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Credence Goods Markets with Fair and Opportunistic Experts

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Abstract

We analyze a credence goods market adapted to a health care market with regulated prices, where physicians are heterogeneous regarding their fairness concerns. The *opportunistic physicians* only consider monetary incentives while the *fair physicians*, in addition to a monetary payoff, gain an non-monetary utility from being honest towards patients. We investigate how this heterogeneity affects the physicians' equilibrium level of overcharging and the patients' search for second opinions (which determines overall welfare). The impact of the heterogeneity on the fraud level is ambiguous and depends on several factors such as the size of the fairness utility, the share of fair physicians, the search level and the initial fraud level. Introducing heterogeneity does not affect the fraud or the search level when the share of fair physicians is small. However, when social welfare is not at its maximum, social welfare always increases if we introduce a sufficiently large share of fair physicians.

JEL classification: D82; I11; L15.

Keywords: credence goods; heterogeneous experts; fairness; overcharging

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1 Introduction

In a credence goods market, information asymmetries between customers and experts may lead to incentives for experts to sell the wrong quality or charge an inappropriate price (Darby and Karni, 1973), since a customer can neither ex-ante nor ex-post estimate which quality of a traded good he needs (Emons, 1997). Furthermore, the possibility of being defrauded may make the customer mistrust an expert and search for additional opinions (Pitchik and Schotter, 1987). Health care markets are considered prime examples of credence goods markets. They are characterized by the information advantage of physicians over their patients who do not have the physicians' medical knowledge (Mimra et al., 2016). We consider a credence goods market that is adapted to a health care set-up, where physicians are the experts and patients are the customers. Treatment prices are assumed to be exogenously given just like many prices in health care markets, for instance in Germany (Sülzle and Wambach, 2005). In our theoretical framework, we analyze the physicians' incentives to defraud and the patients' incentives to search.

Dulleck et al. (2011) experimentally analyze the fraudulent behavior of experts for credence goods. Their findings indicate that some experts care only about their monetary incentives, whereas others consider their own payoff but also their customers' payoffs in their decisions. In their experiment, some experts were always honest even when the fraud incentives were high. That is, there may be heterogeneity among credence goods experts regarding fairness concerns towards customers and these concerns may be of different extent. Regarding a health care market, physicians may have a tendency to care not only about monetary incentives but also about their patients' well-being. This can be reasoned with norms like the Oath of Hippocrates (Kesternich et al., 2015) as well as the Charter on Medical Professionalism developed and published in 2002 by the ABIM Foundation, ACP-ASIM Foundation, and the European Federation of Internal Medicine (Project of the ABIM Foundation and ACP-ASIM Foundation and European Federation of Internal Medicine, 2002) and since then endorsed by more than 100 professional associations worldwide (Iezzoni et al., 2012). Principles of this charter state that physicians should not exploit their patients for financial gain and that physicians should always be honest to their patients (Project of the ABIM Foundation and ACP-ASIM Foundation and European Federation of Internal Medicine, 2002).

Building upon Wolinsky (1993) and Sülzle and Wambach (2005), we consider a model, where we suppose the physicians to be heterogeneous in their interest in treating patients fairly. More precisely, we assume there are two types of physicians, a fair type and an opportunistic type. Fair physicians care about money and being honest so that they receive a non-monetary utility (called fairness utility) when they treat patients honestly. This fairness utility can also be regarded as a good conscience for acting appropriately. Opportunistic physicians only consider the monetary payoff when trading off cheating against being honest. Furthermore, we analyze different sizes of the fairness utility, leading to cases in which a fair physician may not cheat at all or in which the monetary payoff must be particularly large to make a fair physician cheat. The goal of our research study is to investigate *how the physicians' heterogeneity with respect to fairness concerns affects the physicians' fraud level* and *how the heterogeneity influences the patients' search for second opinions and thus social welfare.*

There exist several papers in the credence goods literature that analyze the experts' fraud incentives and the customers' search for second opinions. In his seminal work, Wolinsky (1993) finds that in a market with endogenous prices there is no fraud when the customers' search costs are sufficiently low. By contrast, if the prices are exogeneously given then there is no market equilibrium without fraud. Sülzle and Wambach (2005) investigate a credence goods market where prices are exogenous and patients are co-insured. They highlight that an increase in the co-insurance rate has ambiguous effects on equilibrium fraud and welfare. In a field experiment, investigating the fraud incentives for taxi drivers, Balafoutas et al. (2013) observe that local passengers get taken on significantly shorter routes than passengers with no knowledge about the area. Dulleck and Kerschbamer (2006) show that in a credence goods market with endogenous prices fraudulent behavior by experts might be prevented by the market mechanism. This is the case when certain conditions such as large economies of scope between diagnosis and treatment are fulfilled.

Marty (1999) investigates a credence goods market with fixed prices and two types of experts. The opportunistic type is a pure (monetary) profit-maximizer and might reject customers while the second type is always honest to all customers. Marty illustrates that an opportunistic expert could be prevented from defrauding as a consequence of the customers' rejection strategy and the honest treatments of the other types of experts. In our model, physicians with a fairness utility are not always honest. Furthermore, in our framework a physician does not know whether a patient already visited another expert, whereas in Marty's model the experts can observe whether it is a customer's first or second visit. Sülzle and Wambach (2005) also discuss situations where a fraction of experts is always honest. Our focus, however, lies on the settings where also the fair physicians might have incentives to defraud. This relates our article to Liu (2011), who studies a credence goods market with selfish experts, who are pure (monetary) profit-maximizers, and conscientious experts, who receive an additional utility from fixing a customer's problem. Liu observes that the selfish experts might in fact have stronger fraud incentives when there is a conscientious expert in the market. One major contrast to our paper is that Liu models a credence goods market where prices are set by the experts, whereas we assume treatment prices to be regulated.

Our main results can be summarized as follows. When the fraud level and social welfare are already maximized (i.e. the patients' search rate is minimized) in the homogeneous benchmark case with only opportunistic physicians, then there are only changes in the fraud level and search rate when we introduce a large fairness utility for a share of physicians. Additionally, even when social welfare and fraud are not maximized, we observe no impact on the fraud or the search level when implementing only a small share of fair physicians, who have lower fraud incentives than the opportunistic physicians. Furthermore, given welfare and fraud are not at their maximum in the benchmark case, then the search rate is lowered with certainty if we introduce a sufficiently large share of fair physicians. This share can be medium or large depending on the initial equilibrium of the benchmark case. The impact of heterogeneity on the equilibrium fraud level is ambiguous. Different factors such as the share of fair physicians, the size of the fairness utility, the search rate and the initial fraud level rate can have a pivotal influence on the fraud level. When we incorporate a large share of fair physicians with a large fairness utility, the equilibrium with maximal welfare but also maximal fraud becomes the unique equilibrium. In addition, we compare our main framework with a setting, where the fairness utility is modeled as a bad conscience instead of a good conscience. We find that the fair physicians have higher fraud incentives with a bad conscience than with a good conscience.

The rest of the paper is organized as follows. Section 2 introduces the model. In Section 3 we analyze the patients' and physicians' optimization problems and examine the equilibria. Section 4 discusses an alternative framework where a fair physician receives a bad conscience when being dishonest. Section 5 concludes.

2 The Model

There is a continuum of patients in the market.[1] Each patient is aware of being ill but does not know how serious his illness is. He either suffers from a major problem M with probability $\phi \in [0,1]$ or from a small problem S with probability $1-\phi$. Each patient consults at least one physician for having his problem diagnosed and bears search and waiting costs $k > 0$ per visit. Receiving a successful treatment generates the benefit $V > 0$ for a patient.

There is a large but limited number N of physicians in the market. We consider two types of physicians, a fair type F and an opportunistic type O, that differ in their interest in treating fairly. The share of opportunistic physicians in the market is given by $\delta \in (0,1)$ and the share of fair physicians consequently by $1-\delta$. Each physician i, where $i \in \{F,O\}$, diagnoses each visiting patient at no cost and recognizes a patient's problem with certainty. A visiting patient receives a treatment recommendation from the physician and decides whether he wants to accept the recommendation or reject it. If he accepts the treatment, he has to pay for the accepted treatment and receives the correct treatment in any case. However, the patient cannot verify which type of treatment he ultimately receives, due to his lack of medical knowledge. This setting gives a physician the possibility to overcharge her S-patients by recommending them a major treatment. When a patient with a small problem accepts the major treatment, he pays for it while receiving a small treatment. As the patients always receive the appropriate treatment, there is no under- or overtreatment.[2] A fair physician gains a non-monetary utility $\alpha_F > 0$,

[1] We refer to a patient as 'he' and to a physician as 'she'.

[2] Overtreatment is not considered due to a lack of financial incentives for a physician in our model. Undertreatment is ruled out since we consider a physician to be liable for risking her patient's health. Thus, M-patients

which we denote a fairness utility, from treating a patient with a small problem honestly. An opportunistic physician O only cares about monetary incentives and therefore receives no non-monetary utility, i.e. $\alpha_O = 0$, when diagnosing an S-patient honestly. Finally, a a physician i gives an S-patient a recommendation for an M-treatment with probability $x_i \in [0,1]$ and a recommendation for an S-treatment with probability $1-x_i$.

The patients know that they might be overcharged. Thus, they might reject a treatment recommendation. The patients are also aware that only overcharging is an option. Therefore, they accept a recommendation for a minor treatment with certainty but may reject an M-treatment. In our set-up, a patient can only decline an M-treatment recommendation on his first visit. On a second visit, a patient accepts any diagnosis.[3] On a first visit, a patient accepts an M-treatment with probability $y \in [0,1]$ and rejects it with probability $1-y$. Note that a physician cannot observe whether it is a patient's first or second visit and that the physicians' heterogeneity is not common knowledge among patients, but among physicians.

Treating a patient is costly for a physician. Treating a patient with a small problem induces a cost of $c_S > 0$ and treating a patient with a major problem a cost of $c_M > c_S > 0$. A patient has to pay a price for each treatment and we consider the treatment prices to be exogenously given. The price for a major treatment is $p_M = c_M$ and the price for a small treatment is $p_S = c_S + e$, where $e > 0$ is a physician's monetary mark-up for treating a patient with a small problem honestly. We presume $p_M > p_S$. Finally, the patient's utility is given by $U = V - p_j - nk$, where $j \in \{S, M\}$ and $n \in \{1,2\}$ is the number of physicians he visits. We suppose the benefit V to be sufficiently large, i.e. $V > p_j + nk$, such that it is always beneficial for a patient to have his problem treated. In addition, we assume the search and waiting costs k to be sufficiently small, i.e. $k < p_M - p_S$, such that receiving a second opinion might be beneficial for a patient.

