Research Article

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Addictive Treatment

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Abstract: A treatment prescribed by an incompetent expert can cause long-term damage. However, this damage may not be recognized in the short term. I propose a theoretical model in which an incompetent expert can act dishonestly. Specifically, she can prescribe an improper treatment, which seems to be effective in the short-term but has long-term negative side effects. I show that, surprisingly, the possibility of dishonest behavior may encourage consumers to approach experts and enhance social welfare.

Keywords: addiction; experts; competence

1 Introduction

The medicine received under the control of a doctor should be safe. However, misuse of some medicines, such as pain relievers or antidepressants, can lead to addiction. This risk increases if an incompetent doctor prescribes a drug. If a doctor cannot provide proper treatment to a patient, she can prescribe a drug that provides an illusion of relief, but in the long term, is harmful. However, the long-term negative effect can be recognized only when it is too late to affect a doctor's reputation. For example, if a doctor cannot find a safe drug that relieves pain, she can prescribe an extra dose of some less effective medicine. The increased dose causes pain relief, but may also be addictive.

Another example is an investment in a company, which may use fraudulent systems such as pyramid schemes. These kinds of schemes can be profitable for

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small investors in the short term but destructive in the long term. Similarly, a politician can promote a populist policy, which helps her to be elected but is discovered later as a wrong one.

I suggest the following theoretical model. In a two-period game, a consumer has some problem and decides whether to approach an expert and to pay for her advice. The expert prescribes a treatment to the consumer, and the treatment can be effective or not. The expert can be competent or incompetent. The treatment prescribed by the competent expert is effective with higher probability. Competence is the private information of the expert.

In a benchmark case, the expert does not act strategically, and just prescribes the treatment according to her competence. In this case, if the price of the visit to the expert is low, the consumer approaches her after any outcome of the previous visit. For a high price he does not approach, disregarding previous outcomes. For a medium price he approaches, if and only if the outcome of the previous visit is effective.

Next, consider a case in which the expert can act strategically, namely, cheat and prescribe a treatment that seems effective in the short term but harmful in the long term. The long-term damage is realized after the second period only.

Surprisingly, if the possibility of cheating is present, the consumer approaches the expert even after observing an ineffective outcome for price where he does not approach the benchmark case. The explanation is that since only an incompetent expert cheats in an equilibrium, although cheating looks to be in the short-term similar to the effective outcome, after the ineffective outcome the consumer's belief that the expert is competent increases. However, for sufficiently high prior beliefs that the expert is competent, after the effective outcome, the consumer approaches her. Thus, suspicion of cheating encourages trade. If the long-term negative effect is sufficiently low or if the belief that the expert is competent is high, the expected social welfare is higher due to the possibility of cheating.

This paper belongs to the literature on markets of experts and credence goods (Dulleck and Kerschbamer 2006; Balafoutas and Kerschbamer 2020). Experience good (Nelson 1970) is a good whose quality is realized after its consumption, whereas the quality of credence goods is not realized even after its consumption (Darby and Karni 1973). A standard example of a credence good is a treatment provided by an expert (e.g. doctor or technician) to a consumer with some problem. Typically, treatment solves this problem, but the consumer does not know whether this treatment was required or whether the problem could be solved in a less expensive way. Additionally, if consequences of the treatment are recognized only after a long period of time, such as in my setting, it is considered a credence good. In my paper, the treatment by the competent expert is an experience good, but the treatment by the incompetent and dishonest (cheating) expert is a credence good.

An ineffective outcome of the treatment is realized, but following the effective outcome, the consumer does not know if there are long-term negative side effects. Therefore, my setting does not completely fit either of the two notions above.[1]

In Pesendorfer and Wolinsky (2003), experts differ in their competence level, but a consumer can approach more than one expert to receive a second opinion. Dulleck and Kerschbamer (2009) distinguish between 'experts', who can diagnose consumer problems, and 'discounters', who provide treatment without a diagnosis. The consumer knows the treatment provider's type. In Emons (2001), the service provided by the expert is also unobserved, and the expert can cheat by not supplying it sufficiently. In my paper, only one type of expert can be dishonest. In Bester and Dahm (2018), the expert needs to invest a cost to obtain a precise diagnosis. Moreover, the outcome of the treatment is private information of the consumer, and his or her payment to the expert depends on the outcome.

