Essays on the Theory of Industrial Organization: Credence Goods, Vertical Relations, and Product Bundling

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Chapter 3

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* also care about being honest towards patients. We investigate how this heterogeneity affects the physicians' level of overcharging and the patients' search for second opinions (which crucially affects overall welfare). The impact of introducing heterogeneity on the fraud level is ambiguous and depends on several factors such as the extent of the fairness concerns, the share of imposed 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 patients sometimes search, then the search level always increases if the fraction of imposed fair physicians is sufficiently large.

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3.1 Introduction

In a credence goods market, information asymmetries between customers and expert sellers may lead to incentives for the 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). The possibility of being defrauded may make the customer mistrust an expert and search for additional opinions (Wolinsky, 1993). 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 credence goods experts. Their findings indicate that some experts care only about their own monetary payoffs, whereas others consider their own payoff but also their customers' payoffs in their decisions. Moreover, some experts in their experiment were always honest despite strong fraud incentives. This shows that there may be heterogeneity among credence goods experts regarding fairness concerns towards customers and that the concerns may be of different extents. In a health care market, physicians might 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 that 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 overcharging against being honest. 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 is to investigate *how the physicians' heterogeneity with respect to fairness concerns affects the physicians' overcharging level, the patients' search for second opinions and overall welfare.*

The incentives for experts to defraud customers and the incentives for customers to search for second opinions in credence goods markets have been studied before. In his seminal work, Wolinsky (1993) finds that in a market with endogenous prices there is no expert fraud. It ultimately depends on the size of customers' search and waiting costs whether a market equilibrium with second opinions occurs when prices are flexible. If prices are fixed, there exists one equilibrium without second opinions but only equilibria with fraud. Sülzle and Wambach (2005) investigate a credence goods market where prices are exogenous and customers are co-insured. They highlight that an increase in the co-insurance rate has ambiguous effects on equilibrium fraud and search. 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. More precisely, when the conditions of homogeneous customers, commitment to treatment by experts as well as customers once a diagnosis was performed and verifiability of treatment by customers or liability of experts for inappropriate treatments are satisfied, experts post prices that induce honest behavior.

Marty (1999) studies a credence goods market with fixed prices and two types of experts. The opportunistic type is a pure (monetary) profit-maximizer and might defraud customers while the second type is always honest to the customers. Marty illustrates that an opportunistic expert could be prevented from always defrauding by the customers' rejection strategy and the honest treatments of the other experts. In our model, the fair experts are not necessarily honest and an expert does not know whether a customer 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 the fair experts may have incentives to defraud as well.

This relates our article to Liu (2011), who analyzes a credence goods market with selfish experts, who are pure (monetary) profit-maximizers, and conscientious experts, who care about their own profits and a customer's well-being. Therefore, the conscientious experts 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. Thus, in our set-up no equilibria can occur where the customers can recognize the type of experts by the posted price vector, which is contrary to Liu's model. Waibel (2017) investigates a model with fixed prices where experts face conscience costs when defrauding customers and customers bear trust costs when they fear to be defrauded. He illustrates that an increase in the experts' conscience costs always results in less customer search with respect to second opinions and might increase the level of fraud. One major contrast to our model is that Waibel assumes the experts to be homogeneous, while in our framework the experts are heterogeneous. Note that we also discuss a setting where a fraction of experts suffers from a guilty conscience when defrauding customers instead of gaining an additionally utility when being honest.

Our main results can be summarized as follows. When the fraud level is already maximized and the patients' search rate already minimized (and hence welfare is maximized) in a 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 fraction of physicians. Additionally, even when the search is not minimized and fraud is not maximized, we observe no impact on the fraud or the search level when implementing only a small share of fair physicians. In this setting, however, the search rate is always lowered if we introduce a sufficiently large share of fair physicians. This share can be medium or large depending on the initial search (and fraud) rate. Moreover, when the heterogeneity induces no changes regarding the search and fraud level, social welfare is, nevertheless, always increased given fraud was not maximized and search not minimized. This is due to the physician surplus being raised by adding the fairness utility.

The impact of heterogeneity on the equilibrium fraud level is ambiguous. Different factors such as the imposed share of fair physicians, the size of the fairness utility, the search rate and the initial fraud level decisively influence whether and how the fraud level changes. If we incorporate a large share of fair physicians with a fairness utility of medium size, the equilibrium with maximum welfare and maximum fraud becomes the unique equilibrium. In addition, we find that the fair physicians have stronger fraud incentives with a guilty conscience than with a good conscience.

The rest of the paper is organized as follows. Section 3.2 introduces the model. In Section 3.3, we perform the analysis and examine the equilibria. Section 3.4 discusses the guilty conscience setting. Section 3.5 concludes.

3.2 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. It is a common knowledge that a patient either

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

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. It is common knowledge that 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 in any case. 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 recommendation, he has to pay for the accepted treatment and always receives the needed treatment. However, the patient can neither verify nor observe which type of treatment he ultimately receives, because of 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. A fair physician gains a non-monetary utility $\alpha_F > 0$, which we denote as *fairness utility*, from treating a patient with a small problem honestly. An opportunistic physician O only cares about monetary incentives and therefore receives non-monetary utility of zero, i.e. $\alpha_O = 0$, when diagnosing an S-patient honestly. Finally, a physician of type 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 $1-x_i$.

Treating a patient is costly for a physician. Treating a patient with a small problem induces costs of $c_S > 0$ for a physician and treating a patient with a major problem costs 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 given by $p_M = c_M$ and the price for a small treatment by $p_S = c_S + e$, where $e > 0$ is a physician's monetary mark-up for treating a patient with a small problem honestly. We assume that $p_M > p_S$. Note that as patients always receive the needed treatment, there is no under- or overtreatment. Undertreatment is ruled out since we consider a physician to be liable for risking her patient's health. Thus, M-patients are always treated correctly. There is no overtreatment because overcharging dominates overtreating here as successfully overtreating an S-patient would generate a payoff of $p_M - c_M = 0$ for a physician.

The patients know that they might be overcharged. Hence, they might reject a treatment recommendation. The patients are also aware that only overcharging is an option. Therefore, they always accept an S-treatment recommendation but may reject an M-treatment recommendation. We assume that a patient can only decline an M-treatment recommendation on his first visit.[2] On a first visit, a patient accepts an M-treatment with probability $y \in [0,1]$ and rejects it with probability $1-y$. On a second visit, a patient accepts any diagnosis by assumption. However, we suppose that a physician cannot observe whether it is a patient's first or second visit. 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 patient's 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 an opinion from a second physician might be beneficial for a patient.

The payoff π_i a physician gains per patient is the (absolute) difference between the agreed treatment price and the actual treatment costs. A physician 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 $p_S - c_S + \alpha_i = e + \alpha_i$. The *fraud payoff* for (successfully) 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 $p_M - c_M = 0$.

We next solve the patients' and the physicians' optimization problems in order 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. This means that all patients play the same acceptance strategy y and all physicians of the same type play the same recommendation policy x_i. Consequently, all opportunistic physicians choose the same strategy x_O and all fair physicians choose the same strategy x_F in an equilibrium.

3.3 Analysis

3.3.1 Patient Decision

A patient maximizes his expected utility by minimizing his expected treatment costs.[3] 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. Since the patients cannot observe a physician's type, they choose their best strategy for a given X. Finally, the patients' symmetric best response correspondence is described by the following lemma:

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

[3] 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.

Lemma 3.1. *For a given $X \in [0,1]$, the patients' symmetric best response correspondence is given as*

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

where

$$X_{1,2} = \frac{1}{2}\left(1 - \frac{k}{p_M - p_S}\right) \pm \sqrt{\frac{1}{4}\left(1 - \frac{k}{p_M - p_S}\right)^2 - \frac{\phi}{1-\phi}\frac{k}{p_M - p_S}}. \tag{3.1}$$

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

According to Lemma 3.1, 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, there is a good chance that the first diagnosis is fraudulent and that the second diagnosis is honest.