The payoff π_i a physician makes per patient is the (absolute) difference between the agreed treatment price and the actual treatment costs. A physician only can only earn a positive payoff when a patient accepts a diagnosis. Upon rejection, a physician simply earns a zero payoff. The *honest payoff* for treating an S-patient honestly is given by $p_S - c_S + \alpha_i = e + \alpha_i$. The *fraud payoff* for defrauding a patient with small problem is given by $p_M - c_S$. The fraud payoff is greater than the monetary mark-up/the opportunistic type's payoff for being honest, e, by our assumption $p_M > p_S = c_S + e$. The payoff for treating an M-patient is simply $p_M - c_M = 0$.

In the following, we solve the patients' and the physicians' optimization problems in order to to derive the equilibria of the model. We focus on symmetric Nash equilibria, where all players of the same type play the same strategy strategy. That is, all patients play the same acceptance strategy y and all physicians of the same type choose the same recommendation policy x_i.

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are always treated correctly.

[3] This assumption is in line with for example Wolinsky (1993, 1995); Sülzle and Wambach (2005).

3 Analysis

3.1 Patient Decision

A patient maximizes his expected utility by minimizing his expected treatment costs.[4] A patient minimizes his expected treatment costs by choosing the optimal acceptance strategy y. Assume that all physicians in the market overcharge patients with small problems with probability $X = \delta X_O + (1-\delta)X_F$, where X_F is the fair physicians' average level of fraud and X_O is the opportunistic physicians' level of fraud. The patients' optimal strategy is not influenced by the physicians' heterogeneity as the patients can neither observe the physicians characteristics nor are aware of the heterogeneity. Therefore, the patients' symmetric best response is described by

Lemma 1. *For a given $X \in [0,1]$, the patients' symmetric best response correspondence is given as*

$$y^*(X) \in \begin{cases} \{0\} & \text{if } X \in (X_1, X_2), \\ \{1\} & \text{if } X \in [0, X_1) \cup (X_2, 1], \\ [0,1] & \text{if } X \in \{X_1, X_2\}, \end{cases}$$

where

$$X_{1,2} = \frac{1}{2}\left(1 - \frac{k}{p_M - p_s}\right) \pm \sqrt{\frac{1}{4}\left(1 - \frac{k}{p_M - p_S}\right)^2 - \frac{\phi}{1-\phi}\frac{k}{p_M - p_S}}. \tag{1}$$

Proof. See Lemma 1 in Sülzle and Wambach (2005) and the proof therein. □

According to Lemma 1, patients always accept a major treatment recommendation on their first visit when the level of fraud in the market is relatively low or relatively high. In the former case, the first physician is already honest with a high probability and in the latter case, the first and the second physician are likely to cheat. Patients search for a second opinion only when the fraud level is medium, i.e. $X \in (X_1, X_2)$. In that case, the first diagnosis may be fraudulent and the second diagnosis may be honest.

3.2 Physician Choice

In the following, we analyze the physicians' optimal defrauding behavior for both, the fair and the opportunistic type of physicians. First we develop a physician's individual best response and then distinguish between the symmetric best responses of both types of physicians.[5] We

[4]We do not assume the patients to be insured. However, imposing a co-insurance rate like in Sülzle and Wambach (2005) would not affect our results qualitatively.

[5]We illustrate the physicians' best response correspondence according to Sülzle and Wambach (2005).

assume $e < \frac{p_M - c_S}{2-y}$ in our framework. This is because we concentrate on the impact of the heterogeneity on equilibrium outcomes and analyze all situations with fraud.[6]

An individual physician of type i maximizes her expected payoff when facing a patient with a small problem by choosing the optimal recommendation policy x_i. Assume that all patients accept a major treatment on their first visit with probability y and that all other physicians defraud S-patients with probability X. Then, a physician aims to maximize the following payoff:

$$\pi_i = (1-x_i)(e+\alpha_i) + x_i \frac{y+X(1-y)}{1+X(1-y)}(p_M - c_S). \tag{2}$$

When a physician faces a patient with a small problem, she receives the payoff $e+\alpha_i$ with certainty if she diagnoses honestly. The physician is honest with probability $1-x_i$ but she is dishonest with probability x_i. When she diagnoses dishonestly, she gains the fraud payoff $p_M - c_S$ with probability $\frac{y+X(1-y)}{1+X(1-y)}$. This probability takes into account that a share $\frac{1}{1+X(1-y)}$ of S-patients is on its first visit and accepts a fraudulent diagnosis with probability y. Additionally, it considers that a share $\frac{X(1-y)}{1+X(1-y)}$ of S-patients is already on its second visit and accepts any treatment.

By Equation 2, a physician of type i recommends a major treatment to an S-patient with probability $1(0)$ if and only if the certain honest payoff is smaller than the expected fraud payoff. That is, when

$$e+\alpha_i < (>) \frac{y+X(1-y)}{1+X(1-y)}(p_M - c_S). \tag{3}$$

When the honest payoff equals the expected fraud payoff, a physician is simply indifferent between cheating and being honest. Lemma 2 summarizes our findings.

Lemma 2. *Let (X,y) be given. Then, a physician's individual best response reads*

$$x_i(X,y) \in \begin{cases} \{0\} & \text{if } e > \frac{y+X(1-y)}{1+X(1-y)}(p_M - c_S) - \alpha_i, \\ [0,1] & \text{if } e = \frac{y+X(1-y)}{1+X(1-y)}(p_M - c_S) - \alpha_i, \\ \{1\} & \text{if } e < \frac{y+X(1-y)}{1+X(1-y)}(p_M - c_S) - \alpha_i. \end{cases} \tag{4}$$

According to Lemma 2, the following holds because of $\alpha_F > \alpha_O$. First, when the fair physicians cheat or are indifferent, the opportunistic physicians defraud with certainty. Second, when the opportunistic physicians are honest or indifferent, the fair physicians are always honest. Finally, the fair physicians have lower fraud incentives than the opportunistic physicians. The fair physicians cheat only when the monetary mark-up of being honest, e, is smaller than $\frac{y+X(1-y)}{1+X(1-y)}(p_M - c_S) - \alpha_F$, while the opportunistic physicians might cheat for $e > \frac{y+X(1-y)}{1+X(1-y)}(p_M - c_S) - \alpha_F$.

[6]See Appendix A.1 for further explanation.

It must hold for a physicians' symmetric best response that an individual physician's defrauding strategy of one type i, x_i, corresponds to the other physicians' defrauding behavior of the same type, X_i. In what follows, we first derive the opportunistic physicians' symmetric best response and then the fair physicians' symmetric best response.

3.2.1 Opportunistic Physicians

Lemma 3 describes the opportunistic physicians' symmetric best response for a given X_F and y. The lemma illustrates how the best response depends on the share of opportunistic physicians in the market, δ.

Lemma 3. *Given a* large share *of opportunistic physicians, i.e.* $\delta > \frac{e-y(p_M-c_S)}{(1-y)(p_M-c_S-e)}$, *the opportunistic physicians' symmetric best response correspondence is given by*

$$X_O^*(X_F,y) \in \begin{cases} \left\{0, \frac{e-y(p_M-c_S)}{\delta(1-y)(p_M-c_S-e)}, 1\right\} & \text{if } X_F \in \{0\} \text{ and } y \in \left[0, \frac{e}{p_M-c_S}\right], \\ \{1\} & \text{else.} \end{cases}$$

Given a small *or* medium share*, i.e.* $\frac{e-y_2(p_M-c_S)}{(1-y_2)(p_M-c_S-e)} \leq \delta \leq \frac{e-y_1(p_M-c_S)}{(1-y_1)(p_M-c_S-e)}$, *the opportunistic physicians' symmetric best response correspondence is given by*

$$X_O^*(X_F,y) \in \begin{cases} \{0\} & \text{if } X_F \in \{0\} \text{ and } y \in \left[0, \frac{e-\delta(p_M-c_S-e)}{p_M-c_S-\delta(p_M-c_S-e)}\right], \\ \left\{0, \frac{e-y(p_M-c_S)}{\delta(1-y)(p_M-c_S-e)}, 1\right\} & \text{if } X_F \in \{0\} \text{ and } y \in \left[\frac{e-\delta(p_M-c_S-e)}{p_M-c_S-\delta(p_M-c_S-e)}, \frac{e}{p_M-c_S}\right], \\ \{1\} & \text{else,} \end{cases}$$

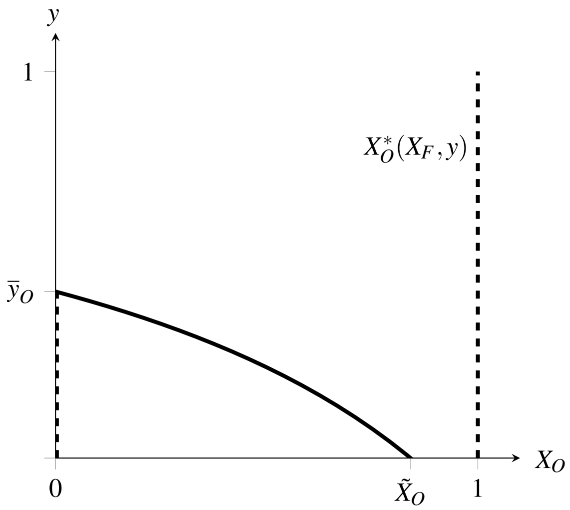
where $y_1 := y \in \left(0, \frac{e-\delta(p_M-c_S-e)}{p_M-c_S-\delta(p_M-c_S-e)}\right]$ *and* $y_2 := y \in \left[\frac{e-\delta(p_M-c_S-e)}{p_M-c_S-\delta(p_M-c_S-e)}, 1\right)$.

Proof. See Appendix A.1. □

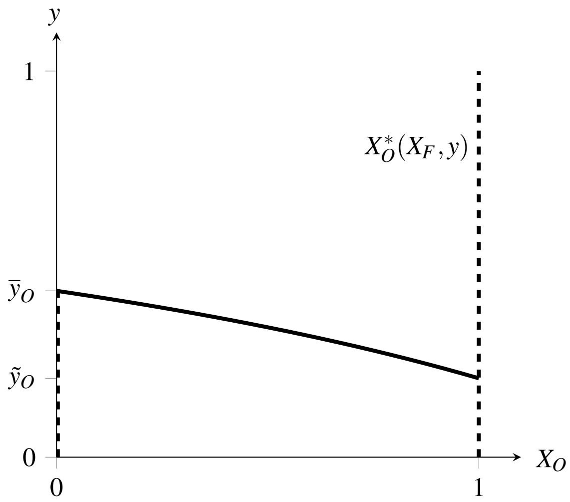
First of all, notice that the term $\frac{e-y(p_M-c_S)}{(1-y)(p_M-c_S-e)}$ becomes negative for $y > \frac{e}{p_M-c_S}$, but that $\delta > 0$. Therefore, the two cases of δ that are described in Lemma 3 are all possible cases in our framework. We now turn to the intuition for the lemma. As stated above, when the fair physicians cheat or randomize between cheating and treating honestly, it is always optimal for an opportunistic physician to defraud patients with small problems. In addition, when the patients' acceptance rate regarding an M-treatment on the first visit, y, is larger than $\frac{e}{p_M-c_S} =: \bar{y}_O$, then there is good chance for an opportunistic physician to successfully defraud a patient with a small problem. Thus, an opportunistic physician prefers to defraud for $y \geq \bar{y}_O$.

