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## Second Opinions in Markets for Expert Services: Experimental Evidence

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CER-ETH – Center of Economic Research at ETH Zurich

Second Opinions in Markets for Expert Services: Experimental Evidence

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**ETH**

Eidgenössische Technische Hochschule Zürich  
Swiss Federal Institute of Technology Zurich

# 1 Introduction

Information asymmetries are so prevalent in markets for physician services that they can be said to characterize these markets.<sup>1</sup> One particular asymmetry between physicians and patients is that for many health problems, patients cannot diagnose themselves. Instead, they have to rely on a physician to diagnose their problem, give a treatment recommendation, and provide the treatment. Physicians thus have an informational advantage over their patients with regard to the health problem and the appropriate treatment. Ex post, patients may observe whether their health problem was cured, at least in the short term, but they still might not know whether the provided treatment was actually necessary and/or whether the service charged was not a more expensive service than the one provided. Therefore, in many cases, physician services and health care services more generally are *credence goods*. The underlying asymmetry of information between physicians and patients characteristic of credence goods thus allows for physician-induced demand (PID).<sup>2</sup>

In addition to the idiosyncrasies in each physician-patient relationship, the scope for the exploitation of the asymmetric information leading to physician-induced demand depends on the institutional and legal environment as well as market characteristics such as competitive pressure and the relevance of reputation-building. One potentially powerful instrument in these markets to curb overtreatment is the re-examination or threat of re-examination of physicians' diagnoses via second opinions. Health insurers in several countries (e. g., the US and Germany) encourage their insurees to search for a second opinion when they are recommended an expensive treatment in order to reduce mis-diagnoses and overtreatment. In Switzerland, some insurers even grant a discount of up to 15% if insurees search for a second opinion before undergoing surgeries such as artificial knee or hip joints or planned Caesareans.

In this paper, we experimentally investigate physician-induced demand in a credence goods set-up in which patients can obtain a second opinion from another physician. We focus on the important case of overtreatment, as it entails an inefficiency due to the fact that more complex treatments typically have higher costs, such that health

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<sup>1</sup>See, e.g., Gaynor (1994).

<sup>2</sup>Evans (1974) was the first to argue that physicians can influence the demand for medical care. McGuire (2000) defines physician-induced demand as follows: "Physician-induced demand exists when the physician influences a patient's demand for care against the physician's interpretation of the best interest of the patient"– i.e., the physician is not a perfect agent for the patient.

care resources are wasted.<sup>3</sup> A typical example where overtreatment is a concern involves artificial knee joints. A study on German data found that in wealthier German municipalities, there are more knee surgeries even though there are fewer cases of arthrosis (Bertelsmann Stiftung, 2013).

Our experimental game is based on the general credence goods model developed by Wolinsky (1993) with exogenous prices as laid out in Sülzle and Wambach (2005).<sup>4</sup> Both Wolinsky (1993) and Sülzle and Wambach (2005) analyze overcharging; a minor reformulation leads to overtreatment incentives. Theoretically, this setting is interesting for several reasons. First, when customers can seek a second opinion at moderate search costs, the game has multiple equilibria: one in pure strategies in which no customer searches and all experts overtreat, despite the possibility of obtaining second opinions, and two in mixed strategies in which there is some searching and some overtreatment. Thus, introducing second opinions at moderate search costs does not necessarily reduce overtreatment in theory per se. Second, whether a reduction in search costs increases or decreases overtreatment and searching also depends on the equilibria played. Counterintuitively, overtreatment may increase with lower search costs. Third, given that second opinions are inefficient in themselves via incurred search costs and duplicated diagnosis costs,<sup>5</sup> it is not clear whether market efficiency improves with second opinions. The fact that theoretical predictions are not clear-cut motivates our approach to conduct a lab experiment. We conduct an experiment with a general credence goods framing; for the purposes of this study, we will refer to experts as physicians and customers as patients.

We find that introducing costly second opinions significantly reduces the level of overtreatment. The reduction in the actual overtreatment level between our baseline experimental condition<sup>6</sup> where patients cannot search for a second opinion and the conditions with search is about 40 percentage points. Furthermore, we find that although lowering patients' search costs leads to significantly more second opinions, the level of overtreatment does not change significantly. Market efficiency rises significantly with the introduction of second opinions when search costs are low, but

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<sup>3</sup>Overtreatment might also have adverse long-term effects lowering patient utility. Here, we concentrate on the cost inefficiency from overtreatment.

<sup>4</sup>Fixed prices are common in health care markets. Prices are either set as a result of a bargaining process at a central level (e.g., in the US) or according to legal regulations (e.g., in Germany) (Sülzle and Wambach, 2005). Other examples of credence goods markets with fixed prices are legal services and cab rides.

<sup>5</sup>In our set-up, diagnosis costs are zero for simplicity. However, the set-up could easily be modified to incorporate positive diagnosis costs.