3.3.2 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 response correspondences of both types of physicians.[4] We 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.[5]

An individual physician of type i maximizes her expected payoff when facing a patient with a small problem by choosing her optimal recommendation policy x_i. Remember that she earns a zero payoff when treating an M-patient. 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 payoff

$$\pi_i = (1 - x_i)(e + \alpha_i) + x_i \frac{y + X(1-y)}{1 + X(1-y)}(p_M - c_S). \tag{3.2}$$

When a physician faces a patient with a small problem, she is honest with probability $1 - x_i$ but she is dishonest with probability x_i. She receives the payoff $e + \alpha_i$ in any

[4]We depict the physicians' best response correspondence following Sülzle and Wambach (2005).

[5]See Appendix 3.6.1 for further explanation regarding the assumption.

case if she diagnoses honestly. 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 takes into account that a share $\frac{X(1-y)}{1+X(1-y)}$ of S-patients is already on its second visit and accepts any treatment recommendation.

By Equation 3.2, 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, if

$$e + \alpha_i < (>) \frac{y + X(1-y)}{1 + X(1-y)}(p_M - c_S). \tag{3.3}$$

Given the payoffs are equal, a physician is simply indifferent between cheating and being honest. Lemma 3.2 summarizes our findings concerning a physician's fraud incentives.

Lemma 3.2. *Let (X, y) be given. Then, a physician's individual best response reads*

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

By Lemma 3.2, the following holds because of $\alpha_F > \alpha_O$. First, when the fair physicians cheat or are indifferent, the opportunistic physicians always defraud. Second, when the opportunistic physicians are honest or indifferent, the fair physicians are always honest. This is because the fair physicians have weaker fraud incentives than the opportunistic physicians: a fair physician cheats only when the monetary mark-up of being honest, e, is smaller than $\frac{y+X(1-y)}{1+X(1-y)}(p_M - c_S) - \alpha_F$, whereas an opportunistic physician might defraud for $e > \frac{y+X(1-y)}{1+X(1-y)}(p_M - c_S) - \alpha_F$.

It must hold in a symmetric equilibrium that a physician's individual cheating strategy of one type i, x_i, corresponds to the other physicians' cheating strategy 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.

Opportunistic Physicians

Lemma 3.3 provides the opportunistic physicians' symmetric best response correspondence for a given fair physicians' level of fraud, X_F, and a given patients' acceptance rate, y. The lemma describes how the best response depends on the share of opportunistic physicians in the market, δ, and consequently on the share of fair physicians in the market, $1 - \delta$.

Lemma 3.3. *For 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*

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

For a small or medium share δ, *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*

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

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 3.6.1. □

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 3.3 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, y, is larger than $\frac{e}{p_M-c_S} =: \overline{y}_O$, then there is a high probability for an opportunistic physician to successfully defraud a patient with a small problem. Hence, an opportunistic physician also always defrauds for $y \geq \overline{y}_O$.

In what follows, we provide intuitions only for the cases of Lemma 3.3, in which all fair physicians treat honestly (i.e. $X_F = 0$, see Figure 3.1) and where we have a patients' acceptance rate (at least) below $\overline{y}_O$. Assume first that there is a large share of opportunistic physicians (Figure 3.1a) and that $y \leq \overline{y}_O$. In this situation, we must look at the other opportunistic physicians' defrauding behavior in order to determine an individual opportunistic physician's best response. 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 relatively high probability, due to the low to medium y. Therefore, being honest is more profitable than cheating for an individual opportunistic physician. In contrast, if all other opportunistic physicians defraud, there are many patients with small problems on their second visit and on a second visit, a patient accepts any treatment recommendation. As a consequence, it is an 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 (the indifference region is depicted by the black bold solid line in Figure 3.1a).

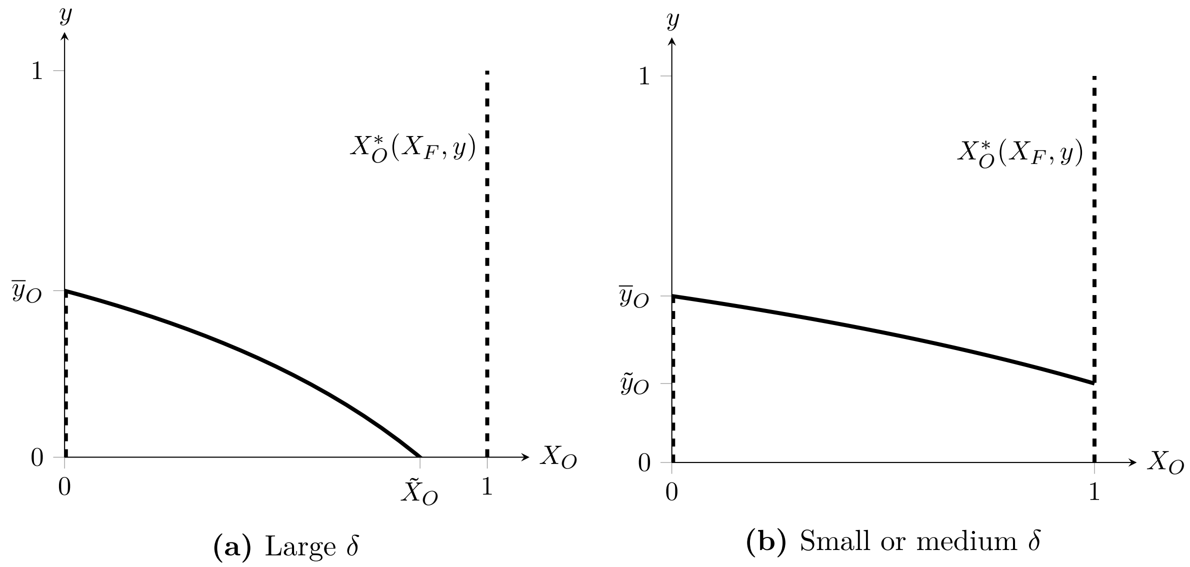


Figure 3.1: Opportunistic physicians' symmetric best response correspondence given $X_F = 0$ and different δ. Note that $\tilde{X}_O := \frac{e}{\delta(p_M - c_S - e)}$.

Consider further $X_F = 0$ but a small or medium fraction of opportunistic physicians (Figure 3.1b). In this scenario, cheating is an option for an opportunistic physician only at a rather medium acceptance rate, i.e. $y \in [\tilde{y}_O, \overline{y}_O]$, 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 then there are several honest fair physicians in the market and thus too many patients with small problems on their first visit. Consequently, at a low acceptance rate, i.e. $y \leq \tilde{y}_O$, treating honestly is always more beneficial for an opportunistic physician. Now imagine that $y \in [\tilde{y}_O, \overline{y}_O]$. Analogous to the case with a large share of opportunistic physicians, it is an individual opportunistic physician's best strategy to cheat (treat honestly) in this case when all other opportunistic physicians cheat (treat honestly). The reason for the difference in the physician's defrauding behavior is again how the other opportunistic physicians' defrauding behavior affects the amount of patients on a second visit. In this setting, there is for $y \in [\tilde{y}_O, \overline{y}_O]$ a region where the opportunistic physicians are indifferent (displayed by the black bold solid line in Figure 3.1b).

Fair Physicians

Lemma 3.4 depicts how the fair physicians' symmetric best response correspondence for a given opportunistic physicians' fraud level, X_O, and a given patients' acceptance rate, y, depends on the fairness utility, α_F, and on the share of opportunistic physicians, δ.