In what follows, we provide intuitions for the cases of Lemma 3, in which all fair physicians treat honestly (i.e. $X_F = 0$, see Figure 1) and where we have a patients' acceptance rate (at least) below $\bar{y}_O$. Assume first that there is a large share of opportunistic physicians (Figure 1a). In this situation, an individual opportunistic physician's best strategy depends on the other opportunistic physicians' defrauding behavior. Suppose that all other physicians are honest. Then, all patients with a small problem are on their first visit and would reject a fraudulent diagnosis with a high probability, due to the low y. Therefore, being honest is more profitable than cheating for an opportunistic physician. However, when all other opportunistic physicians defraud, there are many patients with small problems on their second visit. On a second visit, a patient accepts any treatment recommendation. As a consequence, it is an individual opportunistic physician's best response to cheat in that case. It is also possible that an opportunistic physician randomizes in this setting given all other opportunistic physicians randomize as well (this indifference area is depicted by the black bold solid line in Figure 1a).

Now consider a small or medium share of opportunistic physicians (Figure 1b). In this setting, cheating is an option only at a somewhat higher acceptance rate, i.e. $y \in [\tilde{y}_O, \bar{y}_O]$, where $\tilde{y}_O := \frac{e-\delta(p_M-c_S-e)}{p_M-c_S-\delta(p_M-c_S-e)}$. This is because there are many honest fair physicians in the market and thus many patients with small problems on their first visit. Consequently, at a very low acceptance rate, i.e. $y \leq \tilde{y}_O$, treating honestly is always more beneficial than cheating for an opportunistic physician. Now imagine that $y \in [\tilde{y}_O, \bar{y}_O]$. Analogously to the case with a large share of opportunistic physicians, it is an individual opportunistic physician's best strategy to cheat (treat honestly) when all other opportunistic physicians cheat (treat honestly) for the same reasons as above. Again there is a region where the opportunistic physicians are indifferent between defrauding and being honest (depicted by the black bold solid line in Figure 1b).



(a) Large δ



(b) Small or medium δ

Figure 1: Opportunistic physicians' symmetric best response correspondence given $X_F = 0$ and different δ. Note that $\tilde{X}_O := \frac{e}{\delta(p_M-c_S-e)}$.

3.2.2 Fair Physicians

Lemma 4 characterizes how the fair physicians' symmetric best response for a given X_O and y depends on the fairness utility, α_F, and on the share of opportunistic physicians, δ.

Lemma 4. *Given a* small fairness utility, *i.e.* $\alpha_F < \frac{p_M - c_S}{2-y} - e$, *and* $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, *the fair physicians' symmetric best response correspondence is given by*

$$X_F^*(X_O, y) \in \begin{cases} \{0\} & \text{if } X_O \in \{0\} \text{ or } X_O \in (0,1), \\ \{1\} & \text{else.} \end{cases}$$

Given a small fairness utility α *and* $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, *the fair physicians' symmetric best response correspondence is given by*

$$X_F^*(X_O, y) \in \begin{cases} \{0\} & \text{if } X_O \in \{0\} \text{ or } X_O \in (0,1), \\ \left\{0, \frac{e+\alpha_F - y(p_M - c_S)}{(1-\delta)(1-y)(p_M - c_S - e - \alpha_F)} - \frac{\delta}{1-\delta}, 1\right\} & \text{if } X_O \in \{1\} \text{ and } y \in \left[0, \frac{e+\alpha_F - \delta(p_M - c_S - e - \alpha_F)}{p_M - c_S - \delta(p_M - c_S - e - \alpha_F)}\right], \\ \{1\} & \text{else.} \end{cases}$$

Given a medium fairness utility, *i.e.* $p_M - c_S - e > \alpha_F > \frac{p_M - c_S}{2-y} - e$, *the fair physicians' symmetric best response correspondence is given by*

$$X_F^*(X_O, y) \in \begin{cases} \{1\} & \text{if } X_O \in \{1\} \text{ and } y \in \left[\frac{e+\alpha_F - \delta(p_M - c_S - e - \alpha_F)}{p_M - c_S - \delta(p_M - c_S - e - \alpha_F)}, 1\right], \\ \{0\} & \text{else.} \end{cases}$$

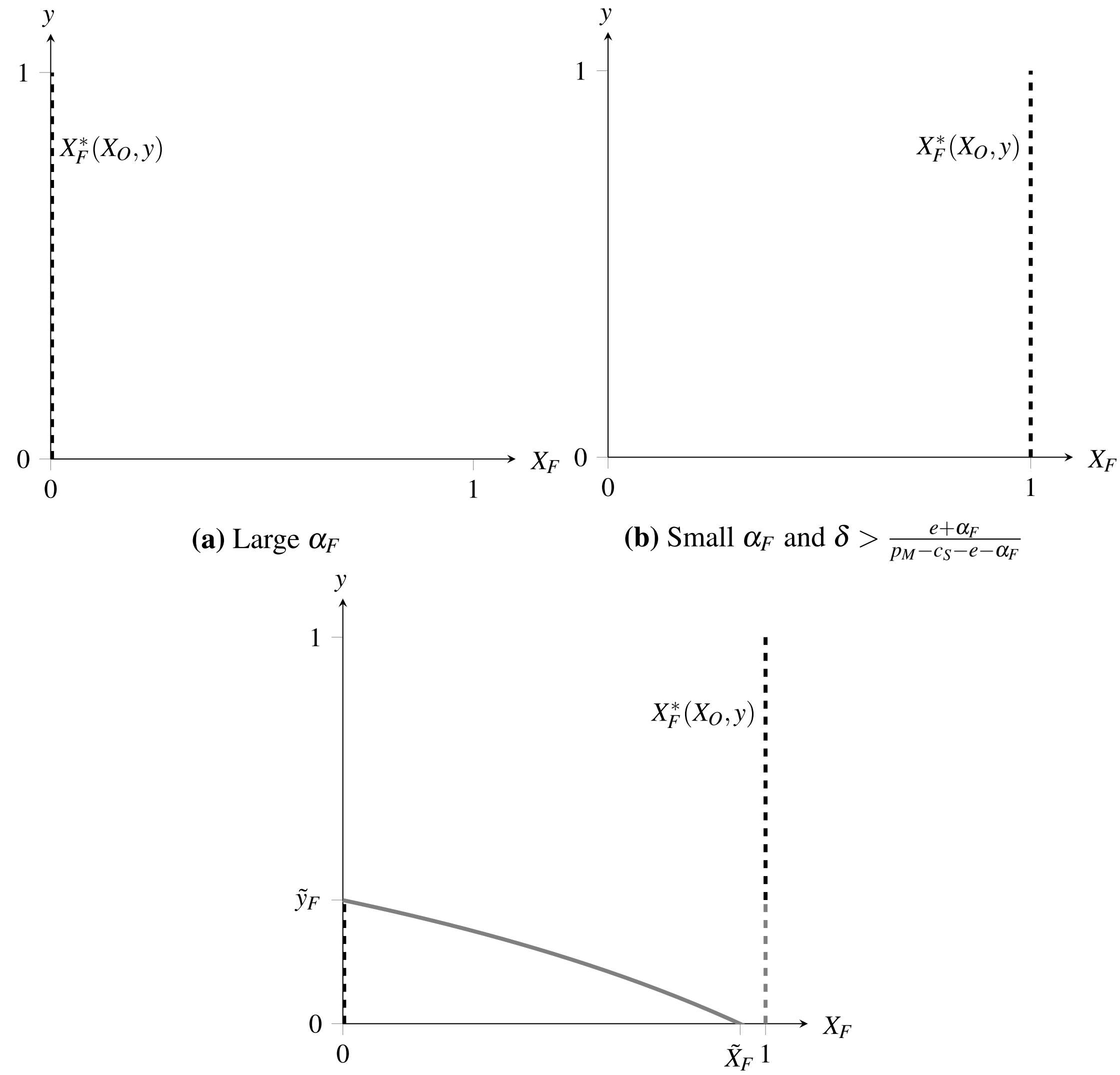
Given a large fairness utility, *i.e.* $\alpha_F > p_M - c_S - e$, *the fair physicians' symmetric best response correspondence is given by*

$$X_F^*(X_O, y) \in \{0\}.$$

Proof. See Appendix A.2. □

As explained above, when the opportunistic physicians treat honestly or are indifferent, a fair physician always treats honestly. According to Lemma 4, when the physicians' fairness utility is large (Figure 2a), it is also always a fair physician's best response to be honest. This is because when the fairness utility is large, her honest payoff is greater than her fraud payoff. However, with a small or medium fairness utility, the honest payoff is smaller than the fraud payoff for a fair physician. In the following, we provide the intuition for the cases of Lemma 4, where the opportunistic physicians cheat (i.e. $X_O = 1$) and where the fairness utility is small or medium (Figures 2b and 2c).

We find that when the fairness utility is small or medium and the patients' acceptance rate, y, is greater than $\frac{e+\alpha_F - \delta(p_M - c_S - e - \alpha_F)}{p_M - c_S - \delta(p_M - c_S - e - \alpha_F)} =: \tilde{y}_F$, it is always an individual fair physician's best strategy to defraud patients with small problems. As the patients do not search a lot or are likely to be on their second visit, due to the cheating opportunistic physicians, there is a high probability of receiving the fraud payoff. In addition, when the fairness utility is small and there is *huge share* of opportunistic physicians in the market, i.e. $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$ (Figure 2b), it is also a fair physician's best strategy to overcharge independent of the size of y. As all opportunistic physicians cheat, there are many patients with small problems on their second visit. Therefore, even at a small acceptance rate, a fair physician prefers to cheat in this case.



(a) Large α_F

(b) Small α_F and $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$

(c) Small/medium α_F and $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$

Figure 2: Fair physicians' symmetric best response correspondence given $X_O = 1$ and different α and δ. Notice that $\tilde{X}_F := \frac{e+\alpha_F}{(1-\delta)(p_M - c_S - e - \alpha_F)} - \frac{\delta}{1-\delta}$.