<sup>6</sup>Note that we refer to the experimental treatments as “conditions” as opposed to physician “treatment”.

not when they are high. Under low search costs, the reduction in treatment costs due to less overtreatment overcompensates the increase in total incurred search costs.<sup>7</sup>

## Related literature

**Credence goods** The seminal contribution on credence goods is Darby and Karni (1973), who introduce the term of credence goods for expert services and show that experts might have an incentive to overtreat customers. Pitchik and Schotter (1987) analyze an expert's strategic overtreatment recommendation when the customer can reject the expert's advice, and Wolinsky (1993) analyzes competition in markets for expert services with second opinions. Dulleck and Kerschbamer (2006) provide a unifying theoretical framework and a synthesis of many findings in the literature. Dulleck et al. (2011) conduct the first experiment on credence goods markets, varying the market structure as well as liability and verifiability rules. Mimra et al. (2013) show how both the pricing regime and different reputation mechanisms impact experts' fraudulent behavior. The current paper contributes to the existing literature by experimentally analyzing how second opinions impact overtreatment incentives and market outcomes in expert markets.<sup>8</sup>

**Physician-induced demand** McGuire (2000) gives an overview and a discussion of the vast theoretical and empirical literature on physician-induced demand. Asymmetric information in the form of the physician's superior information about the patient's health problem type and strategic physician-patient interactions is explicitly modeled in De Jaegher and Jegers (2001) in a set-up similar to Pitchik and

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<sup>7</sup>The efficiency results relate to the absolute level of market efficiency. In relative terms, market efficiency rises with the introduction of second opinions under both low and high search costs. Note, however, that the level of efficiency in the market naturally depends on parameter choices, especially with regard to the level of search costs and the difference in treatment costs.

<sup>8</sup>To the best of our knowledge, the only experimental work on second opinions in credence goods markets is an unpublished working paper by Pitchik and Schotter (1984). The authors focus on the impact of two expert types on the levels of overcharging and efficiency in the market. Whereas competent firms always diagnose the customer's problem correctly, incompetent firms sometimes incorrectly diagnose the problem. The authors find low levels of overcharging but no evidence that the levels differ between competent and incompetent firms. Reducing the number of incompetent firms leads to significantly less overcharging. The low levels of fraud compared to our results can be explained by the much lower search costs. In their set-up, search costs only make up 1/25th of the possible loss due to overcharging. As overcharging is purely redistributive, the authors introduce several new efficiency measures in order to account for the fraud level. They find that for all measures, efficiency increases with a larger share of competent firms. The authors conclude that a licensing program that would reduce the number of incompetent firms in the market would hence improve the market outcome.

Schotter (1987). A few empirical studies have attempted to address the asymmetry of information underlying the physician-induced demand hypothesis directly.<sup>9</sup> Analyzing survey data, Domenighetti et al. (1993) report that in the Swiss canton of Ticino, doctors, lawyers, and their family members undergo the seven most important surgeries 33% less often than other people, indicating that presumed customer information (as indicated by the family’s profession) and liability concerns influence treatment decisions. However, using medical occupation as the measure of customer information to test demand inducement is somewhat problematic, as there might be non-inducement shifts in demand by medical professionals—for example, due to a reduced price for medical care or different attitudes toward health. Using a measure of health information based on responses to questions about health competence from the Swiss Health Survey, Schmid (2015) finds that the number of office visits decreases with a higher level of consumer health information, but finds no effect on the likelihood of visiting a physician. This could be evidence of physician-induced demand; however, better-informed patients might also be more efficient in producing their own health. In a field experiment in China, Currie et al. (2011) sent students trained as simulated patients with identical flu-like complaints to physicians in hospitals.<sup>10</sup> The authors then analyzed whether sending the physician a signal that the patient was informed about inappropriate antibiotic use would reduce prescription rates.<sup>11</sup> They find that the signal reduced the probability of receiving an antibiotic prescription by 25 percentage points, from 64% to 39%, and that the signal also reduced drug expenditures. However, one problem with qualifying this result as physician-induced demand is however that the information signal might be perceived by physicians as a patient preference signal. In a follow-up study, Currie et al. (2014) varied patient demand by either explicitly demanding antibiotics or not, and furthermore varied financial incentives for the prescribing physician by indicating whether the patient would buy the prescribed antibiotics at the hospital pharmacy or not. In this case, the authors find that the number of prescriptions

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<sup>9</sup>Although there is a large volume of research supportive of physician-induced demand, one problem is that a clear discrimination between the physician-induced demand hypothesis and other theories often cannot be made; see McGuire (2000).

<sup>10</sup>Hospitals and physicians in China have substantial monetary incentives to prescribe medications, in particular more expensive drugs such as newer and more powerful antibiotics that should be reserved for more dangerous infections.

<sup>11</sup>Currie et al. (2011) sent pairs of well-matched simulated patients to the same physician within a short time frame. Each pair followed the same transcript, except that one patient added, “I learned from the Internet that simple flu/cold patients should not take antibiotics.”

was significantly lower when the financial incentive was removed, independent of whether patients demanded antibiotics or not.<sup>12</sup>

**Health economics lab experiments** Lab experiments in health care markets have only recently begun to receive more attention. The advantage of lab experiments like the current study is that physician-induced demand can be clearly identified. Hennig-Schmidt et al. (2011) compare physicians' treatment behavior under two payment schemes: fee-for-service and capitation. The authors show that patients are overtreated under fee-for-service whereas they are undertreated under capitation. In two follow-up studies, Brosig-Koch et al. (2013, 2015a) investigate how to improve patient treatment by introducing pay-for-performance and mixed payment schemes. Green (2014) analyzes different payment structures for physicians in a real effort experiment, finding that payment systems with retrospective reimbursements (i.e., fee-for-service, and fee-for-service with pay-for-performance) resulted in the lowest overall quality of services for patients, whereas physicians provided a higher overall quality of service under prospective structures such as salary and capitation. Huck et al. (2014) investigate how patients' insurance coverage and free choice of physicians influence physician and patient behavior in an experimental credence goods market. They find that insurance increases both overtreatment on the expert side and the number of expert visits on the customer side. Physician choice leads to decreased overtreatment and partly offsets the negative effects of insurance.