Lemma 3.4. *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*

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

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

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

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*

$$X_F^*(X_O,y) \in \begin{cases} \{1\} & \text{if } X_O \in \{1\} \text{ and } y \in [\tilde{y}_F,1], \\ \{0\} & \text{else.} \end{cases}$$

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

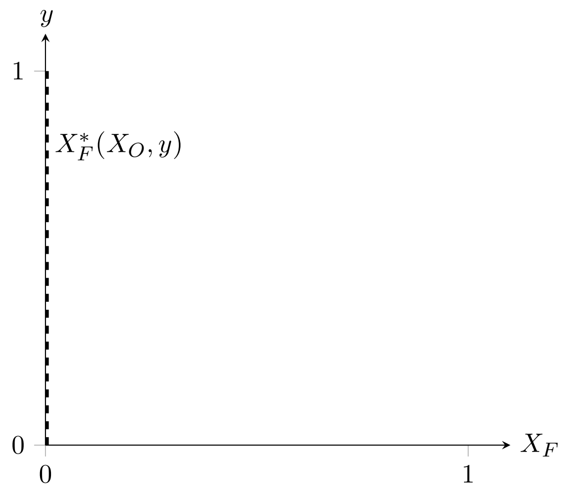
$$X_F^*(X_O,y) \in \{0\},$$

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

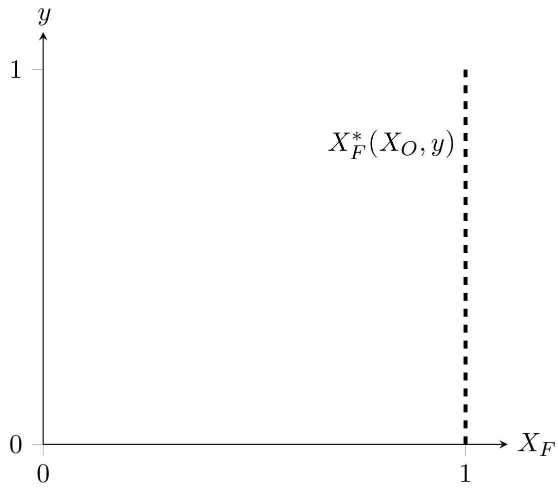
Proof. See Appendix 3.6.2. □

As explained above, when the opportunistic physicians treat honestly or are indifferent, a fair physician always treats honestly. According to Lemma 3.4, when the physicians' fairness utility is large (Figure 3.2a), it is also always a fair physician's best response to be honest. This is because when the fairness utility is large, a fair physician's honest payoff is greater than her fraud payoff. However, with a small or medium fairness utility, her honest payoff is smaller than her fraud payoff. In the following, we provide the intuition only for the cases of Lemma 3.4, where the opportunistic physicians cheat (i.e. $X_O = 1$) and where the fairness utility is small or medium (Figures 3.2b and 3.2c).

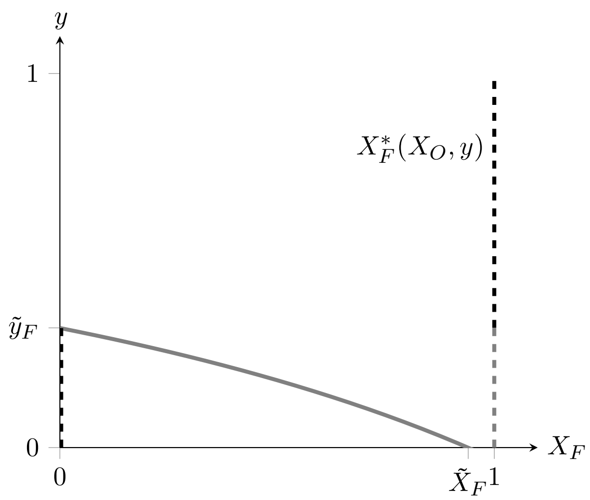
We find that when the fairness utility is small or medium and the patients' acceptance rate, y, is greater than $\frac{e+\alpha_F-\delta(p_M-c_S-e-\alpha_F)}{p_M-c_S-\delta(p_M-c_S-e-\alpha_F)} =: \tilde{y}_F$, it is always an individual fair physician's best strategy to defraud patients with small problems. 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 a *huge share of opportunistic physicians* in the market, i.e. $\delta > \frac{e+\alpha_F}{p_M-c_S-e-\alpha_F}$ (Figure 3.2b), 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 situation.



(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 3.2: 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 3.2c) and a small fairness utility (i.e. the best response correspondence includes the gray lines in Figure 3.2c), an individual fair physician's best response is determined by the other fair physicians' behavior for $y \leq \tilde{y}_F$. In this setting, a fair physician cheats when all other fair physicians cheat. As then all 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 scenario, there are several S-patients on their first visit and they are likely to reject a fraudulent diagnosis, due to the relatively low y. In addition, for the low y exists a region where all fair physicians are indifferent (depicted by the gray bold solid line in Figure 3.2c). 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 3.2c). In that situation, 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, i.e. if $y \leq \tilde{y}_F$.

3.3.3 Equilibrium Analysis

We next investigate which types of equilibria can occur in our model. Subsequently, we compare the equilibrium results to a homogenous benchmark case with only opportunistic physicians ($\delta = 1$) to investigate the effect of the heterogeneity in fairness concerns on the physicians' fraud level, the patients' search rate and overvall welfare.[6] 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 X^* (Figure 3.3). 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^*. Overall, five physicians' joint best responses can be mutually compatible as stated by

Corollary 3.1. *Depending on the acceptance strategy, y, the market level of fraud, X, the fairness utility, α_F, and the distribution of fair and opportunistic physicians, 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 their patients honestly and the opportunistic physicians randomize between honest and fraudulent diagnoses for patients with small problems.*
3. *The fair physicians treat their patients honestly and the opportunistic physicians defraud patients with small problems.*
4. *The fair physicians randomize between honest and fraudulent diagnoses and the opportunistic physicians defraud patients with small problems.*
5. *Both types of physicians defraud patients with small problems.*

Corollary 3.1 follows directly from Lemma 3.3 and Lemma 3.4. The share of opportunistic and consequently fair physicians as well as the strength of the fairness concerns can affect the nature of the joint best response correspondence. If $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, cases 3 and 4 of Corollary 3.1 do not arise as part of the joint best response correspondence. The case of honest fair physicians and cheating opportunistic physicians can be a joint best response only for $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, but regardless of the size of the fairness utility. Furthermore, it is possible that the fair physicians are indifferent while the opportunistic physicians cheat

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

only for a small fairness utility (such that the joint best response correspondence includes the gray lines in Figure 3.3 and Figures 3.4b - 3.4d)[7] and $\delta < \frac{e+\alpha_F}{p_M-c_S-e-\alpha_F}$. In addition, when the fairness utility is large, we always have a joint best response correspondence where the fair physicians are honest in any case.

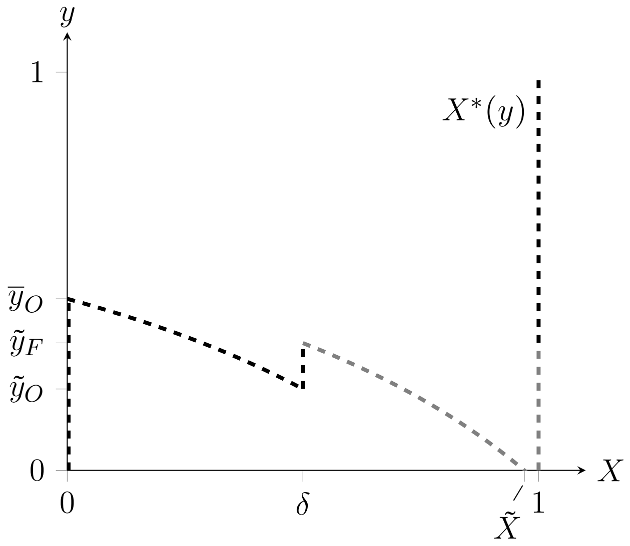


Figure 3.3: Physicians' joint best response correspondence given a small or medium δ and a small or medium α_F. Note that $\tilde{X} := \frac{e+\alpha_F}{p_M-c_S-e-\alpha_F}$.

