi_s'(p_e^*)$ is the self-interested provider's profit when she deviates to the ethical provider's equilibrium strategy. Note that $\pi_s'(p_e^*) = (1 - \beta)(p_e^* - C_L)$ since the self-interested provider will dump H -type customers. Furthermore, $\pi_s^{\text{sep}}(p_{sH}^*, p_{sL}^*)$ should be the same as the self-interested provider's maximum profit computed in the proof of Lemma 1. Therefore, the condition for nondeviation by the self-interested provider becomes $\pi_s^{\text{sep}}(p_{sH}^*, p_{sL}^*) = \beta(W_L - C_L)(W_H - C_H)/(W_H - C_L) + (1 - \beta)(W_L - C_L) \geq \pi_s'(p_e^*) = (1 - \beta)(p_e^* - C_L)$, which leads to $p_e^* \leq \hat{p}_e \equiv W_L + (\beta/(1 - \beta))((W_L - C_L)/(W_H - C_L))(W_H - C_H) < E(W)$.

Note that the last part of the above inequality $\hat{p}_e < E(W)$ is easily proved below. First note that

$$W_L + \frac{\beta}{1 - \beta} \frac{W_L - C_L}{W_H - C_L} (W_H - C_H) < \beta W_H + (1 - \beta) W_L \\ \Leftrightarrow \beta < 1 - \frac{(W_L - C_L)(W_H - C_H)}{(W_H - W_L)(W_H - C_L)} \equiv \text{RHS}$$

(where RHS denotes the right-hand side). Since $E(W) < C_H$, i.e., $\beta W_H + (1 - \beta) W_L < C_H$, we obtain $\beta < (C_H - W_L)/(W_H - W_L)$. Furthermore, one can easily verify algebraically that $(C_H - W_L)/(W_H - W_L) < \text{RHS}$ is always true given our assumption $W_H > C_H > W_L$. Therefore, $\hat{p}_e < E(W)$.

Clearly, the usual strict belief system about the provider's type (i.e., any deviation to a uniform menu different from the ethical provider's equilibrium price p_e^* comes from a self-interested provider) supports the separating equilibria. \square

PROOF OF COROLLARY 1. The ethical provider's equilibrium profit (2) can be simplified to

$$\pi_e^{\text{sep}} = W_L + \frac{(W_H - C_H)(W_L - C_L)}{(1/\beta - 1)(W_H - C_L)} + (\alpha W_L - C_L) + \beta[\alpha(W_H - W_L) - (C_H - C_L)],$$

which clearly increases in β on $\beta \in (0, 1)$. In contrast, the self-interested provider's profit (1) can be simplified to $\pi_s^{\text{sep}} = [1 - ((C_H - C_L)/(W_H - C_L))\beta](W_L - C_L)$, which is a decreasing function in β for $\beta \in (0, 1)$ since $0 < (C_H - C_L)/(W_H - C_L) < 1$. \square

PROOF OF COROLLARY 2. Substituting W_{sep} and W_{max} into the definition of market efficiency, we obtain

$$\varepsilon = \frac{W_{\text{max}} - W_{\text{sep}}}{W_{\text{max}}} = \frac{[1 - (1 - \gamma) \frac{W_H - W_L}{W_H - C_L}]\beta(W_H - C_H) + (1 - \beta)(W_L - C_L)}{\beta(W_H - C_H) + (1 - \beta)(W_L - C_L)}.$$

Clearly, $\partial \varepsilon / \partial \gamma > 0$. \square

PROOF OF PROPOSITION 2. We need to show that neither type of provider has a profitable deviation from equilibrium conditional on the customer's belief system about the provider's type. The provider is self-interested if she posts any differential menu. The provider is ethical if she posts a uniform menu with $p \leq \hat{p}_e$. If the provider's uniform price $p > \hat{p}_e$, the posterior distribution of the provider type is the same as the prior:

Using Bayes' rule,

$$\Pr(H | p^*) = \frac{\Pr(p^* | H)\Pr(H)}{\Pr(p^* | H)\Pr(H) + \Pr(p^* | L)\Pr(L)} = \frac{\beta\gamma}{\beta\gamma + (1 - \beta)}.$$

The customer's expected welfare loss if not accepting service conditional on the service being offered at p^* is thus $E[W | p^*] = W_H \Pr(H | p^*) + (1 - \Pr(H | p^*))W_L = (\beta\gamma W_H + (1 - \beta)W_L)/(\beta\gamma + (1 - \beta))$.

Therefore, the customer will accept the service offer at any uniform price of $p^* \in [\hat{p}_e, (\beta\gamma W_H + (1 - \beta)W_L)/(\beta\gamma + (1 - \beta))]$.

We first show that the self-interested provider has no profitable deviation from equilibrium conditional on the customer's belief system. The self-interested provider will make a strictly lower profit than her pooling equilibrium profit if she deviates to a uniform menu with $p < p^*$ since she still serves the same number of the L -type customers but will reduce her profit because $p < p^*$ (she

rejects the H -type customer). She also makes a lower profit if she deviates to $p > p^*$, because customers believe that such deviations are made by a self-interested provider and hence will reject the offer $p > W_L$. If the self-interested provider deviates to a differential price menu, her maximum profit is $\pi'_s(W_H, W_L) = (\beta(W_L - C_L)(W_H - C_H))/(W_H - C_L) + (1 - \beta)(W_L - C_L) < \pi_s^{\text{pool}}(p^*) = (1 - \beta)(p^* - C_L)$, as given in Lemma 1. Note that for all $p > \hat{p}_e$, the pooling profit is larger than the maximum profit from a differential price menu. Thus, the self-interested provider will not deviate from p^* .

Now we show that the ethical provider does not have any profitable deviation. She does not want to deviate to any lower uniform price $p < p^*$ since the customer always accepts her offer p^* anyway. She will make a lower profit (than her pooling equilibrium profit) if she deviates to any higher uniform price $p > p^*$ because she will be believed to be a self-interested provider and customers will reject service at any uniform price $p > W_L$. Similarly, she also makes a lower profit if she deviates to any differential price menu (which leads the customers to believe that she is a self-interested provider). Thus, we have shown that neither type of provider will deviate from the equilibrium conditional on the customer's decision based on his belief system. \square

PROOF OF PROPOSITION 4. In the proof of Corollary 2, we computed the market efficiency for the separating equilibrium case (where $\gamma < \gamma^*$) and showed $\varepsilon(\gamma)$ is an increasing function of γ . When $\gamma > \gamma^*$, the market is in the (uniform pricing) pooling equilibrium regime; the welfare loss is given by $W_{\text{pool}} = (1 - \gamma)\beta(W_H - C_H)$ and $\varepsilon(\gamma) = 1 - W_{\text{pool}}/W_{\text{max}}$ also increases in γ . Note that as illustrated in Figure 2, $\varepsilon(\delta^*) = \lim_{\gamma \nearrow \gamma^*} \varepsilon(\gamma)$, where $\delta^* = (W_L - C_L)/(W_H - C_L)$, and the limit is taken from the left. Therefore, clearly, for any $\gamma \in (\gamma^*, \delta^*)$, there exists some $\gamma^c < \gamma^* < \gamma$ such that for any $\gamma' \in (\gamma^c, \gamma^*)$, $\varepsilon(\gamma) < \varepsilon(\gamma')$. \square

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