The remainder of the paper is structured as follows. In Section 2, we introduce the theoretical framework. In Section 3, we present the experimental set-up before examining the results in Section 4. In Section 5, we discuss the impact of framing and the choice of our subject pool on our results. The final section concludes.

## 2 Theoretical framework

The seminal works on expert markets with second opinions are Pitchik and Schotter (1987) and Wolinsky (1993). The framework we use for the experiment is the fixed-price analysis of Wolinsky (1993) as implemented in Sülzle and Wambach (2005).

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<sup>12</sup>In a variant in which patients communicated that they knew about inappropriate antibiotic use, prescriptions were also reduced, but to a lesser degree than with the removal of the financial incentive.

We reformulate their setup to account for the case of overtreatment. Below, we will present the set-up and results in detail to highlight the crucial mechanics of the model.

Experts in the model maximize their expected payoff from treatment recommendation decisions. Particularly in health care, there is the persistent question of whether experts (here, physicians) are driven by other considerations such as honesty or concerns about customer (patient) benefits. The reason why we maintain the objective of own-payoff maximization for the physicians in our set-up as in Wolinsky (1993) is the following. Overtreatment as considered here results in inefficiently high treatment costs and patients paying a higher price. However, patients' direct benefits from treatment are not affected by overtreatment; in a health care setting, this would imply that patient *health* benefits are not reduced by overtreatment.<sup>13</sup>

## 2.1 Market

There are  $N$  patients and  $M$  physicians (where  $N$  and  $M$  are large). Each patient suffers from a problem that is either major or minor. A patient suffers from a major problem with probability  $h$ ; she suffers from a minor problem with probability  $1-h$ . Probability  $h$  is common knowledge among patients and physicians. Although the patient observes that she has a problem, she does not know which type of problem it is. Physicians are able to perfectly diagnose the problem at no cost and give treatment recommendations. If a patient accepts a physician's treatment recommendation, the physician performs the treatment. A major treatment  $H$  leads to costs of  $c_H$  and a minor treatment  $L$  entails costs of  $c_L < c_H$ . The major treatment heals both types of problems; the minor treatment heals the minor but not the major problem. Patients derive a utility of  $v$  when their problem is resolved.<sup>14</sup> Each patient visits a physician. After receiving the first treatment recommendation, patients can search for one second opinion at search costs of  $k$  and undergo treatment with the second physician visited.<sup>15</sup> Physicians do not know whether a patient is on her first or second visit.<sup>16</sup>

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<sup>13</sup>For an analysis of the role of social preferences and a detailed discussion of the implications of framing, see Section 5.

<sup>14</sup> $v$  is sufficiently large such that receiving a treatment always makes the patient better off than no treatment.

<sup>15</sup>We assume that search costs for yet another opinion exceed  $v - k$ , such that patients never search for a third, fourth, etc. opinion.

<sup>16</sup>Note that this assumption is an elegant way of reducing the problem to two stages while providing the physician with incentives similar to those in the setting patients can search for second opinions more than once.



We will focus on the physicians' incentives to overtreat their patients, i.e., to provide the major treatment even though the minor treatment would be sufficient. To this end, we rule out undertreatment (i.e., providing insufficient treatment) by assuming physician liability. Furthermore, the type of treatment performed by a physician is verifiable, such that physicians cannot charge for a more expensive treatment than is actually provided. Treatment prices are  $p_L$  for the minor treatment and  $p_H$  for the major treatment. A payoff-maximizing physician then has the incentive to overtreat a patient with a minor problem if the mark-up on the major treatment is higher than the mark-up on the minor treatment. We thus assume  $p_H - c_H = e_H > e_L = p_L - c_L$ , where  $e_i$  denotes the mark-up on treatment  $i$  (where  $i \in \{H, L\}$ ).<sup>17</sup>

In this game, a patient who receives a minor-treatment recommendation accepts with certainty.<sup>18</sup> A patient who receives a major-treatment recommendation on her first physician visit rejects this recommendation and searches for a second opinion with probability  $s \in [0, 1]$ , where searching for a second opinion entails search costs of  $k$ . The patient accepts the second treatment recommendation with certainty. The patient's payoff is given by  $v - p_i - (d - 1)k$ , where  $d \in \{1, 2\}$  indicates the number of physician visits. In our set-up, patients pay the full treatment price. However, all results derived will also apply for insured patients as long as their insurance contract includes a positive co-payment. A physician's strategy is the recommendation policy  $x \in [0, 1]$ , which is the probability that the physician will recommend the major treatment to a patient with the minor problem.<sup>19</sup> Due to liability, a patient with a major problem always receives a major-treatment recommendation. The physician's payoff from recommending treatment  $i$  to a patient is  $e_i$  if the patient accepts the treatment and 0 if the patient rejects it.

## 2.2 Equilibria

The following equilibrium analysis is adapted from Sülzle and Wambach (2005) to allow for the case of overtreatment. We will set out the patients' and the physi-

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<sup>17</sup>This assumption mirrors the price structure we observe particularly in the health care market, but which also holds for legal advice services. For example, Wehkamp (2012) points out that DRG (Diagnosis Related Groups), a payment system that classifies hospital cases based on the diagnosis (see Fetter et al., 1980; Fetter and Freeman, 1986; Baker, 2002), often rewards complicated treatments with a higher mark-up than standard treatments. Note that from a theoretical perspective, a regulator could impose equal mark-ups for both types of treatment in order to prevent overtreatment. Empirically, however, we often observe that regulators fail to implement equal mark-ups.

<sup>18</sup>Note again that liability rules out undertreatment.