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 situations with a small or a medium fairness utility, but display the settings with a large fairness utility and therefore solely honest fair physicians in Appendix 3.6.4.
Lemma 3.5 characterizes the conditions under which the mutual compatibility of a physicians' joint best response is derived.

Lemma 3.5. *A mutually compatible physicians' 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 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 3.6.3. □

Thereby, the mutual compatibility is determined by the best response either of a fair type or of an opportunistic type for $X \neq \delta$, due to the differences in fraud incentives. It is determined by the best response of both types when $X = \delta$.

[7] Note that the case depicted in 3.4a can only occur with a small fairness utility.

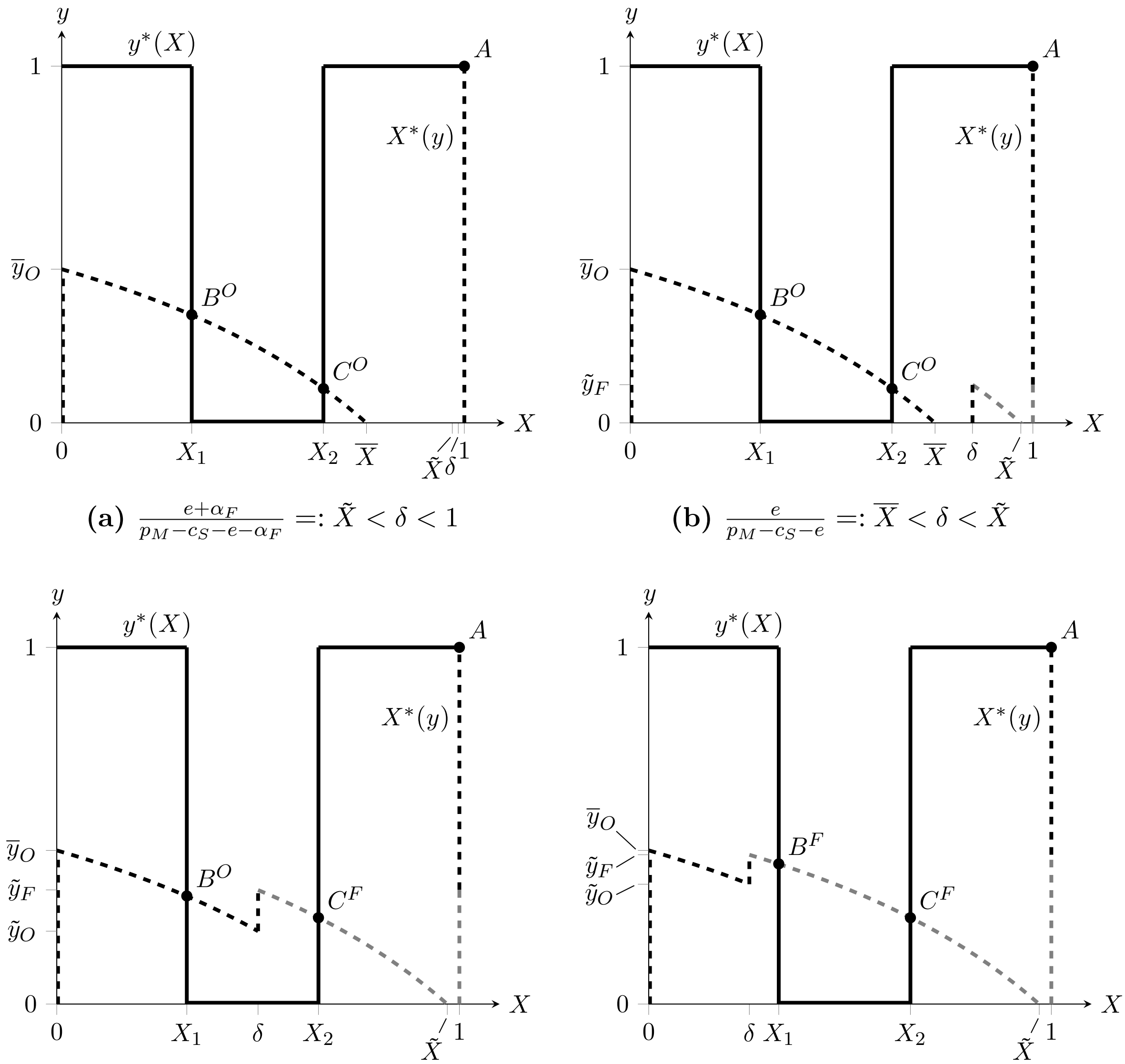
[8] Sülzle and Wambach (2005) discuss three equilibrium settings. However, two more settings are possible, where in each setting a continuum of equilibria arises (see Figure 3.7).

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 3.4) for different distributions of fair and opportunistic physicians in the market (see Figures 3.4a - 3.4d). We compare these equilibrium settings to the homogeneous benchmark case. We focus in the following analysis on how the physicians' heterogeneity in fairness concerns affects the physicians' equilibrium level of fraud, X^*, and the optimal patients' search/acceptance rate, y^*.[9] Proposition 3.1 summarizes our results.

Proposition 3.1. *If the homogeneous reference market is in a pure-strategy equilibrium, denoted A, where all physicians always defraud and no patient searches for a second opinion, then introducing a small or medium fairness utility for a share of physicians neither affects the physicians' level of fraud X^* nor the patients' acceptance rate y^*.*
If the homogeneous 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 or medium fairness utility for a share of physicians has ambiguous effects on the physicians' level of fraud and the patients' acceptance rate.

The sum of physician and patient surplus constitute the social welfare. In our framework, the demand is inelastic as every patient receives a (sufficient) treatment on his first or second visit. Therefore, welfare is maximized when the accumulated patients' search costs are minimized. This is the case when no patient looks for a second opinion ($y = 1$) since then every patient only bears k in total as search costs. Consequently, in the pure-strategy equilibrium A welfare is maximized because each patient visits only one physician. Nevertheless, fraud is at its maximum as well in A. According to Proposition 3.1, equilibrium A is not influenced concerning market outcomes by introducing a small or medium fairness utility for a fraction of physicians (compare Figure 3.4). 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 always gained in A when a physician cheats. Hence, for every physician it is the best strategy to cheat and, in turn, 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 or F) corresponds to the type of physician whose best response determines whether the joint best response in an equilibrium is mutually compatible.
First look at the case where a very small share of physicians has a fairness utility and thus a huge share of physicians is opportunistic, i.e. $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$ (Figure 3.4a), which implies a small fairness utility. Then the equilibrium outcomes in terms of the search rate and the fraud level remain the same as in the homogeneous market. This is

[9] Be aware that we only consider local changes regarding the impact of heterogeneity on equilibria.