In my setting, the expert provides proper treatment, which is still ineffective with some probability. This is different from the no-liability assumption (Dulleck and Kerschbamer 2006; Fong et al. 2014), where an expert can commit fraud by intentionally providing an undertreatment.

Another related strand of literature concerns reputation games. To name a few, these games are studied in Fudenberg and Levine (1992); Ely and Välimäki (2003) and Pei (2024). In the latter, as in my model, the memory is constrained. In these studies, one of the players is of the 'good' or 'bad' type and seeks to convince another player that he is of the 'good' type. Unlike in the current work, the correct outcome is observed after each period. In my model, the short-term effective outcome may be illusive.

Addiction is a possible side-effect of the treatment. For a general theoretical model of addiction see Gul and Pesendorfer (2007).

2 Model

The game has two stages. Players are expert (she) and consumer (he). In each stage, the consumer decides whether to approach the expert or not. In the first round, the consumer relies on prior beliefs about the expert, while in the following round, before making the decision, he observes the outcome of the previous round. If he does not approach her, then both players receive zero payoff, and the game stops. If the consumer approaches her, he pays a constant payment p for the visit. This payment p is the expert's payoff for this round. The expert then prescribes a treatment

1 See Gradwohl and Jelnov (2024) for a notion of partial credence good, where both experience and credence goods are special cases.

to the consumer. The treatment prescribed is the same in both rounds. Specifically, if the consumer approaches an expert in the first round and, after observing its outcome, decides to approach her in the second round, he receives the same treatment as in the first round. An explanation is that it is difficult for the expert to admit that the treatment prescribed by her was wrong. It is more convenient for her to claim that the effectiveness of the treatment will be realized in the next period, even if it was not realized in the previous period. Obviously, the expert will prescribe the same treatment if it seems effective.

The expert is *competent* (c) with a common prior π, and *incompetent*, otherwise. She can choose an *honest* strategy (h) or a *dishonest* strategy ($\bar{h}$).

If the expert is competent and acts honestly, then she prescribes a proper treatment, which is effective with probability α, and ineffective otherwise. In the former case, the consumer's utility for this round is $u - p$. If the treatment is ineffective, the consumer's payoff in this round is $-p$.

The incompetent expert cannot prescribe proper treatment. If she is honest, she prescribes some treatment that is effective with probability $\beta < \alpha$, and ineffective otherwise. Outcomes for the effective or ineffective treatment are as in the case of the competent expert.

If the expert is dishonest, she prescribes some treatment that is effective in the short-term but harmful in the long-term. Specifically, at the end of the first round, the consumer observes that the treatment is effective. However, if he approaches the expert in the second round, then damage is realized. The payoff of the consumer in the second round is then $-v - p$, $v > 0$.[2]

Assume that $\pi\alpha u > p$ and $\beta u < p$. Namely, a consumer prefers to approach the expert, given prior belief that she is competent, and if the competent expert is honest. Obviously, he approaches the expert if the belief in her competence is higher than the prior belief. However, the consumer prefers not to approach the expert if he believes that she is incompetent, even if she acts honestly.

The total payoff of the expert is $\sum_{j\in\mathbb{A}} p\delta^j$, where $0 < \delta \leq 1$ is the discount rate, and $\mathbb{A} \subseteq \{1, 2\}$ is a set of all rounds where consumers approach the expert. For the analysis, $\delta = 1$ is assumed without loss of generality.

3 Analysis

Lemma 1. *There is no equilibrium, where the competent expert is dishonest with certainty, and the consumer approaches in the second period.*

2 The consumer is ignorant about the treatment he obtains, but realizes its outcome.

Proof. If the competent expert acts dishonestly, then the consumer derives that in the second period he will obtain either $-v$, or βu. By $\beta u < p$ assumption he does not approach in the second period. □

Consider next an equilibrium where the competent expert acts honestly with certainty.