<sup>19</sup>Again, the physician does not know whether a patient is on her first or second physician visit.

icians' optimization problems and characterize the market equilibria. We consider symmetric equilibria where all physicians choose the same recommendation policy  $x$  and all patients have the same search rate  $s$ . A physician's treatment recommendation is a signal to the patient about her type of problem. When receiving a diagnosis on her first visit, the patient updates her beliefs about her type of problem. The patient believes that she has a minor problem with probability 1 when she gets a minor-treatment recommendation. When receiving a major-treatment recommendation, the patient believes herself to have a minor problem with probability  $(1-h)x/(h+(1-h)x)$ .<sup>20</sup>

When receiving a major-treatment recommendation, the patient searches with probability 1 (0) if the costs of accepting the major-treatment recommendation right away are higher (lower) than the costs of searching for a second opinion. The patient is indifferent if these costs are equal, i.e., if

$$p_H = k + \frac{h}{h+(1-h)x}p_H + \frac{(1-h)x}{h+(1-h)x}(xp_H + (1-x)p_L) \quad (1)$$

holds. If the patient does not search for a second opinion, she pays the price  $p_H$  for the major treatment. If she searches for a second opinion, she incurs search costs of  $k$  and again has to pay the high price  $p_H$  if she indeed needs the major treatment (which happens with probability  $h/(h+(1-h)x)$ ) or is defrauded again (which happens with probability  $(1-h)x^2/(h+(1-h)x)$ ). She only pays the lower price  $p_L$  if she has the minor problem and is not overtreated on her second visit (which happens with probability  $(1-h)x(1-x)/(h+(1-h)x)$ ).

Define  $\Delta p := p_H - p_L > 0$  and  $\varphi := k/\Delta p > 0$ . Rearranging expression (1) gives

$$0 = x^2 - (1-\varphi)x + \frac{h}{1-h}\varphi. \quad (2)$$

For equation (2) to have a (real) solution, it must hold that  $\varphi < 1$  ( $k < \Delta p$ ). We thus assume that search costs are sufficiently low such that never searching for a second opinion (independent of  $x$ ) is not optimal. Solving the equation for  $x$  gives the following two solutions:

$$x' = \frac{1-\varphi}{2} - \sqrt{\frac{(1-\varphi)^2}{4} - \frac{h}{1-h}\varphi}$$

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<sup>20</sup>Note that  $(1-h)x$  is the probability of having a minor problem and being overtreated;  $h+(1-h)x$  is the probability of receiving a major diagnosis.

and

$$x'' = \frac{1 - \varphi}{2} + \sqrt{\frac{(1 - \varphi)^2}{4} - \frac{h}{1 - h}\varphi}.$$

Given these solutions, the patient's best response is characterized as follows:

$$s^*(x) \in \begin{cases} 0 & \text{if } x \in [0, x') \cup (x'', 1] \\ [0, 1] & \text{if } x \in \{x', x''\} \\ 1 & \text{if } x \in (x', x''). \end{cases}$$

Turning to the physicians, suppose that patients search for a second opinion with probability  $s$  and all other physicians have the recommendation policy  $x$ . Then, the profit function of each individual physician  $j$  ( $j \in \{1, 2, \dots, M\}$ ) facing a patient with a minor problem is given by

$$\max_{x_j} \pi_j = x_j \frac{1 - s + xs}{1 + xs} e_H + (1 - x_j) e_L.$$

With probability  $x_j$ , the physician overtreats this patient, which results in a profit of  $e_H$  if the patient does not search for a second opinion. A share of patients  $1/(1 + xs)$  are on their first visit and do not search for a second opinion with probability  $1 - s$ , whereas a share  $xs/(1 + xs)$  have received a major-treatment recommendation from another physician and therefore do not search for a second opinion with certainty. With probability  $1 - x_j$ , the physician recommends the honest treatment, which yields a certain profit of  $e_L$ .

Since we focus on symmetric best responses, it must hold that the physician's individual defrauding strategy  $x_j$  corresponds to the other physicians' defrauding strategy  $x$ . The optimal symmetric recommendation policy can then be characterized as follows for  $e_L < e_H/(1 + s)$ :<sup>21</sup>

$$x^*(s) \in \begin{cases} 1 & \text{if } s \in \left[0, 1 - \frac{e_L}{e_H}\right] \\ \left\{0, \frac{e_L - (1 - s)e_H}{s(e_H - e_L)}, 1\right\} & \text{if } s \in \left[1 - \frac{e_L}{e_H}, 1\right]. \end{cases}$$

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<sup>21</sup>For details, see Sülzle and Wambach (2005).

If there is only a low probability that patients will search for a second opinion, physicians always recommend the major treatment. If patients search for a second opinion relatively often, then physicians

- always recommend the major treatment if all other physicians do so, as there is a high probability that a patient with a minor problem is already on her second visit and will accept the recommendation;
- always recommend the minor treatment if all other physicians do so, as there is a high probability that a patient with a minor problem is on her first visit and will reject a major-treatment recommendation; or
- mix.

Given both parties' best response correspondences, market equilibria can be determined as summarized in the following result:<sup>22</sup>

**Statement 1. (Wolinsky, 1993; Sülzle and Wambach, 2005)**

(a) For  $e_L < e_H$  and  $k > \Delta p$ , there exists a unique equilibrium in the above physician market where patients never search for a second opinion and physicians always overtreat.