(a) $\frac{e+\alpha_F}{p_M-c_S-e-\alpha_F} =: \tilde{X} < \delta < 1$

(b) $\frac{e}{p_M-c_S-e} =: \overline{X} < \delta < \tilde{X}$

(c) $X_1 < \delta < X_2$

(d) $0 < \delta < X_1$

Figure 3.4: Equilibrium settings with different distributions of fair and opportunistic physicians

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. This means that 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 $\frac{e+\alpha_F}{p_M-c_S-e-\alpha_F} > \delta > \frac{e}{p_M-c_S-e}$ (Figure 3.4b), which implies $\delta > X_2$, we again find no changes regarding the patients' acceptance rate and the physicians' fraud level. This observation holds independent of the fairness utility being small or medium and for the same intuition as for $\delta > \frac{e+\alpha_F}{p_M-c_S-e-\alpha_F}$. Yet, the welfare is raised in any equilibrium by imposing a fairness utility because of an increase in the aggregate physician surplus due to an increase in the honest payoff for a fraction of physicians. Note that we always find this kind of rise in welfare when there are no

other changes regarding X^* and y^* in the mixed-strategy equilibria.
Next presume that in the heterogeneous market there is a balanced share of fair and opportunistic physicians such that $X_1 < \delta < X_2$ (Figure 3.4c). If 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 in this setting. Additionally, even at the somewhat greater acceptance rate 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. Equilibrium B^O exists as in the previous cases. This is because at the rather medium search rate in B^O, cheating can still be profitable for an opportunistic physician.
In conclusion, introducing a medium share of fair physicians can result in changes concerning search and fraud only when the homogeneous market is in equilibrium C. When C is the initial equilibrium and small fairness concerns for a medium share of physicians 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 increased in comparison to C but the level of fraud can be lowered or increased, depending on the new equilibrium (B^F or A). This means that even introducing fairness concerns for a medium share of physicians has no effect on the level of fraud X^* when the concerns are small, regardless of the original equilibrium. Additionally, implementing fair physicians that have weaker fraud incentives than the opportunistic physicians might actually raise, in fact maximize, the physicians' fraud level.
Last, consider the setting with a relatively large share of fair physicians such that $1 - \delta > 1 - X_1$ and thus $\delta < X_1$ (Figure 3.4d).[10] In that 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 medium acceptance rate in this scenario. In case the fairness utility is medium, the only remaining market equilibrium is A. To sum up, when the benchmark market is in equilibrium B or C, introducing a small fairness utility for a large share of physician leads to B^F or C^F, respectively, becoming the new equilibrium.

[10] The equilibrium setting with solely fair physicians ($\delta = 0$) would be the same as the equilibrium setting with $\delta < X_1$.

This means that the patients' search level is lowered by the introduction of heterogeneity but the fraud level remains unchanged. However, imposing fairness concerns of a medium degree for a large share of physicians always maximizes social welfare but also the fraud level, irrespective of B or C being the initial equilibrium.[11]

3.4 Discussion: Guilty Conscience

In our model above, we assume the physicians to derive an additional benefit from being fair. This benefit can be regarded as a good conscience for acting appropriately. One might argue that social norms like the Oath of Hippocrates or the Charter on Medical Professionalism aim at giving physicians a guilty conscience when acting inappropriately. To consider this aspect, we incorporate the fairness utility α_F^{GC}, where the superscript GC stands for the guilty conscience case, as a loss for a fair physician when defrauding a patient. We compare this case to the good conscience case above. A fair physician's expected payoff when having a guilty conscience is given as

$$\pi_F^{GC} = (1 - x_F)e + x_F \frac{y + X(1-y)}{1 + X(1-y)}(p_M - c_S - \alpha_F^{GC}). \tag{3.4}$$

We derive the physicians' joint best response correspondence for the guilty conscience case and depict the equilibrium setting for this case graphically in Figure 3.5 with $\alpha_F^{GC} = \alpha_F$ for $\delta < \tilde{X}$. The bold solid and dotted red lines display the physicians' best response in Figure 3.5. For $\delta > \tilde{X}$, no changes occur in comparison to the joint best response with the good conscience types. For a better comparison, we additionally display the physicians' joint best response correspondence of the good conscience case in the figure.[12] The red dotted lines arise as part of the best response only if $\alpha_F^{GC} < p_M - c_S - e(2-y)$, which we consider the small fairness utility in this setting. The medium fairness utility is given by $p_M - c_S - e > \alpha_F^{GC} > p_M - c_S - e(2-y)$ and the large fairness utility by $\alpha_F^{GC} > p_M - c_S - e$.

The following comparison implies $X_O = 1$ since given the opportunistic physicians treat honestly or randomize, any fair physician is honest regardless of being a good or guilty conscience type. The fair physicians with a guilty conscience always cheat for $y > \frac{e - \delta(p_M - c_S - e - \alpha_F^{GC})}{p_M - c_S - \alpha_F^{GC} - \delta(p_M - c_S - e - \alpha_F^{GC})} =: \tilde{y}^{GC}$. Thereby, they always cheat at a lower patients' acceptance rate than the good conscience types, who always cheat only for $y > \tilde{y}_F$, where $\tilde{y}_F > \tilde{y}^{GC}$. In addition, the indifference fraud level is smaller for the guilty conscience types than for the good conscience types so that $\tilde{X}^{GC} < \tilde{X}$. Hence, in the region $X \in [\tilde{X}^{GC}, \tilde{X}]$, where a good conscience type may be indifferent, a guilty

[11] Further equilibrium cases, in which we observe continua of equilibria, can be found in Appendix 3.6.4.

[12] It is portrayed by the dashed lines (grey and black) for $X \geq \delta$. For $X < \delta$, the joint best responses of both cases (guilty and good conscience) coincide.

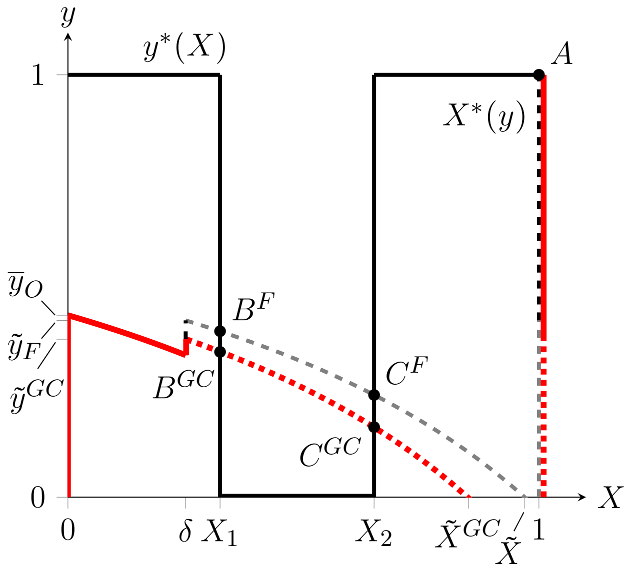


Figure 3.5: Equilibrium setting for $\delta < X_1$ and a small or medium guilty conscience fairness utility α_F^{GC}. Notice that $\tilde{X}^{GC} := \frac{e}{p_M - c_S - e - \alpha_F^{GC}}$.

conscience type would overcharge in any case. Furthermore, a guilty conscience type treats honestly with certainty given $y < \tilde{y}^{GC}$ only if $\alpha_F^{GC} > p_M - c_S - e(2-y)$, where $p_M - c_S - e(2-y) > \frac{p_M - c_S}{2-y} - e$ for $y < 1$. This means that the guilty conscience physicians might cheat for $\alpha_F^{GC} \in (\frac{p_M - c_S}{2-y} - e, p_M - c_S - e(2-y))$, whereas the good conscience physicians are always honest when $\alpha_F \in (\frac{p_M - c_S}{2-y} - e, p_M - c_S - e(2-y))$ for a sufficiently small y. Moreover, when $y = 1$, both types would defraud patients when the respective fairness utility is smaller than $p_M - c_S - e$.

Our findings indicate that a guilty conscience fair physician has ceteris paribus stronger 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 raises the honest payoff which is received in any case when being honest. The guilty conscience fairness utility reduces the fraud payoff which might be rejected anyway if $y < 1$. Additionally, the equilibria B^{GC} and C^{GC} generate larger patients' search costs than B^F and C^F, respectively. Furthermore, the equilibrium A is less efficient in terms of welfare with a guilty conscience than with a good conscience, even though the search rate is the same in the A of both cases. The reason for this is that the fairness utility reduces the fraud payoff in the guilty conscience setting, which is received by all physicians in A, whereas it does not affect the fraud payoff in the good conscience scenario. To conclude, our observations illustrate that generating a good conscience could be more effective in weakening fraud incentives for physicians and in creating more efficient equilibrium outcomes than creating a guilty conscience.