Assume that the incompetent expert chooses to be honest with probability σ. Recall that the expert prescribes the same treatment in each round, so once she decides to act honestly in the first round, she continues with this action to the second round. If a consumer observes that in round 1 the treatment was effective, he concludes that the expert is competent with probability.

$$P_c^e = \frac{\pi\alpha}{\pi\alpha + (1-\pi)[\sigma\beta + 1 - \sigma]}. \tag{1}$$

Then in period 2, the consumer prefers to approach the expert if

$$-p + P_c^e \alpha u + \left(1 - P_c^e\right)[\sigma\beta u - (1-\sigma)v] > 0.$$

After observing effective treatment in the first round, the consumer approaches the expert if

$$\frac{\pi\alpha^2 u + (1-\pi)[\sigma\beta + 1 - \sigma][\sigma\beta u - v(1-\sigma)]}{\pi\alpha + (1-\pi)[\sigma\beta + 1 - \sigma]} > p. \tag{2}$$

After observing that the treatment in the first round was ineffective, the consumer believes that the expert is competent with probability

$$P_c^{\bar{e}} = \frac{\pi(1-\alpha)}{\pi(1-\alpha) + (1-\pi)\sigma(1-\beta)}.$$

In equilibrium, after observing ineffective treatment in the first round, the consumer approaches the expert if

$$\frac{\pi(1-\alpha)\alpha u + (1-\pi)\sigma(1-\beta)\beta u}{\pi(1-\alpha) + (1-\pi)\sigma(1-\beta)} > p. \tag{3}$$

Note that after ineffective treatment the consumer knows with certainty that dishonest behavior was not chosen.

As a benchmark, suppose that dishonest behavior is not possible ($\sigma = 1$). Then the left hand side of (2) is higher than the left hand side of (3). Therefore:

1. If $p < u\frac{\pi\alpha(1-\alpha)+(1-\pi)(1-\beta)\beta}{\pi(1-\alpha)+(1-\pi)(1-\beta)}$ (or, equivalently, $\frac{(1-\beta)(p-\beta u)}{(1-\beta)(p-\beta u)+(1-\alpha)(\alpha u-p)} < \pi$), then the consumer approaches the expert after any outcome.
2. If $u\frac{\pi\alpha(1-\alpha)+(1-\pi)(1-\beta)\beta}{\pi(1-\alpha)+(1-\pi)(1-\beta)} < p < u\frac{\pi\alpha^2+(1-\pi)\beta^2}{\pi\alpha+(1-\pi)\beta}$ (equivalently, $\frac{\beta(p-\beta u)}{\beta(p-\beta u)+\alpha(\alpha u-p)} < \pi < \frac{(1-\beta)(p-\beta u)}{(1-\beta)(p-\beta u)+(1-\alpha)(\alpha u-p)}$), then the consumer approaches the expert after the effective outcome and does not approach after the ineffective one.
3. If $u\frac{\pi\alpha^2+(1-\pi)\beta^2}{\pi\alpha+(1-\pi)\beta} < p$ (or $\pi < \frac{\beta(p-\beta u)}{\beta(p-\beta u)+\alpha(\alpha u-p)}$), then the consumer does not approach the expert after any outcome.

Returning to the general case analysis. Let $\bar{\sigma}$ be such that for $\sigma = \bar{\sigma}$ the left hand side of (3) equals the left hand side of (2). Assume $p \neq \frac{\pi(1-\alpha)\alpha u+(1-\pi)\bar{\sigma}(1-\beta)\beta u}{\pi(1-\alpha)+(1-\pi)\bar{\sigma}(1-\beta)}$. Thus, there is no equilibrium where the consumer is indifferent between approaching or not approaching after both effective and ineffective outcomes.