(b) For  $e_L < e_H/(1 + s)$  and  $k < \Delta p$ , there exist three equilibria in the above physician market where patients may search for a second opinion:

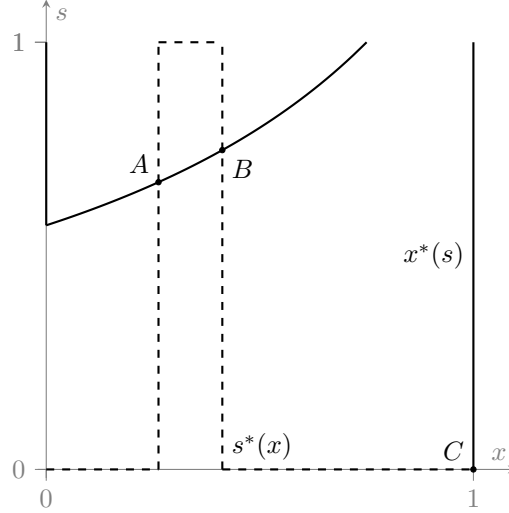
(i) in the two mixed-strategy equilibria, physicians sometimes defraud patients with a minor problem and patients sometimes search for a second opinion if they receive a major diagnosis;

(ii) in the pure-strategy equilibrium, physicians always defraud their patients, who never search for a second opinion.

If search costs are high, the unique equilibrium is characterized by no search and full overtreatment. For moderate search costs, the equilibria in part (b) of the statement are illustrated in *Figure 1*. The intuition for these equilibria is as follows. In the pure-strategy equilibrium (see *C* in *Figure 1*), patients never search for a second opinion. Therefore, it is the physicians' best response to always overtreat patients with a minor problem. Anticipating the physicians' behavior, a patient's best response is

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<sup>22</sup>We focus on the cases that will be relevant for the experimental analysis.



**Figure 1:** Market equilibria.

to never search for a second opinion because any other physician will overtreat the patient as well. In the mixed-strategy equilibria, patients are indifferent between accepting a major diagnosis and searching for another opinion whereas the physicians are indifferent between giving a correct treatment recommendation or giving a major-treatment recommendation to a patient with a minor problem. In one of the mixed-strategy equilibria (see  $B$  in *Figure 1*), there is both more overtreatment and more searching for second opinions than in the other mixed-strategy equilibrium (see  $A$  in *Figure 1*).<sup>23</sup>

### Decrease in search costs

To analyze the effect of policies that encourage second opinions (e.g., through subsidies), we analyze the effect of a change in search costs  $k$ .

**Lemma 1.** *If search costs decrease (increase), patients ceteris paribus search for a second opinion for a broader (smaller) range of overtreatment levels.*

<sup>23</sup>In the game, a crucial feature is the fact that physicians do not know whether patients are on their first or second visit. A variant of the game is that physicians have this information but a patient may reject the second opinion and return to the first physician. In this game, the strategy for the patient prescribes search probabilities for the first and the second visit, and the strategy for the physician specifies the recommendation policy for a patient with the minor problem on her first visit and the recommendation policy for a patient with the minor problem on her second visit. The game has an equilibrium with full overtreatment and no search as well as a continuum of equilibria with search and partial overtreatment. Results on this variant of the game are available from the authors upon request.

*Proof.* Consider the following derivative

$$\frac{\partial x'}{\partial k} = -\frac{1}{2\Delta p} + \frac{\frac{1}{2}(1-\varphi) + \frac{h}{1-h}}{2\Delta p \sqrt{\frac{(1-\varphi)^2}{4} - \frac{h}{1-h}\varphi}}. \quad (3)$$

Setting expression (3) equal to 0 and solving for  $k$  does not give a solution, i.e., the sign of expression (3) does not change. As  $\partial x'/\partial k = h/(1-h)\Delta p > 0$  for  $k = 0$ , we can conclude that  $\partial x'/\partial k > 0$  is true. A similar argument holds for  $\partial x''/\partial k$ .  $\square$

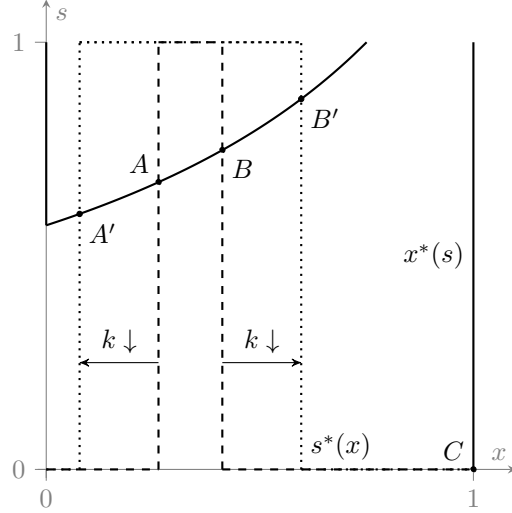
Reducing patients' costs for obtaining a second opinion makes it *ceteris paribus* more attractive for patients to check a major-treatment recommendation with a second physician. The resulting equilibrium behavior, however, depends on the type of equilibrium played:

**Lemma 2.** *A decrease in search costs leads to the following changes in equilibrium:*

- (i) *in the mixed-strategy equilibrium with a lower (higher) overtreatment level and a lower (higher) search rate, there is less (more) overtreatment and search activity decreases (increases);*
- (ii) *there are no changes in the pure-strategy equilibrium.*

*Proof.* A decrease in patients' search costs *ceteris paribus* leads to more searches for second opinions (see *Lemma 1*). The physicians' best response correspondence remains unchanged when patients' search costs are lowered. Thus, to be indifferent between overtreating and treating honestly, a physician has to overtreat less (more) often, starting from the equilibrium with a low (high) level of undertreatment and a low (high) search rate.  $\square$

An illustration of *Lemma 2* is given in *Figure 2*. The intuition is as follows. Physicians overtreat more often in the equilibrium with a higher overtreatment rate because they anticipate that patients will search for a second opinion more often. Hence, more patients are on their second visit and will not search for another opinion with certainty. Thus, physicians' incentives to overtreat increase. In the equilibrium with a lower overtreatment level, physicians overtreat less often because patients are most likely on their first visit, and it is very likely that patients will search for a second opinion upon receiving a major-treatment recommendation. As a consequence, physicians' incentives to overtreat decrease, such that patients' actual search rate can decrease.