3.5 Conclusion

We theoretically study how heterogeneity among physicians regarding their concerns for fairness affects the patients' search for second opinions, the level of fraud and social welfare in a credence goods market with regulated prices. We consider a heterogeneous market where a fraction of physicians is opportunistic and the complementary fraction is fair. The opportunistic physicians only care about 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. The 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.

Intuitively, one could expect the amount of fraud to decrease by inserting fairness concerns for a share of physicians, since a fairness utility may lower a physician's rationale to cheat. As a consequence, one could additionally expect the search rate to decrease because with physicians being more honest, fewer patients would have to look for a second opinion. However, we observe sometimes counterintuitive effects in our model. The final effects depend on the degree of the fairness concerns, the distribution of fair and opportunistic physicians, the initial search rate and the initial fraud level.

Given the homogeneous market is an equilibrium state with maximum fraud and no patient search, only introducing a large fairness utility (which eliminates all fraud incentives for fair physicians) can lead to changes in the search rate rate or the level of fraud. Obviously, the fraud level decreases but the search rate may actually increase. Finally, with a large fairness utility, we generate the same heterogenous equilibrium settings as Sülzle and Wambach (2005). If we start in a an equilibrium, where fraud is not maximized and search is not minimized, introducing a fairness utility always raises welfare but in some cases only because the physician surplus is raised by adding the fairness utility.

When the homogeneous market is in equilibrium with a relatively high level of fraud and a relatively high search rate, inserting a fairness utility for a share of physicians influences the search rate or the fraud level only if it is introduced for at least a medium share of physicians. Then, the search level always decreases but the impact on fraud depends on the size of the fairness utility and on the ultimate share of imposed fair physicians. Starting in a homogeneous equilibrium with a relatively low level of fraud and a medium search level, equilibrium outcomes are only affected by incorporating a fairness utility for a large share of physicians. Again, the search rate is always lowered and the influence on the fraud level depends on the kind of physicians' heterogeneity. In either case, introducing a fairness utility may raise the social welfare but also the level of fraud to the maximum despite the fair physicians having weaker fraud incentives than the opportunistic ones, which is in clear contrast to intuition.

We derive the implication from our findings that social norms like the Oath of Hippocrates or the Charter on Medical Professionalism, that have the goal to raise the awareness of physicians, may not necessarily improve market efficiency. Especially not if they affect only a few physicians or if their impact is not very strong. One might argue that such social norms aim at creating a guilty conscience for physicians when acting unfairly. For that reason, we additionally discuss a case where the fair physicians develop a guilty conscience when cheating. In this situation, a fair physician's fraud payoff is reduced by the fairness utility. We find that the guilty conscience physicians have stronger fraud incentives than the good conscience physicians. Furthermore, the equilibrium outcomes are mostly more efficient regarding welfare in the good conscience case. Hence, generating a good conscience might be more effective in weakening fraud incentives and improving market efficiency in a (health care) credence goods market than creating a guilty conscience.

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3.6 Appendix

3.6.1 Proof of Lemma 3.3

Sülzle and Wambach (2005) find that there are no fraud incentives for (opportunistic) physicians when $e \geq \frac{p_M - c_S}{2-y}$ and $y \leq \frac{e}{p_M - c_S}$ hold. We analyze the effect of the physicians' heterogeneity and the degree of the fairness utility, not of the monetary mark-up e, on market outcomes. Additionally, we study all possible settings with fraud. Therefore, we impose the assumption $e < \frac{p_M - c_S}{2-y}$ in our model.
According to the physician's individual best response in Lemma 3.2, an opportunistic physician has stronger fraud incentives than a fair physician. Thus, if the fair physicians always ($X_F = 1$) or sometimes ($X_F \in (0, 1)$) defraud patients with a small problem, an opportunistic physician will always cheat. Hence, in the following, we only analyze the situation where all fair physicians are honest ($X_F = 0$) to derive the opportunistic physi-

cians' symmetric best response. The opportunistic physicians' symmetric best response is derived from the individual best response of an opportunistic physician. This means that we consider $\alpha_O = 0$.

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

1. $y = 1$. All patients always accept an M-diagnosis on their first visit. Setting $y = 1$ in (3.3) and rearranging leads to

$$e < p_M - c_S. \tag{3.5}$$

   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 (3.3) and rearranging yields

$$e \left\{ \begin{array}{c} > \\ = \\ < \end{array} \right\} \frac{\delta X_O}{1 + \delta X_O}(p_M - c_S). \tag{3.6}$$

   An individual opportunistic physician's best response depends on the other opportunistic physicians' defrauding behavior. 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 $X_O = 0$ in (3.6) shows that an opportunistic physician is always honest given all other opportunistic physicians are honest if and only if

$$e > 0. \tag{3.7}$$

   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 any other 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 small problems. By substituting $X_O = 1$ into (3.6) and rearranging, we derive that an individual opportunistic physician defrauds patients with small problems as well if and only if

$$\delta > \frac{e}{p_M - c_S - e}. \tag{3.8}$$

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 such that she plays $x_O = 1$. When $\delta > \frac{e}{p_M - c_S - e}$ (notice that $p_M > c_S + e = p_S$), there are many patients with small problems on their second visit and, consequently, they would 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 larger 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. A symmetric best response requires that an individual opportunistic physician O randomizes as well. Rearranging (3.6) with an equal sign and solving for X_O illustrates that an individual opportunistic physician is indifferent too if and only if

$$X_O = \frac{e}{\delta(p_M - c_S - e)} =: \tilde{X}_O. \tag{3.9}$$

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 $\delta < \frac{e}{p_M - c_S - e}$, we have $X_O < 1 < \tilde{X}_O$. Then, an opportunistic physician would deviate and diagnose honestly for the same reason 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 (3.3) with an equal sign generates

$$y(p_M - c_S) + \delta X_O(1 - y)(p_M - c_S - e) - e = 0. \tag{3.10}$$

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 (3.10) with an inequality sign shows that an opportunistic physician is honest too if and only if

$$y < \frac{e}{p_M - c_S} =: \overline{y}_O. \tag{3.11}$$

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

(b) $X_O = 1$. It follows from (3.10) with $X_O = 1$ that if all other opportunistic physicians cheat, an individual opportunistic physician cheats too if and only if

$$y(p_M - c_S) + \delta(1-y)(p_M - c_S - e) - e > 0. \tag{3.12}$$

This condition is satisfied if $\delta > \frac{e-y(p_M-c_S)}{(1-y)(p_M-c_S-e)}$ holds. Imagine in the following $\frac{e-y_2(p_M-c_S)}{(1-y_2)(p_M-c_S-e)} \leq \delta \leq \frac{e-y_1(p_M-c_S)}{(1-y_1)(p_M-c_S-e)}$, 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 (3.12) is fulfilled. By contrast, for all values of y_1, condition (3.12) is not met and thus an opportunistic physician deviates and is honest due to the small acceptance rate. Note 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 $\delta > 0$. Hence, 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 too if and only if

$$X_O(y) = \frac{e - y(p_M - c_S)}{\delta(1-y)(p_M - c_S - e)} =: \tilde{X}_O(y). \tag{3.13}$$

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 defraud S-patients but for $X_O(y) < \tilde{X}_O(y)$, she diagnoses honestly in any case. Additionally, differentiation with respect to y illustrates that

$$\frac{d\tilde{X}_O(y)}{dy} = -\frac{1}{\delta(1-y)^2} < 0. \tag{3.14}$$

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 $y = \overline{y}_O$. It follows that for any acceptance strategy $y > \overline{y}_O$, it holds that $X_O(y) > 0 > \tilde{X}_O(y)$. Therefore, an opportunistic physician strictly prefers to defraud for $y > \overline{y}_O$, as already observed above. That is, for $\delta > \frac{e-y(p_M-c_S)}{\delta(1-y)(p_M-c_S-e)}$ and $y < \overline{y}_O$, a mixed strategy $X_O \in (0,1)$ can be a symmetric best response.