Proposition 1. *Let* $p \neq \frac{\pi(1-\alpha)\alpha u+(1-\pi)\bar{\sigma}(1-\beta)\beta u}{\pi(1-\alpha)+(1-\pi)\bar{\sigma}(1-\beta)}$

1. Let $\pi > \frac{(1-\beta)(p-\beta u)}{(1-\beta)(p-\beta u)+(1-\alpha)(\alpha u-p)}$. Then there is an equilibrium where the competent expert always acts honestly and the incompetent expert always acts honestly ($\sigma = 1$). In this equilibrium, the consumer approaches the expert after any outcome. The area where this equilibrium exists increases in β.
2. Let $\pi > \frac{v+p}{v+p+\alpha(\alpha u-p)}$. Then there is an equilibrium where the competent expert always acts honestly and the incompetent expert always acts dishonestly ($\sigma = 0$). In this equilibrium, the consumer approaches the expert after any outcome. The area where this equilibrium exists decreases in v.

Proof. First, observe that in equilibrium, it cannot be the case that the consumer approaches the expert only if he observes effective treatment. In contrast, suppose that this is the consumer's strategy. Therefore, (2) holds, but (3) does not. The incompetent expert, who wishes to encourage her to approach, then acts dishonestly with certainty (recall that after the dishonest strategy, the treatment is always observed as effective); namely, $\sigma = 0$. However, the left-hand side of (3) is higher than one of the (2), contradictions to (2) hold, and (3) does not. Similarly, there is no equilibrium where the consumer approaches the expert only if he observes ineffective treatment.

Consider the equilibrium where $\sigma = 1$. By direct substitution, the left-hand side of (3) is lower than the left-hand side of (2). Namely, the consumer approaches after any outcome if (3) holds. This is equivalent to.

$$\pi > \frac{(1-\beta)(p-\beta u)}{(1-\beta)(p-\beta u)+(1-\alpha)(\alpha u-p)}. \tag{4}$$

The right-hand side of (4) decreases in β. Therefore, the area where this inequality holds increases.

Consider the equilibrium where $\sigma = 0$. Then, by (3) and by $\alpha u > p$, the consumer approaches the expert following an ineffective outcome. Indeed, after the ineffective outcome, he knows with certainty that the expert is competent, since the incompetent expert is always dishonest in this equilibrium, and the dishonest treatment is always effective in the short run. In this type of equilibrium, after effective treatment, the consumer approaches (recall, there is no equilibrium where the consumer approaches after the ineffective outcome only). By (2), he also approaches after the effective outcome if.

$$\frac{\pi\alpha^2 u - (1-\pi)v}{\pi\alpha + 1 - \pi} > p,$$

or, by rearranging the terms,

$$\pi > \frac{v+p}{v+p+\alpha(\alpha u - p)}. \tag{5}$$

By $\alpha u > p, 0 < \frac{v+p}{v+p+\alpha(\alpha u-p)} < 1$. The right hand side of (5) increases in v; therefore, the area where this inequality holds decreases.

In both cases the competent expert has no incentive to deviate and to act dishonestly. □

If π is high, there is an equilibrium where incompetent experts act dishonestly. This happens because, for high π values, the consumer trusts the expert and maintains trust even if one believes that the incompetent expert acts dishonestly (for high π values, the probability of the expert being incompetent is low, so ex ante dishonest behavior is rare). However, for high π, there is also an equilibrium where the expert is always honest. If the consumer trusts an expert and approaches her in any case, there is no incentive for the expert to act dishonestly. In the case of high π there are multiple equilibria, since both equilibria specified in the proposition 1 exist. Since the condition in the part 2 of the proposition depends on v, while the condition in the first part does not depend on it, it is impossible to conclude generally which condition is more restrictive.

Note that $\alpha u > \max[\frac{\pi\alpha^2 u+(1-\pi)[\sigma\beta+1-\sigma][\sigma\beta u-v(1-\sigma)]}{\pi\alpha+(1-\pi)[\sigma\beta+1-\sigma]}, \frac{\pi(1-\alpha)\alpha u+(1-\pi)\sigma(1-\beta)\beta u}{\pi(1-\alpha)+(1-\pi)\sigma(1-\beta)}]$. Therefore, there are p's that satisfy $\alpha u > p$, which violates both (2) and (3). For such a p there is equilibrium where the consumer approaches the expert after any outcome of the first round.

However, the possibility of dishonest behavior may encourage trade, as claims corollary 1.