Furthermore, given $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$ (Figure 2c) and a small fairness utility (i.e. the best response correspondence includes the gray lines in Figure 2c), an individual fair physician's best response depends on the other fair physicians' behavior when $y \leq \tilde{y}_F$. Assume $y \leq \tilde{y}_F$ in the following. In this case, a fair physician cheats when all other fair physicians cheat. As then all other other physicians defraud, there are sufficiently many patients with small problems on their second visit. The fair physician is honest, however, when all other fair physicians treat honestly. In this situation, there are several S-patients on their first visit and they are likely to reject a fraudulent diagnosis. In addition, there exists a region where the fair physicians are indifferent between cheating and not cheating (depicted by the gray solid line in Figure 2c). Now imagine that the fairness utility is medium (which implies $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$ and excludes all gray lines in Figure 2c). Then, the honest payoff is sufficiently large so that it is a fair physician's best strategy to be honest if patients often look for a second opinion.

3.3 Equilibrium Analysis

In the following, we investigate which types of equilibria can occur in our set-up. Subsequently, we compare the equilibrium settings of our model to a homogenous benchmark case with only opportunistic physicians, i.e. $\delta = 1$, to investigate the effect of the heterogeneity on the physicians' fraud level and the patients' search rate.[7]

In order to obtain the Nash equilibria of the heterogeneous market, we combine the patients' best response correspondence y^* with the physicians' joint best response correspondence (Figure 3). We first analyze the physicians' joint best response correspondence, which is a combination of the fair physicians' symmetric best response X_F^* and the opportunistic physicians' symmetric best response X_O^*. The physicians' joint best response correspondence generates the equilibrium level of fraud X^*. Overall, five joint physicians' best responses can be mutually compatible as stated by

Corollary 1. *Depending on the patients' acceptance strategy, y, the market level of fraud, X, the fairness utility, α_F, and the share of opportunistic physicians, δ, the following physicians' joint best responses can occur as part of a Nash equilibrium:*

1. *Both types of physicians treat their patients honestly.*
2. *The fair physicians treat honestly and the opportunistic physicians randomize between honest and fraud diagnoses for patients with small problems.*
3. *The fair physicians treat honestly and the opportunistic physicians defraud patients with small problems.*
4. *The fair physicians randomize between honest and fraud diagnoses and the opportunistic physicians defraud patients with small problems.*
5. *Both types of physicians defraud patients with small problems.*

Corollary 1 follows directly from Lemma 3 and Lemma 4. The share of opportunistic and, consequently, fair physicians as well as the strength of the fairness concern can affect the nature of the joint best response correspondence (Figure 3). When $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, cases 3 and 4 of

[7]The equilibria of the homogenous benchmark case are qualitatively equivalent to the equilibria of Sülzle and Wambach (2005) for $X_2 < \frac{e}{p_M - p_S}$.

Corollary 1 do not arise as part of the joint best response correspondence. However, the case of honest fair physicians and cheating opportunistic physicians can be a joint best response for $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, regardless of the size of the fairness utility. Furthermore, it is possible that the fair physicians are indifferent while the opportunistic physicians cheat only for $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$ and a small fairness utility (i.e. the joint best response correspondence includes the gray lines Figure 3). In addition, when the fairness utility is large, we always have a joint best response correspondence where the fair physicians are honest.

The equilibrium settings for the case that a fraction of physicians is always honest are discussed in Sülzle and Wambach (2005).[8] For that reason, we concentrate in the following on the setting with a small or a medium fairness utility but illustrate the setting with a large fairness utility in Appendix A.4. The physicians' joint best response correspondence for the cases with a small or medium fairness utility is displayed in Figure 3.

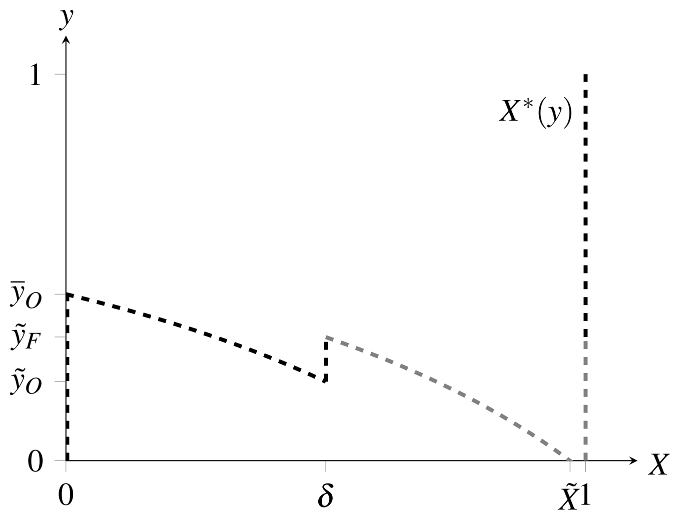


Figure 3: Physicians' joint best response correspondence given a small/medium δ and a small/medium α_F. Note that $\tilde{X} := \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$.

Proposition 1 characterizes the conditions under which the mutual compatibility of a physicians' joint best response is derived.

Proposition 1. *A mutually compatible joint best response is given by an opportunistic physician's best response for $X < \delta$ and by a fair physician's best response for $X > \delta$. For $X = \delta$, a mutually compatible physicians' joint best response is given by the convex combination $\lambda \tilde{y}_F + (1-\lambda)\tilde{y}_O > 0$, where $\lambda \in [0,1]$, if the convex combination exists.*

Proof. See Appendix A.3. □

Thereby, the mutual compatibility is determined either by the best response of a low cost or

[8] Sülzle and Wambach (2005) discuss three equilibrium settings. However, two more settings are possible, where in each setting a continuum of equilibria arises (see Figure 7).

of a high cost type for $X \neq \delta$ due to the differences in fraud incentives. It is determined by the best response of both types when $X = \delta$.

In what follows, we combine the physicians' joint best response correspondence with the patients' best response correspondence (depicted by the black bold solid lines in Figure 4) for different distributions of fair and opportunistic physicians in the market (compare Figure 4a-4c). Comparing these equilibrium settings to the homogeneous benchmark case allows us to analyze the impact of the physicians' heterogeneity with respect to fairness concerns on market outcomes. We focus on the effect of the physicians' heterogeneity on the physicians' equilibrium level of fraud, X^*, and the optimal patients' search/acceptance rate, y^*.[9] Regarding social welfare, the fairness utility is not taken into account in the physicians' surplus as it poses a non-monetary utility that can be seen as some kind of concern or (good) conscience. Proposition 2 summarizes the impact of introducing heterogeneity on equilibrium outcomes. The effects are graphically displayed in Figure 4 and discussed in the remainder of this section.

Proposition 2. *When the homogeneous benchmark market is in a pure-strategy equilibrium, denoted A, where all physicians defraud and no patient looks for a second opinion, then introducing a small/medium fairness utility for a share of physicians neither affects the physicians' level of fraud, X^*, nor the patients' acceptance rate, y^*.*

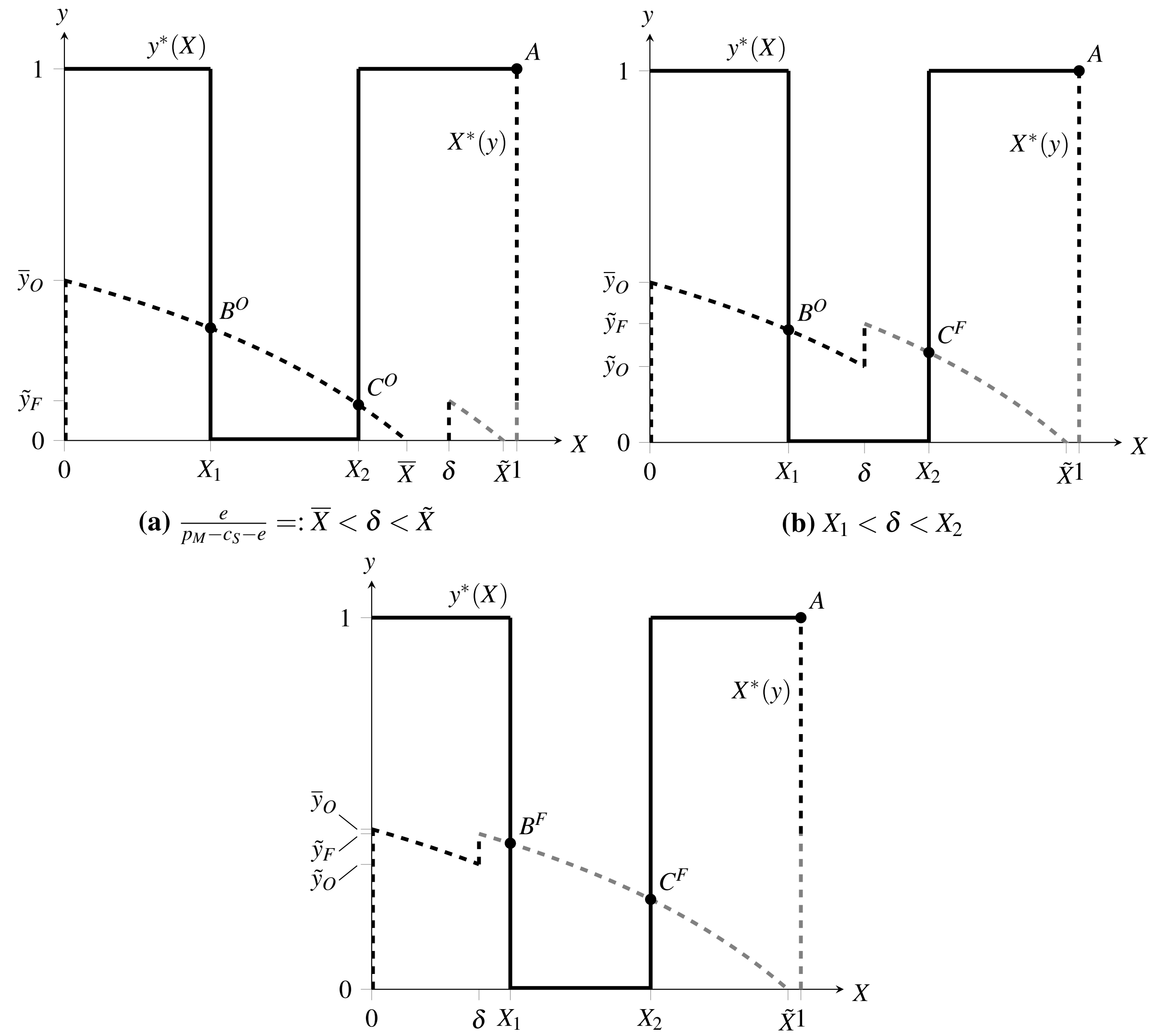
When the homogeneous reference market is in one of two mixed-strategy equilibria, denoted B and C, where physicians cheat and patients search with a positive probability, then introducing a small/medium fairness utility for a share of physicians has ambiguous effects on the physicians' fraud level and the patients' acceptance rate.