Consider now $\frac{e-y_2(p_M-c_S)}{(1-y_2)(p_M-c_S-e)} \leq \delta \leq \frac{e-y_1(p_M-c_S)}{(1-y_1)(p_M-c_S-e)}$. For this case, we observe that $X_O(y_1) < 1 < \tilde{X}_O(y_1)$. Consequently, for all values of y_1, an opportunistic physician deviates and treats honestly. However, we have $\tilde{X}_O(y_2) < 1$. Hence, 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 $\overline{y}_O$, the strategy $X_O \in (0,1)$ is a candidate for a symmetric best response given a small or medium δ.

3.6.2 Proof of Lemma 3.4

By the physician's individual best response in Lemma 3.2, the fair physicians have weaker fraud incentives than the opportunistic physicians. Therefore, the fair physicians will always treat patients with small problems honestly when the opportunistic physicians treat honestly ($X_O = 0$) or randomize ($X_O \in (0, 1)$). For that reason, in what follows we only analyze the case in which all opportunistic physicians cheat in any case ($X_O = 1$) in order 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, which means that we consider $a_F > 0$.

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 (3.3) illustrates that a fair physician defrauds any patient with a small problem if and only if

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

   This means that a fair physician cheats, i.e. plays $x_F = 1$, only when her fairness utility is sufficiently small even when no patient looks for a second opinion and all opportunistic physicians cheat. If $\alpha_F > p_M - c_S - e$, the certain honest payoff is greater than the fraud payoff and hence 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 smaller than the fraud payoff 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 (3.3) and rearranging yields

$$e \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} \frac{(1-\delta)X_F + \delta}{1 + (1-\delta)X_F + \delta}(p_M - c_S) - \alpha_F. \tag{3.15}$$

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

   (a) $X_F = 0$. All other fair physicians always treat all patients honestly. It follows from rearranging (3.15) and considering $X_F = 0$ that an individual fair physician is always honest as well if and only if

$$\delta < \frac{e + \alpha_F}{p_M - c_S - e - \alpha_F}. \tag{3.16}$$

Consequently, when $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, a fair physician deviates and cheats. Notice that $\frac{e+\alpha_F}{p_M - c_S - e - \alpha_F} > 0$ since $\alpha_F < p_M - c_S - e$ 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 $y = 0$). Hence, only when $\alpha_F < \frac{p_M - c_S}{2} - e$, can it hold that $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$. Given a small fairness utility and that there are many cheating opportunistic physicians in the market such that $\delta > \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, it is an individual fair physician's best strategy to defraud. In that case, there are many patients on their second visit so that a fair physician prefers to cheat if her fairness utility is small.

However, given a small fairness utility and $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, there are too few patients with small problems on their second visit and, consequently, a fair physician prefers to treat honestly. Given a medium fairness utility, i.e. $p_M - c_S - e > \alpha_F > \frac{p_M - c_S}{2} - e$ (considering $y = 0$), condition (3.16) is satisfied with certainty since then $\delta < 1 < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$. This means that if a physician has a medium fairness utility, she always recommends honestly to patients with small problems when $y = 0$.

(b) $X_F = 1$. All other fair physicians always overcharge patients with small problems. We substitute $X_F = 1$ into (3.15) and rearrange. We find that an individual fair physician defrauds patients with small problems as well if and only if

$$\alpha_F < \frac{p_M - c_S}{2} - e. \tag{3.17}$$

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. When $p_M - c_S - e > \alpha_F > \frac{p_M - c_S}{2} - e$, the certain honest payoff is increased so much by the fairness utility that a fair physician is always honest even if all other physicians overcharge.

(c) $X_F \in (0, 1)$. All other fair physicians randomize between defrauding 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 (3.15) with an equal sign and solving for X_F that a single fair physician randomizes too between honest and fraudulent diagnoses if and only if

$$X_F = \frac{e + \alpha_F}{(1 - \delta)(p_M - c_S - e - \alpha_F)} - \frac{\delta}{1 - \delta} =: \tilde{X}_F. \tag{3.18}$$

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 $\tilde{X}_F < 1$ when $\alpha_F < \frac{p_M-c_S}{2} - e$. Consequently, for $\delta < \frac{e+\alpha_F}{p_M-c_S-e-\alpha_F}$ 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 thereby $\delta < \frac{e+\alpha_F}{p_M-c_S-e-\alpha_F}$), 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 (3.3) with an equal sign yields

$$y(p_M - c_S) + ((1-\delta)X_F + \delta)(1-y)(p_M - c_S - e - \alpha_F) - e - \alpha_F = 0. \tag{3.19}$$

We distinguish the same three cases regarding the other fair physicians' level of fraud as above:

(a) $X_F = 0$. It follows from (3.19) that if all other fair physicians are honest, an individual fair physician treats honestly too if and only if

$$y < \frac{e + \alpha_F - \delta(p_M - c_S - e - \alpha_F)}{p_M - c_S - \delta(p_M - c_S - e - \alpha_F)} =: \tilde{y}_F. \tag{3.20}$$

Hence, it is a fair physician's best strategy to diagnose honestly for low values of y, i.e. when $y < \tilde{y}_F$. If $y > \tilde{y}_F$, a fair physician prefers to cheat. If $y = \tilde{y}_F$, she is just indifferent. Notice that the denominator of $\tilde{y}_F$ is greater than zero because of $\frac{p_M-c_S}{p_M-c_S-e-\alpha_F} > 1 > \delta$ and that $\tilde{y}_F > 0$ for $\delta < \frac{e+\alpha_F}{p_M-c_S-e-\alpha_F}$. That is, if $\delta > \frac{e+\alpha_F}{p_M-c_S-e-\alpha_F}$, we always have $y > \tilde{y}_F$.

(b) $X_F = 1$. From (3.19) we obtain that given all other fair physicians cheat, an individual fair physician cheats too if and only if

$$y(p_M - c_S) + (1-y)(p_M - c_S - e - \alpha_F) - e - \alpha_F > 0. \tag{3.21}$$

The condition (3.21) is satisfied when $\alpha_F < \frac{p_M-c_S}{2-y} - e$, where $\frac{p_M-c_S}{2-y} - e > 0$ is given by assumption.

(c) $X_F \in (0,1)$. By (3.19), a fair physician randomizes between cheating and not cheating given all other fair physicians randomize if and only if

$$X_F(y) = \frac{e + \alpha_F - y(p_M - c_S)}{(1-\delta)(1-y)(p_M - c_S - e - \alpha_F)} - \frac{\delta}{1-\delta} =: \tilde{X}_F(y). \tag{3.22}$$

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

$$\frac{d\tilde{X}_F(y)}{dy} = -\frac{1}{(1-\delta)(1-y)^2} < 0. \quad (3.23)$$

This means that an increase in the patients' acceptance rate y 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 finally reaches zero at $y = \tilde{y}_F$. Thus, we get $X_F(y) > 0 > \tilde{X}_F(y)$ if $y > \tilde{y}_F$. Hence, a fair physician overcharges if $y > \tilde{y}_F$, as also illustrated above. Thereby, for $\alpha_F < \frac{p_M - c_S}{2-y} - e$ and $y < \tilde{y}_F$ (which requires $\delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$), the strategy $X_F \in (0, 1)$ is a candidate for a symmetric best response.

3.6.3 Proof of Lemma 3.5

Given a pair (X, y) such that fair and opportunistic physicians treat all 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 weaker fraud incentives than the opportunistic types and therefore never cheat when the opportunistic types are honest.