**Figure 2:** Market equilibria with different search costs.

### 3 Experiment

The previous section has illustrated that due to the multiplicity of equilibria for moderate search costs, the theoretical predictions are not clear cut. To understand the strategic behavior and outcomes in physician markets with second opinions, we therefore take the problem to the lab. In this section, we introduce the experimental design and the parametrization and provide the theoretical predictions for the experimental conditions.

#### 3.1 Design

##### Basic set-up and decision situations

There are 420 participants in our experiment, 210 of which are randomly assigned the role of physicians; the other 210 act as patients. The participants are grouped in markets with six physicians and six patients each.<sup>24</sup> Neither the role nor the assignment to a market changes during the experiment.

The decisions that physicians and patients make are part of the following sequence, which is repeated for each of the eight periods. Each patient's type of problem is

<sup>24</sup>We decided to employ six participants per role and market in all experimental conditions because this ensures that physicians can actually play both mixed-strategy equilibria from the theory section (see below).

drawn independently. With probability  $h$  (or  $1 - h$ ), a patient suffers from a major (or minor) problem. Physicians decide for each of the six patients in their market whether they will or will not overtreat a patient suffering from a minor problem and that is matched to the physician (for the first *or* the second visit).<sup>25</sup> Patients are randomly and independently matched to physicians. The decision situation for patients depends on the condition being played. Patients are passive in the baseline condition and accept all treatment recommendations, whereas in all other conditions, they decide in each period whether to search for a second opinion. If patients decide to search for a second opinion, they incur costs  $k$  and the treatment recommendation of the second physician is implemented. Otherwise, the treatment recommendation of the first physician is implemented. Patients and physicians then observe their own payoffs. Physicians additionally observe the numbers of their patients who received minor and major treatment, respectively, as well as the number of their patients who searched for a second opinion.

A physician's payment for each matched customer per period is  $\pi_{\text{Physician}} = p_i - c_i$  for treatment  $i \in \{L, H\}$ . A patient's payment per period is

$$\pi_{\text{Patient}} = \begin{cases} v - p_i & \text{if the patient does not search for a second opinion} \\ v - p_i - k & \text{if the patient searches for a second opinion.} \end{cases}$$

The parameterization is as follows. We set the probability of suffering from a major problem to  $h = 0.25$ . The price for the major treatment is fixed at  $p_H = 115$  ECU and for the minor treatment at  $p_L = 75$  ECU.<sup>26</sup> The costs for the major and the minor treatment amount to  $c_H = 80$  ECU and  $c_L = 60$  ECU, respectively. Hence, physicians have an incentive to overtreat, as  $p_H - c_H = 35 > 15 = p_L - c_L$ . The cost difference and thus the inefficiency from overtreatment is 20 ECU. The choice of cost levels also ensures that the condition for the existence of the two mixed-strategy equilibria, i.e.,  $e_L = 15 < 35/(1+s) = e_H/(1+s)$ , holds. A patient receives a treatment value of  $v = 130$  ECU. Moreover, the patient faces search costs  $k$  of either 7 ECU in the  $SO_7$  or 13 ECU in the  $SO_{13}$  condition. Thus,  $k < \Delta p = 40$  ECU

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<sup>25</sup>The theoretical model assumes that physicians do not know whether a patient is on the first or second visit. In order to satisfy this assumption, we implement the strategy method. In order to ensure that reputational concerns do not play a role in the repeated game, physicians and patients cannot identify each other. Furthermore, the order in which patients are presented to physicians when they are deciding about the treatment recommendation is random. Hence, physicians cannot mix their strategy for one patient across different periods.

<sup>26</sup>ECU refers to the experimental currency unit used in the experiment.



is always satisfied. Hence, patients may have an incentive to search for a second opinion. All parameters are common knowledge.

## Conditions

There are three main conditions: the baseline condition ( $BL$ ) in which patients cannot search for a second opinion, and two conditions in which patients can search for a second opinion at low ( $SO_7$ ) or high search costs ( $SO_{13}$ ). We conducted six markets in the baseline condition, nine markets in the  $SO_7$  condition, and ten in the  $SO_{13}$  condition.<sup>27</sup> We complement the main conditions with five control conditions of two markets each. *Table 1* provides an overview of the main conditions and the control conditions. In the first control condition, patients have low search costs and physicians interact for 16 instead of eight periods ( $SO_7^{16}$ ), in order to analyze whether there is additional learning and a more pronounced coordination on one of the predicted equilibria. In another control condition with low search costs, physicians are able to observe whether patients are on their first or second visit ( $SO_7^{\text{obs}}$ ). In the unique equilibrium, physicians should always overtreat their patients. We investigate whether the threat of patients to search for a second opinion is sufficient to reduce physicians’ overtreatment level.<sup>28</sup> In the third control condition ( $SO_{14.5}$ ), we implement prohibitively high search costs of  $k = 14.5$  to further investigate whether patients’ mere possibility to search for a second opinion may already be sufficient to discipline physician behavior. Similar to  $SO_7^{\text{obs}}$ , the unique equilibrium is characterized by full overtreatment, but the threat that patients could switch to another physician may keep the overtreatment level low. We also investigate the other motives that the physicians might have when choosing not to overtreat patients. We identify the impact of social preferences and an aversion to recommending a treatment that does not correspond to the actual problem—which is akin to lie aversion—by implementing two further control conditions: one based on the baseline condition ( $BL^{\text{Frame}}$ ), and one on the condition with low search costs ( $SO_7^{\text{Frame}}$ ). In these control conditions, physicians’ decisions are framed as purely allocational instead of “taking an action to solve a problem”.