In our model, the demand is inelastic as every patient receives a treatment on his first or second visit. That is, fraud is just a redistribution. As a consequence, welfare is maximized when the accumulated patients' search costs are minimized. This is the case when no patient looks for a second opinion, i.e. when $y = 1$, since then every patient only bears k in total as search costs. Consequently, in the pure-strategy equilibrium A welfare is maximized since each patient visits only one physician in this equilibrium. However, fraud is at its maximum as well in A. According to Proposition 2, equilibrium A is not influenced by introducing a small/medium fairness utility for a fraction of physicians (compare Figure 4). The intuition behind this is that with a small or medium fairness utility, the fraud payoff is larger than the honest payoff for either type of physician and is gained with certainty in A. Therefore, for every physician it is the best strategy to cheat and thus for each patient it is the best strategy to visit only one physician.

In what follows, we concentrate only on the impact of the heterogeneity on the mixed-strategy equilibria, B and C. We consider every equilibrium, where at least one player plays a mixed strategy, a mixed-strategy equilibrium. In the heterogeneous market, the superscript (O

[9] Effects or similar are always meant in comparison to the benchmark case.

or F) corresponds to the type of physician whose best response determines whether the best response in an equilibrium is mutually compatible. Consider in the following that the benchmark market is in equilibrium B or C.



(a) $\frac{e}{p_M - c_S - e} =: \overline{X} < \delta < \tilde{X}$ **(b)** $X_1 < \delta < X_2$ **(c)** $0 < \delta < X_1$

Figure 4: Equilibrium settings with different distributions of fair and opportunistic physicians.

First look at the heterogeneous case where a very small share of physicians has a fairness utility and thus a huge share of physicians is opportunistic, i.e. $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$ (which implies a small fairness utility). Then the equilibrium configurations in terms of the search rate and the fraud level remain the same as in the homogeneous market.[10] This is an interesting observation since in B^O and C^O the fair physicians always charge honestly while the opportunistic physicians randomize between honest and fraudulent diagnoses. That is, the fair physicians overcharge more on average in B^O and C^O than all physicians in B and C, respectively. Furthermore, when there is a slightly lower share of opportunistic physicians such that

[10]The equilibria of this heterogeneous case are equivalent to the ones in Figure 4a, albeit the joint physicians' best response correspondence slightly differs.

$\frac{e+\alpha_F}{p_M-c_S-e-\alpha_F} > \delta > \frac{e}{p_M-c_S-e}$ (Figure 4a), which implies $\delta > X_2$, we again find no changes regarding the patients' acceptance rate and the physicians' fraud in comparison to the homogeneous market. This observation holds independent of the fairness utility being small or medium and for the same intuition as for $\delta > \frac{e+\alpha_F}{p_M-c_S-e-\alpha_F}$.

Next presume that in the heterogeneous market there is a balanced share of fair and opportunistic physicians, i.e. $X_1 < \delta < X_2$ (Figure 4b). When the fairness utility is small, we find a new mixed-strategy equilibrium, denoted C^F, where the fair physicians as well as patients randomize and the opportunistic physicians cheat. In equilibrium C^F, the patients search less than in C^O/C but the level of fraud is the same in the three equilibria. Equilibrium C^O does not exist in this case since at a patients' acceptance rate below $\tilde{y}_O$ being honest is more profitable than cheating for any physician, due to the many honest fair physicians. However, even at a somewhat greater acceptance rate like in C^F treating honestly is the best response for a fair physician when the fairness utility is medium. Then, equilibrium C^F does not exist either and the market equilibrium is either B^O or A. Note that in B^O and A patients search less than in C^O. Consequently, social welfare in B^O and A is greater than in C^O. Equilibrium B^O is maintained just as in the previous cases because at the search rate in B^O, cheating can still be profitable for an opportunistic physician. To sum up, introducing a medium share of fair physicians can result in changes regarding welfare and fraud only when the homogeneous market is in equilibrium C. When small fairness concerns are introduced, C^F becomes the new market equilibrium. As a consequence, the patients' acceptance rate is raised but the fraud level remains unchanged. If the fairness concerns are of a medium degree, the patients' acceptance rate is again increased but the level of fraud can be lowered or increased depending on the new equilibrium (B^F or A).

Last, consider the setting with a large share of fair physicians, i.e. $1-\delta > 1-X_1$ and thus $\delta < X_1$ (Figure 4c).[11] In this situation, there is another new mixed-strategy equilibrium, denoted B^F, given the fairness utility is small. In B^F, the opportunistic physicians cheat and the patients as well as the fair physicians are indifferent. The patients' acceptance rate in equilibrium B^F is higher than in B^O/B but the fraud level in B^F is equivalent to the one in B^O/B. There is neither an equilibrium C^O nor an equilibrium B^O since being honest is more profitable than cheating for an opportunistic physician even at a rather medium acceptance rate. When the fairness utility is medium, the only remaining market equilibrium is A. Consequently, when the benchmark market is in equilibrium B or C, introducing a small fairness utility for a large share of physician leads to B^O or C^O, respectively, becoming the new equilibrium. That is, the patients' search level is always reduced by the introduction but the fraud level remains unchanged. However, imposing a medium fairness utility for a large share of physicians maximizes social welfare but also the physicians' level of fraud. That means, introducing fair physicians that have lower fraud incentives than the opportunistic physicians might actually increase, in fact maximize, the fraud level.[12]

[11] The equilibrium structure would be the same with only fair physicians, i.e. $\delta = 0$, as in the setting with $\delta < X_1$.
[12] Further equilibrium cases, where we observe a continuum of equilibria, can be found in Appendix A.4.

4 Discussion: Bad Conscience

In our model above, we assume the physicians to derive some additional benefit from being fair. This benefit can be regarded as a good conscience for doing the right thing. One might argue that norms like the Oath of Hippocrates or the charter on medical professionalism aim at giving physicians a bad conscience when acting inappropriately. As a point of comparison, we incorporate the fairness utility α_F^{BAD}, where the superscript BAD stand for the bad conscience case, as a loss for a fair physician when defrauding a patient. Consequently, a fair physician's expected payoff is given as

$$\pi_F^{BAD} = (1-x_F) + x_F \frac{y+X(1-y)}{1+X(1-y)}(p_M - c_S - \alpha_F^{BAD}). \tag{5}$$

We derive the physicians' joint best response correspondence for the bad conscience case and depict the equilibrium setting for this case graphically in Figure 5 with $\alpha_F = \alpha_F^{BAD}$. The bold red lines in the figure depict the joint best response for $X \geq \delta$. For $X < \delta$, no changes occur in comparison to the joint best response with the good conscience types. The red dotted lines only arise as part of the joint best response correspondence if $\alpha_F^{BAD} < p_M - c_S - e(2-y)$ (small fairness utility). A medium fairness utility is given by $p_M - c_S - e > \alpha_F^{BAD} > p_M - c_S - e(2-y)$ and a large one by $\alpha_F^{BAD} > p_M - c_S - e$.

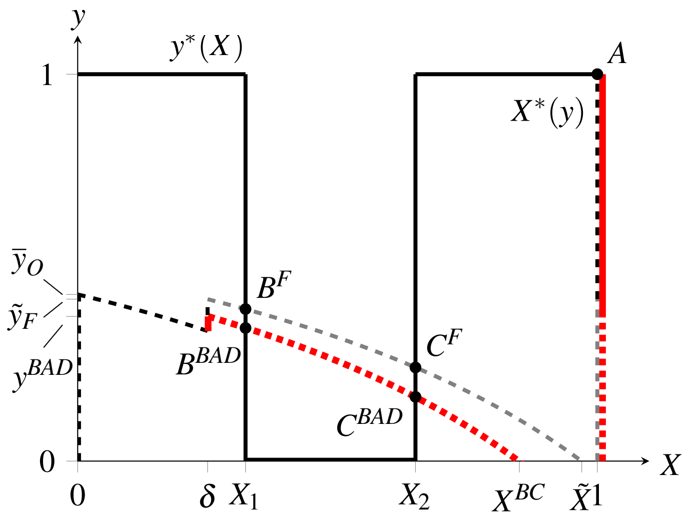


Figure 5: Equilibrium setting for $\delta < X_1$ and a small or medium bad conscience fairness utility, α_F^{BAD}. Notice that $X^{BAD} = \frac{e}{p_M - c_S - e - \alpha_F^{BAD}}$.

The following comparison implies $X_O = 1$ since when the opportunistic physicians treat honestly or randomize, any fair physicians is honest regardless of being a good or bad conscience type. It holds that $y^{BAD} < \tilde{y}_F$ and $\tilde{X} < X^{BAD}$. That is, the fair physicians with a bad conscience always cheat for $y > y^{BAD}$ and thus would cheat with certainty at a lower patients' acceptance rate than the good conscience type. Also, the indifference fraud level is smaller for the bad conscience types than for the good conscience types. Thus, in the region $X \in [X^{BAD}, \tilde{X}]$, where a good conscience type may be indifferent, a bad conscience type would always overcharge. Furthermore, a bad conscience fair physician treats honestly with certainty for $y < y^{BAD}$ only if $\alpha_F^{BAD} > p_M - c_S - e(2-y) > \frac{p_M - c_S}{2-y} - e$. This means that the good conscience physicians are honest with certainty when $\alpha_F \in (p_M - c_S - e(2-y), \frac{p_M - c_S}{2-y} - e)$, whereas the bad conscience physicians might cheat for $\alpha_F^{BAD} \in (p_M - c_S - e(2-y), \frac{p_M - c_S}{2-y} - e)$. In addition, when $y = 1$, both types would defraud when the respective fairness utility is smaller than $p_M - c_S - e$.

Those findings lead to the conclusion that a bad conscience fair physician has ceteris paribus higher fraud incentives than a good conscience one for $X_O = 1$ and $y < 1$. The intuition behind this result is that the good conscience fairness utility increases the honest payoff which is received with certainty when being honest. The bad conscience fairness utility reduces the fraud payoff which might be rejected anyway if $y < 1$. Furthermore, the equilibria B^{BAD} and C^{BAD} are less efficient in terms of social welfare than B^F and C^F, respectively. Our observations illustrate that generating a good conscience could be more effective in reducing fraud incentives for a physician and creating a more efficient equilibrium outcomes than creating a bad conscience.