Corollary 1. *There are parameters of the model, for which there exists an equilibrium, where the consumer approaches the expert after any outcome, and the incompetent expert acts dishonestly. However, for the same parameters in the benchmark case, the consumer approaches the expert only after the effective outcome.*

Proof. Part 2 of the proposition 1 holds when $\frac{\pi\alpha^2 u-(1-\pi)v}{\pi\alpha+1-\pi} > p$. For high values of α and low values of β and v, $u\frac{\pi\alpha(1-\alpha)+(1-\pi)(1-\beta)\beta}{\pi(1-\alpha)+(1-\pi)(1-\beta)} < \frac{\pi\alpha^2 u-(1-\pi)v}{\pi\alpha+1-\pi}$ (recall that $p < u\frac{\pi\alpha(1-\alpha)+(1-\pi)(1-\beta)\beta}{\pi(1-\alpha)+(1-\pi)(1-\beta)}$ is the condition to approach after the ineffective outcome in the benchmark case). For instance, this holds for $\pi = 0.4$, $\alpha = 0.9$, $\beta = 0.15$, $u = 3.5$ and $v = 0.7$. Therefore, there is p, $u\frac{\pi\alpha(1-\alpha)+(1-\pi)(1-\beta)\beta}{\pi(1-\alpha)+(1-\pi)(1-\beta)} < p < \frac{\pi\alpha^2 u-(1-\pi)v}{\pi\alpha+1-\pi}$, such that in the benchmark case the consumer approaches the expert after the effective outcome only, but approaches after any outcome if dishonest behavior takes place. □

Thus, surprisingly, dishonest behavior may encourage the approach of an expert. This happens because if the incompetent expert is dishonest, the ineffective outcome reveals that she is competent, which convinces him to approach her.

In equilibrium 2 of the benchmark case, after an ineffective outcome, no consumer approaches the expert in the second period. Thus, in the equilibrium of part 2 of the proposition 1, where consumers approach in both periods after any outcome, the total expected utility of both players (*social welfare*) may be higher than that in the benchmark case. Proposition 2 shows provides conditions when this is the case. This happens if the side effect v is low, or, alternatively, if the expert is competent with high probability. For simplicity, assume that $\delta = 1$. Note that since p just switches hands, the social welfare in each period is u, 0 or $-v$, according to the outcome and the expert's action.

Proposition 2. *Let $\delta = 1$. The expected social welfare in equilibrium 2 of the benchmark case is lower than that in the equilibrium of part 2 of the proposition 1, if $(\beta + \beta^2)u - u + v < 0$ or if $(\beta + \beta^2)u - u + v > 0$ and $\frac{(\beta+\beta^2)u-u+v}{(\beta+\beta^2)u-u+v+\alpha(1-\alpha)u} < \pi$.*

Proof. In equilibrium 2 of the benchmark case, the expected social welfare is.

$$\pi(\alpha + \alpha^2)u + (1 - \pi)(\beta + \beta^2)u. \tag{6}$$

In equilibrium of part 2 of the proposition 1, the expected social welfare is

$$2\pi\alpha u + (1 - \pi)(u - v). \tag{7}$$

If $(\beta + \beta^2)u - u + v < 0$, then (6) is lower than (7) for any $0 \leq \pi \leq 1$. Otherwise, (6) is lower than (7) for $\frac{(\beta+\beta^2)u-u+v}{(\beta+\beta^2)u-u+v+\alpha(1-\alpha)u} < \pi$. □

For example, for $\beta = 0.15$, $u = 3.5$ and $v = 0.7$, the conditions of both corollary 1 and proposition 2 hold.

4 Discussion

In this model, the game is played for only two periods. If longer timing is assumed, a consumer observes that a competent expert produces an effective outcome with a frequency that approximates α. The incompetent expert then has to mimic this behavior by acting dishonestly in some rounds. Then, social welfare in each period is lower than that in the two-period game equilibrium, where the expert acts honestly only, but higher than that in the equilibrium, where she always cheats.

The assumption that the price paid to the expert is exogenous can be relaxed. However, if treating a consumer is costly for the expert (and not costless, as in the current model), she will not accept a payment less than this cost. The analysis and insights are then similar to those above, with replacement of p by the cost.

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