<sup>27</sup>Note that in the  $SO_7$  condition, ten markets had also been scheduled, but there were too many no-shows at one session to fill the market.

<sup>28</sup>In practice, another concern is that additional diagnostic procedures performed by the second physician may imply unnecessary adverse health effects such that the patient has an incentive to reveal the results from the first visit to the second physician. Possible examples include the case of imaging, where the additional radiation caused by a second scan may result in a higher probability of developing cancer; in the case of invasive diagnoses, a second diagnostic procedure may lead to a higher risk of internal bleeding or infection.

**Table 1:** Experimental conditions.

	Cond.	# of markets	Search costs	# of periods	Phys. obs. # of visit	Frame <sup>a</sup>	Average payoffs (in €)	
							Physicians	Patients
Main conditions	$BL$	6	–	8	no	CG	17.56	13.89
	$SO_7$	9	7	8	no	CG	15.06	17.52
	$SO_{13}$	10	13	8	no	CG	15.32	16.73
Control conditions	$SO_7^{16}$	2	7	16	no	CG	24.58	31.50
	$SO_7^{Obs.}$	2	7	8	yes	CG	14.17	19.79
	$SO_{14.5}$	2	14.5	8	no	CG	15.33	16.88
	$BL^{Frame}$	2	–	8	no	All.	17.42	14.17
	$SO_7^{Frame}$	2	7	8	no	All.	15.42	16.91

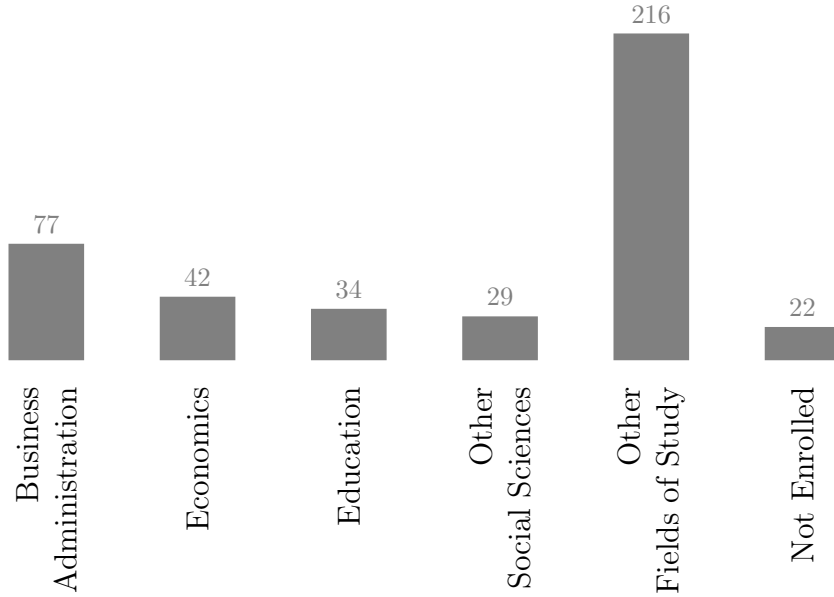
<sup>a</sup> "CG" stands for the credence goods framing whereas "All." refers to the allocational framing.

## Experimental protocol

The experiment was conducted in the Cologne Laboratory for Economic Research (CLER) at the University of Cologne. The 13 sessions for the main experiment were scheduled in March and May 2013. The five sessions for the additional control treatments took place in September 2013 and July 2014. We recruited participants using ORSEE (Greiner, 2004) and ran the experiments using z-Tree (Fischbacher, 2007). The study subjects most frequently represented among participants were business and economics. All but eight participants had a non-medical background. *Figure 3* illustrates the share of the most frequently represented subjects among all participants. The average age of participants was 25 years. 61 percent of the students were female.

We implemented a between-subjects design such that each of the subjects participated in exactly one condition. For each session, we invited 30 subjects. The 24 invited subjects who showed up first at the laboratory were selected to participate. Those subjects who did not participate in the experiment were paid the show-up fee of 2.50 Euro in accordance with the Cologne Laboratory of Experimental Economics regulations. We invited six subjects more than necessary to ensure that enough participants would show up to fill two markets. At the beginning of each session, the instructions were read aloud. Each participant had to correctly answer a set of control questions in order to ensure that she/he understood the instructions. After the experiment, a short questionnaire was used to assess participants' age and gender. At the end of each session, all 24 subjects were privately paid.

The payment included the above-mentioned show-up fee of 2.50 Euro, a reward of 2.50 Euro for answering all control questions correctly, and the payoff from the



**Figure 3:** Participants' field of study across all conditions.

decisions made in the experiment. We rewarded answering all control questions correctly in order to ensure that those physicians matched with few patients over the eight (16) periods would receive a sufficiently high payoff. All eight (16) periods in the experiment were payoff relevant. This payoff mechanism is incentive compatible because complementarities across periods are small.<sup>29</sup> Furthermore, we explicitly incentivized the learning and coordination process of players by making all periods payoff-relevant. The exchange rate was 20 ECU = 1 Euro. The average total payoff per participant amounted to 16.78 Euro. Sessions lasted 75 minutes on average.