5 Conclusion

We theoretically study how heterogeneity among physicians regarding their interest in fairness affects the patients' search for second opinions (and thus social welfare) and the level of fraud in a credence goods market with regulated prices. We consider a heterogeneous setting where a fraction of physicians is opportunistic and the complementary fraction is fair. The opportunistic physicians only care about the monetary incentives and the fair physicians care about monetary incentives and being honest. Fair physicians receive a non-monetary utility (called fairness utility) when they treat patients honestly as opposed to defrauding them by overcharging. This fairness utility can also be seen as a good conscience for being honest. We regard a homogeneous market with solely opportunistic physicians as the benchmark case.

Given the homogeneous market is an equilibrium state with maximum fraud and no patients' search, only introducing a large fairness utility (which eliminates all fraud incentives for fair physicians) leads to changes in the equilibrium. Obviously, the fraud level decreases but welfare may actually fall as well. With a sufficiently large fairness utility, we generate the same heterogenous equilibrium settings as discussed in Sülzle and Wambach (2005).

When we start in an homogeneous equilibrium with a relatively high level of fraud and a relatively high search rate, inserting a fairness utility for a share of physicians affects the search rate or the fraud level only when it is introduced for at least a medium share of physicians. Then, the search level always decreases but the effect on fraud depends on the size of the fairness utility and on the ultimate share of fair physicians. When the fairness utility is small, the fraud level is not influenced. When the fairness utility is of a medium size, fraud is raised or reduced if we introduce a medium share of fair physicians. If the fairness concerns are of a medium degree and the share of fair physicians is large, social welfare and the fraud level are raised to the maximum. Starting in a homogeneous equilibrium with a relatively low level of fraud and a medium search level, equilibrium outcomes are only influenced by incorporating a fairness utility for a large share of physicians. In that case, the search rate is also always lowered. When the fairness concerns are small, the fraud level remains unchanged and when they are medium, fraud is maximized. That is, incorporating a fraction of fair physicians may actually have the effect that fraud is raised despite the fair physicians having lower fraud incentives than the opportunistic physicians.

We additionally discuss a case where the fair physicians have a bad conscience when cheating. In this case, a fair physician's fraud payoff is reduced by the fairness utility. We find that the bad conscience physicians have ceteris paribus higher fraud incentives than the good conscience physicians in some situations. Furthermore, the equilibrium outcomes may be more efficient regarding welfare in the good conscience case. Thus, generating a good conscience may be more effective than creating a bad conscience in decreasing fraud incentives and raising welfare.

Intuitively, one could expect the amount of fraud to decrease by inserting a fairness utility for a share of physicians, since a fairness utility lowers experts' fraud incentives. As a consequence, one would also expect welfare to increase because with physicians being more honest, fewer patients would have to look for a second opinion. However, in our model we observe counter-intuitive effects in some cases. As illustrated, they depend on the degree of the fairness concern, the distribution of fair and opportunistic physicians, the initial search rate and the initial fraud level.

References

Balafoutas, L., A. Beck, R. Kerschbamer, and M. Sutter (2013). What drives taxi drivers? A field experiment on fraud in a market for credence goods. *Review of Economic Studies 80*(3), 876–891.

Darby, M. and E. Karni (1973). Free competition and the optimal amount of fraud. *Journal of Law and Economics 16*(1), 67–88.

Dulleck, U. and R. Kerschbamer (2006). On doctors, mechanics, and computer specialists: The economics of credence goods. *Journal of Economic Literature 44*(1), 5–42.

Dulleck, U., R. Kerschbamer, and M. Sutter (2011). The economics of credence goods: An experiment on the role of liability, verifiability, reputation, and competition. *American Economic Review 101*(2), 526–555.

Emons, W. (1997). Credence goods and fraudulent experts. *The RAND Journal of Economics*, 107–119.

Iezzoni, L. I., S. R. Rao, C. M. DesRoches, C. Vogeli, and E. G. Campbell (2012). Survey shows that at least some physicians are not always open or honest with patients. *Health Affairs 31*(2), 383–391.

Kesternich, I., H. Schumacher, and J. Winter (2015). Professional norms and physician behavior: homo oeconomicus or homo hippocraticus? *Journal of Public Economics 131*, 1–11.

Liu, T. (2011). Credence goods markets with conscientious and selfish experts. *International Economic Review 52*(1), 227–244.

Marty, F. E. (1999). The expert-client information problem. Technical report, working paper.

Mimra, W., A. Rasch, and C. Waibel (2016). Second opinions in markets for expert services: Experimental evidence. *Journal of Economic Behavior & Organization 131*, 106–125.

Pitchik, C. and A. Schotter (1987). Honesty in a model of strategic information transmission. *American Economic Review 77*(5), 1032–36.

Project of the ABIM Foundation and ACP-ASIM Foundation and European Federation of Internal Medicine (2002). Medical professionalism in the new millennium: A physician charter. *Annals of Internal Medicine 136*(3), 243–246.

Sülzle, K. and A. Wambach (2005). Insurance in a market for credence goods. *Journal of Risk and Insurance 72*(1), 159–176.

Wolinsky, A. (1993). Competition in a market for informed experts' services. *RAND Journal of Economics 24*(3), 380–398.

Wolinsky, A. (1995). Competition in markets for credence goods. *Journal of Institutional and Theoretical Economics (JITE) / Zeitschrift für die gesamte Staatswissenschaft 151*(1), 117–131.

A Appendix

A.1 Proof of Lemma 3

Sülzle and Wambach (2005) observe that there are no fraud incentives for (opportunistic) physicians when it holds that $e \geq \frac{p_M - c_S}{2-y}$ and $y \leq \frac{e}{p_M - c_S}$. However, we analyze the effect of of the physicians' heterogeneity and the degree of the fairness utility, not of the monetary mark-up e on market outcomes. Additionally, we analyze all possible settings with fraud. Therefore, we impose the assumption $e < \frac{p_M - c_S}{2-y}$.

According to the physician's individual best response (4), an opportunistic physician has higher fraud incentives than a fair physician. Thus, if the fair physicians defraud patients with a small problem with certainty or with a positive probability, an opportunistic physician will cheat with probability 1. Therefore, in the following, we analyze the situation where all fair physicians are honest ($X_F = 0$) to derive the opportunistic physicians' symmetric best response. The opportunistic physicians' symmetric best response is derived from the individual best response of an opportunistic physician, i.e. considering $\alpha_O = 0$.

Following Sülzle and Wambach (2005), we consider three cases regarding the patients' acceptance strategy, y:

1. $y = 1$. All patients accept an M-diagnosis on their first visit with certainty. Setting $y = 1$ in (3) and rearranging leads to

$$e < p_M - c_S. \tag{A.1}$$

   Obviously, when all patients always accept a recommendation for a major treatment on their first visit, it is an opportunistic physician's best strategy to defraud S-patients even when all fair physicians are honest.

2. $y = 0$. Each patient rejects an M-diagnosis on his first visit. Substituting $y = 0$ and $X = \delta X_O$ into (3) and rearranging yields

$$e \left\{ \begin{array}{c} > \\ = \\ < \end{array} \right\} \frac{\delta X_O}{1+\delta X_O}(p_M - c_S). \tag{A.2}$$

   An individual opportunistic physician's best response depends on the other opportunistic physicians' best response. Thus, we consider three different cases regarding the other opportunistic physicians' defrauding behavior, X_O:

   (a) $X_O = 0$. All other opportunistic physicians always treat all patients honestly. Setting $X = 0$ in (A.2) shows that an opportunistic physician is always honest given all other opportunistic physicians are honest if and only if

$$e > 0. \tag{A.3}$$

   Clearly, given all other physicians are honest, an individual opportunistic physician treat patients with small problems honestly as well, i.e. she plays $x_O = 0$. In that situation, every S-patient is on his first visit because each physician is honest and would reject an M-recommendation with certainty due to $y = 0$.

(b) $X_O = 1$. All other opportunistic physicians always defraud patients with a small problem. By substituting X_O into (A.2) and rearranging, we observe that an individual opportunistic physician defrauds patients with small problems as well if and only if

$$\delta > \frac{e}{p_M - c_S - e}. \tag{A.4}$$

That is, when the share of opportunistic physicians is sufficiently large and all other opportunistic physicians cheat, it is beneficial for an individual opportunistic physician to cheat as well, i.e to play $x_O = 1$. When $\delta > \frac{e}{p_M - c_S - e}$ (notice that $p_M > c_S + e = p_S$), there are sufficiently many patients with small problems on their second visit and they would consequently accept any diagnosis. However, given $\delta < \frac{e}{p_M - c_S - e}$, an opportunistic physician deviates and plays $x_O = 0$. In that situation, there are too many patients with small problems on their first visit due to the high share of honest fair physicians.

(c) $X_O \in (0,1)$. All other opportunistic physicians randomize between defrauding and treating patients with small problems honestly. An opportunistic physicians' best response requires that an individual opportunistic physician O randomizes as well. Rearranging (A.2) with an equal sign and solving for X_O illustrates that an individual opportunistic physician is indifferent too if and only if

$$X_O = \frac{e}{\delta(p_M - c_S - e)} =: \tilde{X}_O. \tag{A.5}$$

Note that an opportunistic physician plays $x_O = 0$ if $X_O < \tilde{X}_O$ and $x_O = 1$ if $X_O > \tilde{X}_O$. Additionally, notice that $0 < \tilde{X}_O < 1$ if $\delta > \frac{e}{p_M - c_S - e}$. Therefore, an opportunistic physicians' symmetric best response $X_O \in (0,1)$ exists only if $\delta > \frac{e}{p_M - c_S - e}$. In case $\delta < \frac{e}{p_M - c_S - e}$, it holds that $X_O < 1 < \tilde{X}_O$. Consequently, an opportunistic physician would deviate and play $x_O = 0$ for the same reasons as above.

3. $y \in (0,1)$. The patients mix between accepting a recommendation for an M-treatment and rejecting it on their first visit. Setting $X = \delta X_O$ and rearranging (3) with an equal sign generates

$$y(p_M - c_S) + \delta X_O(1-y)(p_M - c_S - e) - e = 0. \tag{A.6}$$

We consider the same three cases regarding the other opportunistic physicians' overcharging strategy as above:

(a) $X_O = 0$. Setting $X_O = 0$ and rearranging (A.6) shows that an opportunistic physician is honest as well if and only if

$$y_O < \frac{e}{p_M - c_S} =: \bar{y}_O. \tag{A.7}$$

That is, being honest is an opportunistic physician's best response for low values of y. For $y > \bar{y}_O$, she deviates and overcharges.