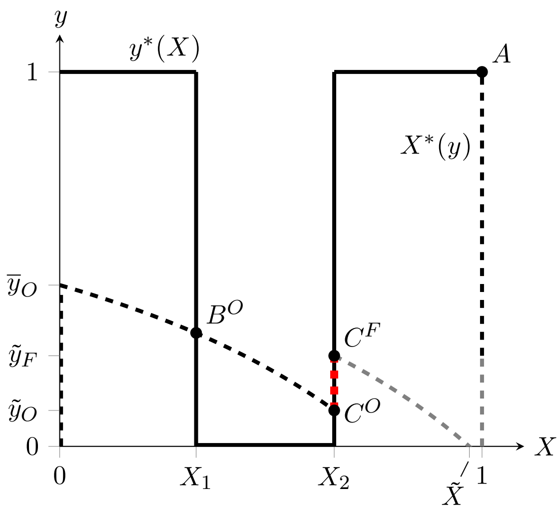
Given a pair (X, y) such that the fair physicians are honest and the opportunistic physicians are indifferent, the according level of fraud is $X = \frac{e - y(p_M - c_S)}{(1-y)(p_M - c_S - e)}$. This fraud level is bounded from above by $min\{\overline{X}, \delta\}$. It is again determined by an opportunistic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

For 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 $y > \tilde{y}_O$. The respective convex combination exists only for $\delta < \frac{e}{p_M - c_S - e}$. When $\frac{e}{p_M - c_S - e} < \delta < \frac{e+\alpha_F}{p_M - c_S - e - \alpha_F}$, the mutual compatibility of the joint best response is ensured by $y < \tilde{y}_F$ since the opportunistic physicians may cheat for any search rate $y \in [0, 1]$ in this situation.

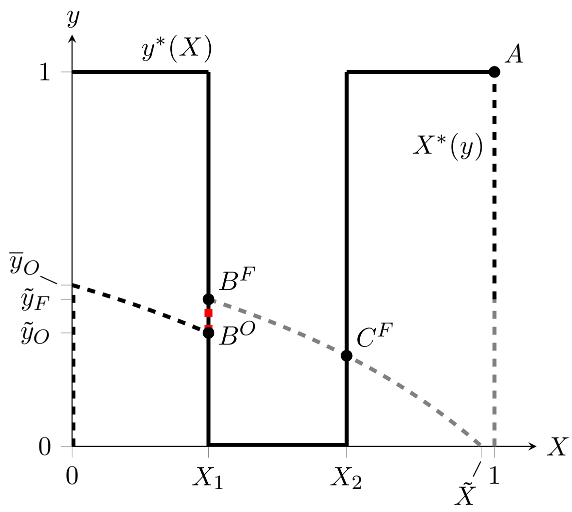
With a pair (X, y) such that the fair physicians randomize and the opportunistic physicians cheat, the only consistent market level of fraud is given by $X = \frac{e + \alpha_F - y(p_M - c_S)}{(1-y)(p_M - c_S - e - \alpha_F)}$, which is bounded from below by δ. It depends on a fair physician's best strategy whether we have a mutually compatible joint best response since the opportunistic physicians always cheat if the fair physicians are indifferent because of their stronger fraud incentives. For a pair (X, y) such that both types of physicians cheat, the according overall level of fraud is $X = 1$, which corresponds to the best response of a fair physician as the opportunistic physicians always cheat in case the fair physicians cheat.

3.6.4 Further Equilibrium Cases

In this section, further equilibrium cases are depicted. Figure 3.6 displays additional equilibrium settings for the case with a small or medium fairness utility, where in each case a continuum of equilibria (marked in bold red) occurs. Thus, we obtain two other mixed-strategy equilibria $\{\lambda C^O + (1-\lambda)C^F | \lambda \in [0,1]\}$ and $\{\lambda B^O + (1-\lambda)B^F | \lambda \in [0,1]\}$ for $\delta = X_2$ (Figure 3.6a) and $\delta = X_1$ (Figure 3.6b), respectively.
Figure 3.7 depicts all cases for the situation where the fair physicians have a large fairness utility and hence no incentives to cheat. Therefore, in Figure 3.7 a mutually compatible physicians' joint best response is always determined by an opportunistic physician's best response. The continua of equilibria are again marked in bold red in Figure 3.7.

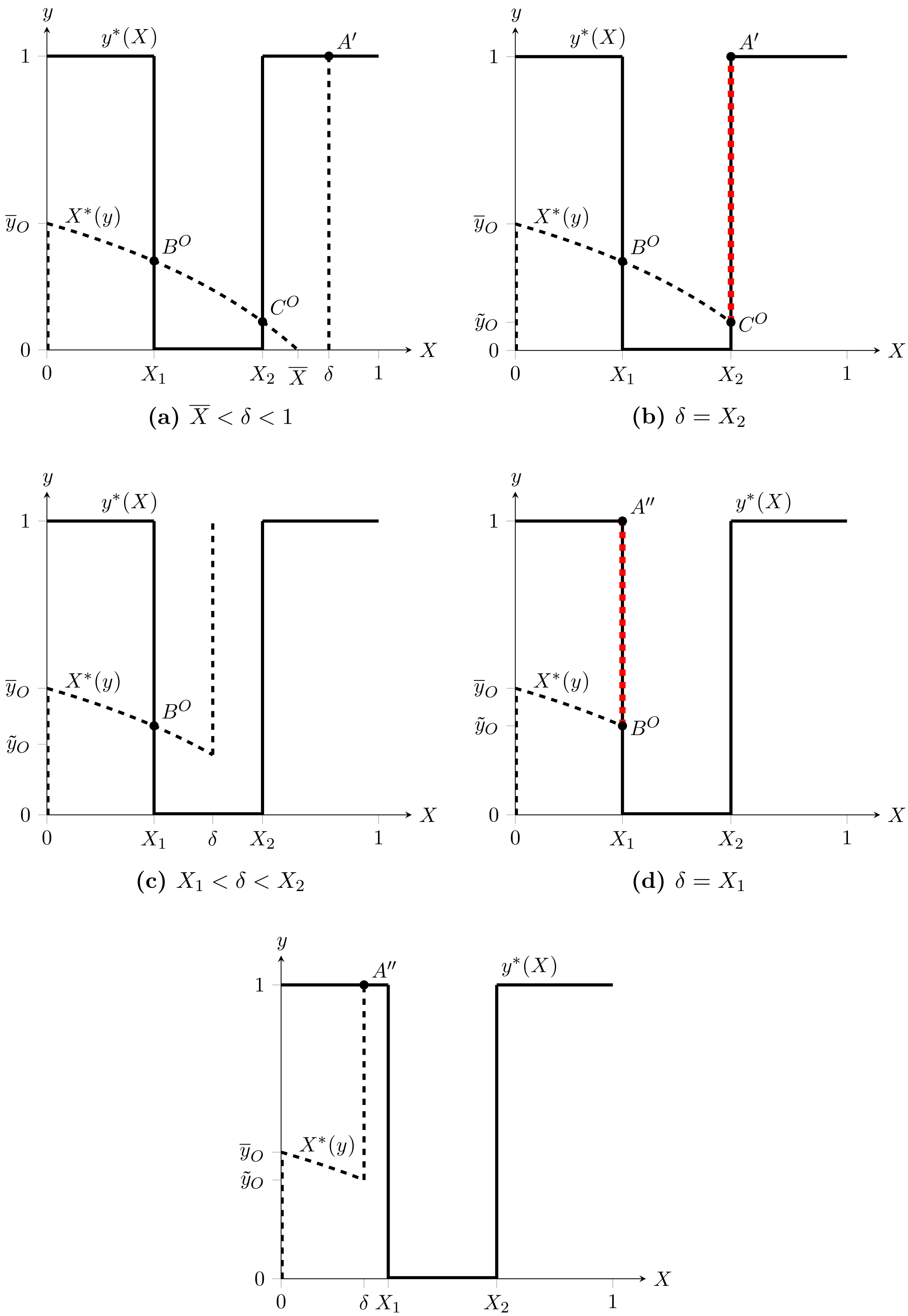


(a) $\delta = X_2$



(b) $\delta = X_1$

Figure 3.6: Addtional equilibrium settings for a small or 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 3.7: Equilibrium settings with a large fairness utility

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