(b) $X_O = 1$. It follows from (A.6) with $X_O = 1$ that if all other opportunistic physicians cheat, an individual opportunistic physician cheats as well if and only if

$$y(p_M - c_S) + \delta(1-y)(p_M - c_S - e) - e > 0. \tag{A.8}$$

This is given if $\delta > \frac{e-y(p_M-c_S)}{(1-y)(p_M-c_S-e)}$. Consider $\frac{e-y_2(p_M-c_S)}{(1-y_2)(p_M-c_S-e)} \leq \delta \leq \frac{e-y_1(p_M-c_S)}{(1-y_1)(p_M-c_S-e)}$, where $y_1 = y \in \left(0, \frac{e-\delta(p_M-c_S-e)}{p_M-c_S-\delta(p_M-c_S-e)}\right]$ and $y_2 = y \in \left[\frac{e-\delta(p_M-c_S-e)}{p_M-c_S-\delta(p_M-c_S-e)}, 1\right)$. For all values of y_2, condition (A.8) is fulfilled. By contrast, for all values of y_1, condition (A.8) is not met and thus an opportunistic physician deviates and treats honestly. Notice that $\frac{e-y(p_M-c_S)}{(1-y)(p_M-c_S-e)} < 0$ for $y < \frac{e}{p_M-c_S}$ but that $\delta > 0$. Consequently, there are no further cases of δ in our model.

(c) $X_O \in (0,1)$. Given all other opportunistic physicians randomize between cheating and not cheating, a single opportunistic physician randomizes as well if and only if

$$X_O(y) = \frac{e - y(p_M - c_S)}{\delta(1-y)(p_M - c_S - e)} =: \tilde{X}_O(y). \tag{A.9}$$

The indifference $\tilde{X}_O(y)$ lies below 1 if $\delta > \frac{e-y(p_M-c_S)}{\delta(1-y)(p_M-c_S-e)}$. Notice that for $X_O(y) > \tilde{X}_O(y)$, an opportunistic physician prefers to overcharge patients but for $X_O(y) < \tilde{X}_O(y)$, she diagnoses honestly with certainty. Additionally, differentiation with respect to y illustrates that

$$\frac{d\tilde{X}_O(y)}{dy} = -\frac{1}{\delta(1-y)^2} < 0. \tag{A.10}$$

This shows that an opportunistic physician is indifferent at a reduced level of fraud X_O when y increases. If more patients accept a fraudulent diagnosis on their first visit, the level of fraud can be lower (which means fewer patients can be on their second visit) to make the opportunistic physician indifferent. The indifference fraud level $\tilde{X}_O$ reaches zero at $y = \bar{y}_O$. It follows that for any acceptance strategy $y > \bar{y}_O$, it holds that $X_O(y) > 0 > \tilde{X}_O(y)$. Therefore, an opportunistic physician strictly prefers to defraud for $y > \bar{y}_O$ as already observed above. That is, for $\delta > \frac{e-y(p_M-c_S)}{\delta(1-y)(p_M-c_S-e)}$ and $y < \bar{y}_O$, a mixed strategy $X_O \in (0,1)$ can be a symmetric best response.

Assume $\frac{e-y_2(p_M-c_S)}{(1-y_2)(p_M-c_S-e)} \leq \delta \leq \frac{e-y_1(p_M-c_S)}{(1-y_1)(p_M-c_S-e)}$. We have $X_O(y_1) < 1 < \tilde{X}_O(y_1)$. Consequently, for all values of y_1, an opportunistic physician deviates and treats honestly. However, it holds that $\tilde{X}_O(y_2) < 1$. As a consequence, for all values of y between $\frac{e-\delta(p_M-c_S-e)}{p_M-c_S-\delta(p_M-c_S-e)} =: \tilde{y}_O$ and $\bar{y}_O$, the strategy $X_O \in (0,1)$ is a candidate for the opportunistic physicians' best response in this case.

A.2 Proof of Lemma 4

By the physician's individual best response (4), the fair physicians have lower fraud incentives than the opportunistic physicians. Therefore, the fair physicians will always treat patients with small problems. Thus, in the following, we analyze the case that all opportunistic physicians cheat with certainty ($X_O = 1$) to derive the fair physicians' symmetric best response. We obtain the fair physicians' symmetric best response from the individual best response of a fair physician, i.e. considering $a_F > 0$.

We distinguish here the same three situations with respect to the patients' acceptance strategy, y, as in the proof for the opportunistic physicians' symmetric best response:

1. $y = 1$. Substituting $y = 1$ into (3) illustrates that a fair physician defrauds any patient with a small problem with certainty for

   $$\alpha_F < p_M - c_S - e.$$

   That is, a fair physician cheats, i.e. plays $x_F = 1$, with certainty only when the fairness utility is sufficiently small even though no patient looks for a second opinion and all opportunistic physicians cheat. If $\alpha_F > p_M - c_S - e$, the honest payoff is greater than the fraud payoff and thus a fair physician is always honest, i.e. she plays $x_F = 0$. Note that $p_M - c_S - e > 0$ since $p_M > p_S = c_S - e$. In case $\alpha_F < p_M - c_S - e$, the honest payoff is too small so that cheating is more profitable than being honest when the fraud payoff is certain. In the rest of the proof of this lemma, we suppose $\alpha_F < p_M - c_S - e$.

2. $y = 0$. Inserting $y = 0$ and $X = (1-\delta)X_F + \delta$ into (3) and rearranging yields

   $$e \left\{ \begin{array}{c} > \\ = \\ < \end{array} \right\} \frac{(1-\delta)X_F + \delta}{1 + (1-\delta)X_F + \delta}(p_M - c_S) - \alpha_F. \tag{A.11}$$

   A fair physician's best response depends on the other fair physicians' defrauding behavior. Thus, we distinguish three situations with respect to the other fair physicians' overcharging behavior, X_F:

   (a) $X_F = 0$. All other fair physicians always treat honestly. It follows from rearranging (A.11) and considering $X_F = 0$ that an individual fair physician is honest as well if and only if

$$\delta < \frac{e + \alpha_F}{p_M - c_S - e - \alpha_F}. \tag{A.12}$$

Consequently, when $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, a fair physician deviates and cheats. Notice that $\frac{e+\alpha_F}{p_M - c_S - e - \alpha_F} > 0$ because of $\alpha_F < p_M - c_S - e$ and that $\frac{e+\alpha_F}{p_M - c_S - e - \alpha_F} < 1$ given $\alpha_F < \frac{p_M - c_S}{2} - e$, i.e. when we have a small fairness utility (considering $y = 0$). That is, only when $\alpha_F < \frac{p_M - c_S}{2} - e$, can it hold that $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$. Therefore, given a small fairness utility and that there are many cheating opportunistic physicians in the market, i.e. $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, it is an individual fair physician's best strategy to defraud. In that case, there are sufficiently many patients on their second visit such that with a small fairness utility a fair physician prefers to cheat. However, given $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$ and a small fairness utility, there are too few patients with small problems on their second visit and thus a fair physician prefers to treat honestly. For a medium fairness utility (considering $y = 0$), i.e. $p_M - c_S - e > \alpha_F > \frac{p_M - c_S}{2} - e$, condition (A.12) is satisfied with certainty since then $\delta < 1 < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$. Consequently, given a medium fairness utility, a fair physician recommends honestly when $y = 0$.

(b) $X_F = 1$. All other fair physicians always overcharge patients with small problems. We substitute $X_F = 1$ into (A.11). Consequently, an individual fair physician defrauds patients with small problems too if and only if

$$\alpha_F < \frac{p_M - c_S}{2} - e. \tag{A.13}$$

Thereby, only if the fairness utility is sufficiently small, will a fair physician cheat too. Notice that $\frac{p_M - c_S}{2} - e > 0$ because $e < \frac{p_M - c_S}{2}$ by assumption. However, when $p_M - c_S - e > \alpha_F > \frac{p_M - c_S}{2} - e$, the certain honest payoff is increased so much that a fair physician is always honest even when all other physicians cheat.

(c) $X_F \in (0,1)$. All other fair physicians randomize between cheating and treating patients with small problems honestly. For a fair physicians' symmetric best response it must hold that an individual fair physician F is indifferent as well. It follows from substituting $X_F \in (0,1)$ into (A.11) with an equal sign and solving for X_F that a single fair physician randomizes too if and only if

$$X_F = \frac{e + \alpha_F}{(1-\delta)(p_M - c_S - e - \alpha_F)} - \frac{\delta}{1-\delta} =: \tilde{X}_F. \tag{A.14}$$

A fair physician plays $x_F = 0$ for $X_F < \tilde{X}_F$ and $x_F = 1$ for $X_F > \tilde{X}_F$. We have $\tilde{X}_F > 0$ when $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$ and $\tilde{X}_F < 1$ for $\alpha_F < \frac{p_M - c_S}{2} - e$. Consequently, when $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$ and $\alpha_F < \frac{p_M - c_S}{2} - e$, the strategy $X_F \in (0,1)$ is a candidate for a best response. However, if $\alpha_F > \frac{p_M - c_S}{2} - e$ (and consequently $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$), we have $X_F < 1 < \tilde{X}_F$ and thus a fair physician deviates and treats honestly. When $\alpha_F < \frac{p_M - c_S}{2} - e$ and $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, we observe $X_F > 0 > \tilde{X}_F$ and therefore a fair physician prefers to defraud. The intuitions for these findings are analogous to the previous cases.

3. $y \in (0,1)$. Substituting $X = (1-\delta)X_F + \delta$ and rearranging (3) with an equal sign yields

$$y(p_M - c_S) + ((1-\delta)X_F + \delta)(1-y)(p_M - c_S - e - \alpha_F) - e - \alpha_F = 0. \tag{A.15}$$

We again distinguish three cases regarding the fair physicians' level of fraud:

(a) $X_F = 0$. It follows from Equation (A.15) that if $X_F = 0$ an individual fair physician treats honestly if and only if

$$y < \frac{e + \alpha_F - \delta(p_M - c_S - e - \alpha_F)}{p_M - c_S - \delta(p_M - c_S - e - \alpha_F)} =: \tilde{y}_F. \tag{A.16}$$

Thus, it is a fair physician's best strategy to diagnose honestly for low values of y. When $y > \tilde{y}_F$, a fair physician prefers to cheat. Notice that the denominator of $\tilde{y}_F$ is greater than zero with certainty and that $\tilde{y}_F > 0$ for $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$.

(b) $X_F = 1$. If all fair other physicians cheat, an individual fair physician cheats too if and only if

$$y(p_M - c_S) + (1-y)(p_M - c_S - e - \alpha_F) - e - \alpha_F > 0. \tag{A.17}$$

The condition (A.17) is satisfied when $\alpha_F < \frac{p_M - c_S}{2-y} - e$, where $\frac{p_M - c_S}{2-y} - e > 0$ by assumption.

(c) $X_F \in (0,1)$. It follows from (A.15) that given all other fair physicians randomize between cheating and not cheating, a single fair physician randomizes as well if and only if

$$X_F(y) = \frac{e + \alpha_F - y(p_M - c_S)}{(1-\delta)(1-y)(p_M - c_S - e - \alpha_F)} - \frac{\delta}{1-\delta} =: \tilde{X}_F(y). \tag{A.18}$$

A fair physician defrauds for $X_F(y) > \tilde{X}_F(y)$ and is honest if $X_F(y) < \tilde{X}_F(y)$. We have $\tilde{X}_F(y) < 1$ for $\alpha_F < \frac{p_M - c_S}{2-y} - e$. Correspondingly, when $\alpha_F > \frac{p_M - c_S}{2-y} - e$, we have $X_F(y) < 1 < \tilde{X}_F(y)$ and consequently a fair physician is honest. Furthermore, differentiation with respect to y illustrates that

$$\frac{d\tilde{X}_F(y)}{dy} = -\frac{1}{(1-\delta)(1-y)^2} < 0. \tag{A.19}$$

That is, an increase in the patients' acceptance rate raises $\tilde{X}_F(y)$. Therefore, fair physicians need fewer patients with small problems on their second visit to be indifferent if more patients are willing to accept an M-treatment on their first visit. The fair physicians' indifference level of fraud, $\tilde{X}_F(y)$, finally reaches zero at $y = \tilde{y}_F$. Therefore, we have $X_F(y) > 0 > \tilde{X}_F(y)$ if $y > \tilde{y}_F$. Thus, a fair physician overcharges when $y > \tilde{y}_F$, as also illustrated above. Thereby, for $\alpha_F < \frac{p_M - c_S}{2-y} - e$ and $y < \tilde{y}_F$, the strategy $X_F \in (0,1)$ is a candidate for a symmetric best response.

A.3 Proof of Proposition 1

Given a pair (X, y) such that fair and opportunistic physicians treat patients honestly, the corresponding overall level of fraud is given by $X = 0$. In this case, a mutually compatible physicians' joint best response is determined by an opportunistic physician's best response as the fair physicians have lower fraud incentives than the opportunistic types and do not cheat in this case.

Given a double (X, y) such that the fair physicians are honest and the opportunistic physicians are indifferent, the according level of fraud is $X = \frac{e - y(p_M - c_S)}{(1-y)(p_M - c_S - e)}$. This fraud level is bounded from above by $min\{\overline{X}, \delta\}$. It is again due to the fair physicians' lower fraud incentives determined by an opportunistic physician's best response whether a joint best response is mutually compatible.

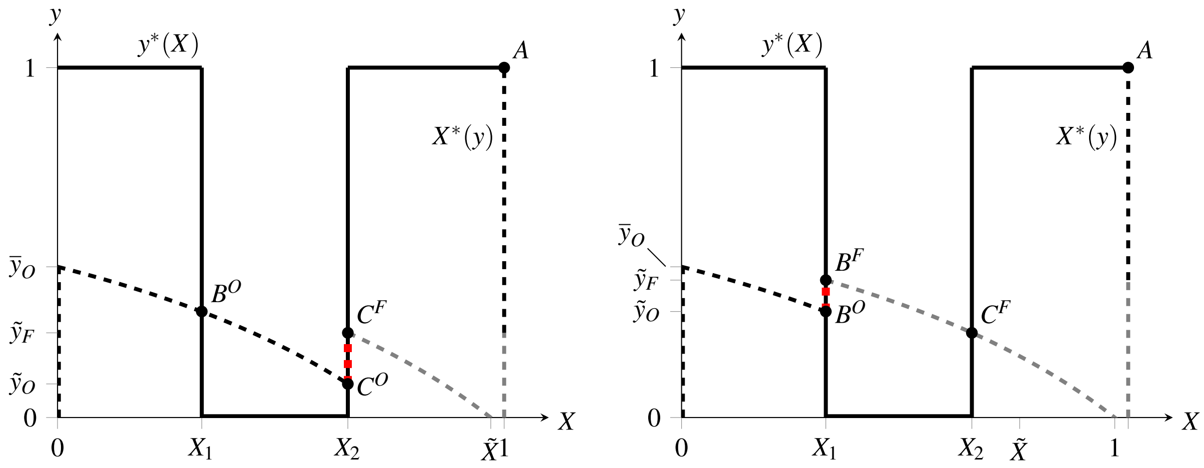
Given a pair (X, y) where the fair physicians diagnose honestly and the opportunistic physicians cheat, the only consistent fraud level is $X = \delta$. A mutually compatible joint best response is given by the convex combination $\lambda \tilde{y}_F + (1-\lambda)\tilde{y}_O$, where $\lambda \in [0,1]$, in case the convex combination exists. The fair physicians' honest behavior is guaranteed by $y < \tilde{y}_F$ and the the opportunistic physicians' dishonest behavior by $y > \tilde{y}_O$. However, the respective convex combination only exists for $\delta < \frac{e}{p_M - c_S - e}$. When $\frac{e + \alpha_F}{p_M - c_S - e - \alpha_F} > \delta > \frac{e}{p_M - c_S - e}$, the mutual compatibility is ensured by $y < \tilde{y}_F$ since the opportunistic physicians may cheat for any search rate $y \in [0,1]$ in this situation.

With a pair (X, y) such that the fair physicians randomize and the opportunistic physicians cheat, the only consistent market level of fraud is given by $X = \frac{e + \alpha_F - y(p_M - c_S)}{(1-y)(p_M - c_S - e - \alpha_F)}$, which is bounded from below by δ. It depends on a fair physician's best strategy whether we have a mutually compatible joint best response. This is because the opportunistic physicians cheat with certainty when the fair physicians are indifferent.

For a pair (X, y) such that both types of physicians cheat, the corresponding overall level of fraud is $X = 1$, which corresponds to the best response of a fair physician.

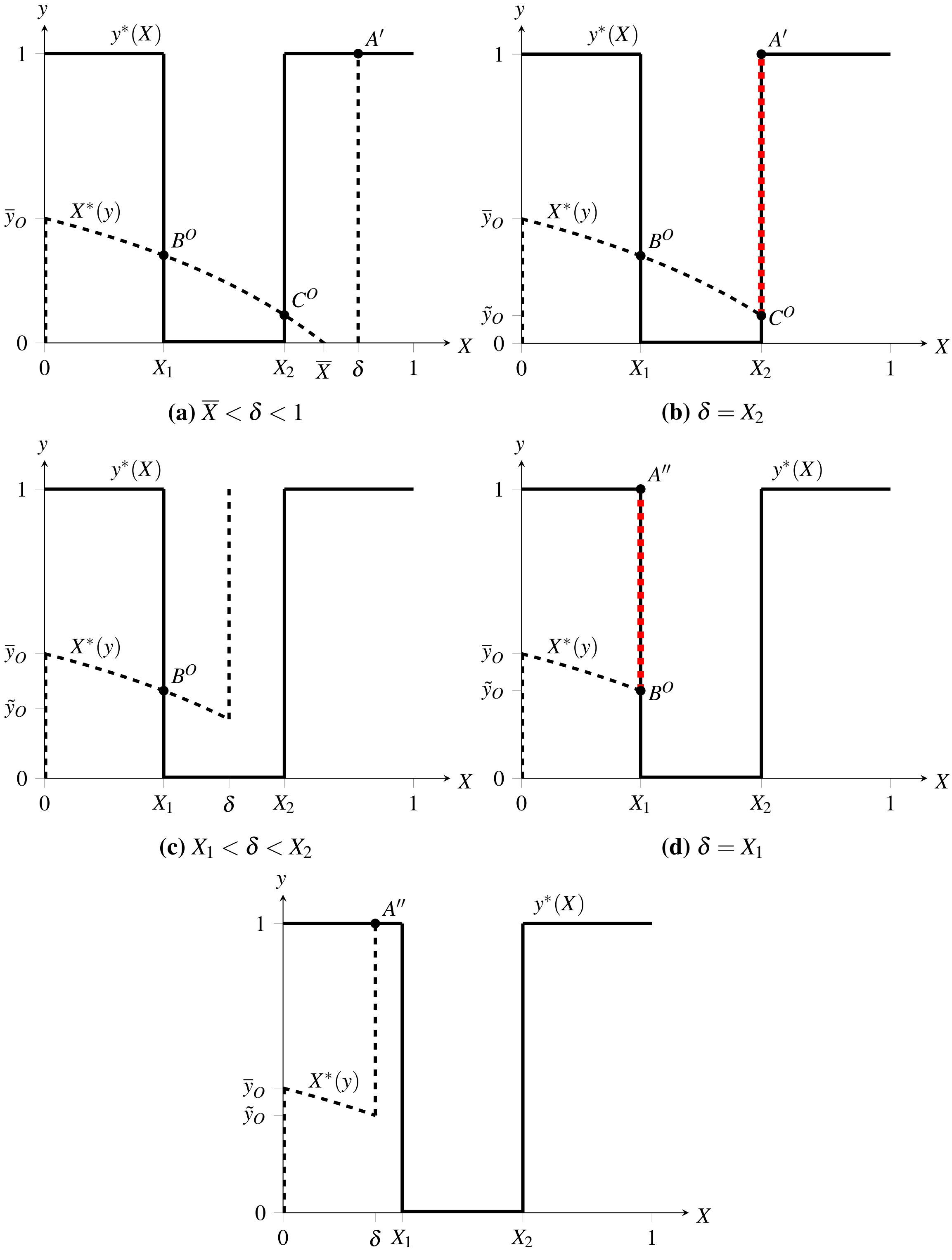
A.4 Further Equilibrium Cases

In what follows, further equilibrium settings are depicted. Figure 6 displays additional cases for the setting with a small or medium fairness utility, where in each case a continuum of equilibria (marked in bold red) occurs. Figure 7 depicts all cases for the situation where the fair physicians have a large fairness utility and thus no incentives to cheat. Therefore, in Figure 7 a mutually compatible physicians' joint best response is always determined by an opportunistic physician's best response.



(a) $\delta = X_2$ **(b)** $\delta = X_1$

Figure 6: Addtional equilibrium settings for a small/medium fairness utility, where continua of equilibria occur.



(a) $\overline{X} < \delta < 1$ **(b)** $\delta = X_2$ **(c)** $X_1 < \delta < X_2$ **(d)** $\delta = X_1$ **(e)** $0 < \delta < X_1$

Figure 7: Equilibrium settings given a large fairness utility.

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