### 3.2 Theoretical predictions and hypotheses

Given the above parameters, the equilibria can be specified as displayed in *Table 2*.  $x^*$  denotes the physicians' optimal symmetric recommendation strategy and  $s^*$  is the patients' optimal search rate.

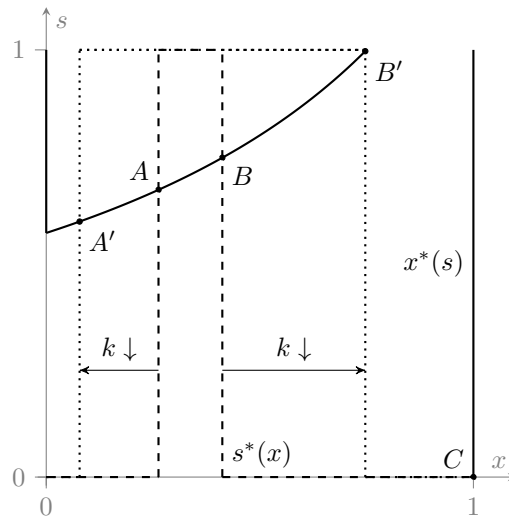
*Figure 4* illustrates the different equilibria for our experimental parametrization.

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<sup>29</sup>Physicians cannot identify patients, and choices for patients are displayed in a random order, such that physicians cannot mix their strategy for a given patient across periods.

**Table 2:** Market equilibria with experimental parametrization.

Condition	Equilibrium predictions			
	$x^*$	$A$ or $A'$	$B$ or $B'$	$C$
$BL$	$x^*$	–	–	100.00%
	$s^*$	–	–	0.00%
$SO_7$	$x^*$	7.81%	74.69%	100.00%
	$s^*$	59.81%	99.69%	0.00%
$SO_{13}$	$x^*$	26.28%	41.21%	100.00%
	$s^*$	67.25%	74.75%	0.00%



**Figure 4:** Market equilibria with experimental parametrization.

In the analysis, three aspects are of prime interest: (i) whether second opinions reduce overtreatment, (ii) what impact a reduction in patients' search costs has on search intensity and overtreatment, and (iii) whether second opinions increase market efficiency, depending on the level of search costs. In the following analysis, we organize the hypotheses along these questions.

### Introduction of second opinions

Even when patients have the possibility to search for second opinions, there exists an equilibrium in which physicians always overtreat and patients never search. However, further equilibria exist in which there is less than full overtreatment.

**Hypothesis 1.** *The level of overtreatment when patients can search for second opinions is equal to or lower than the overtreatment level in BL.*

### **Decrease in search costs**

From the analysis of equilibria, it is obvious that a decrease in search costs may have ambiguous effects, e.g., it is possible that a decrease in search costs jointly leads to more search but also higher overtreatment, or jointly less search and less overtreatment. However, counterintuitively, if there is searching under high search costs, a decrease in search costs does not jointly lead to more search and less overtreatment. This is the case even if there is a change in the type of equilibrium played.

**Hypothesis 2.** *If patients search for second opinions under high search costs, reducing search costs does not jointly lead to more search and less overtreatment.*

### **Efficiency**

Regarding the efficiency level, note that it is determined by two opposing effects: the level of overtreatment and the incurred search costs. Hence, it is not obvious whether introducing the possibility to search for a second opinion increases market efficiency. As a matter of fact, even if there is less overtreatment due to search, the costs associated with search may outweigh the positive effect of savings on costs for unnecessary major treatments.

We make use of two efficiency measures in order to provide a more detailed comparison: the absolute and the relative efficiency level. We define the absolute efficiency level as the sum of patients' and physicians' surpluses per market across the eight periods. The relative efficiency represents the normalized absolute efficiency level in a  $[0, 1]$  interval. Hence, the minimum absolute efficiency per condition corresponds to a relative efficiency of 0, while the maximum absolute efficiency level corresponds to a relative efficiency of 1. In the baseline condition, a relative efficiency of 0 corresponds to a situation in which physicians always overtreat. In the  $SO_7$  and  $SO_{13}$  conditions, a relative efficiency level of 0 indicates that physicians always overtreat and patients always search for a second opinion. Note that due to the additional costs incurred when searching for a second opinion, the minimum absolute efficiency level is lower in  $SO_7$  and  $SO_{13}$  than in  $BL$ , whereas the minimum relative efficiency is 0 in all three treatments.

Table 3 shows the efficiency levels for the different equilibria. The efficiency levels are calculated based on the predicted physician and patient behavior. We base the efficiency predictions on the realization of patient types in the experiment.

**Table 3:** Efficiency predictions.

Condition	Efficiency	Equilibrium predictions		
		$A$ or $A'$	$B$ or $B'$	$C$
$BL$ [2400–3120 ECU]	Abs. eff.	–	–	2400 ECU
	Rel. eff.	–	–	0.00%
$SO_7$ [2064–3120 ECU]	Abs. eff.	2863 ECU	2247 ECU	2400 ECU
	Rel. eff.	75.64%	17.36 %	31.82%
$SO_{13}$ [1776–3120 ECU]	Abs. eff.	2511 ECU	2357 ECU	2400 ECU
	Rel. eff.	54.70%	43.21 %	46.43%

Absolute efficiency values (Abs. eff.) refer to total average surplus per market over all periods. Relative efficiency values (Rel. eff.) are normalized to the interval  $[0, 1]$ . Relative efficiency of 0 (1) corresponds to the minimum (maximum) absolute efficiency for the respective condition. Numbers in brackets below conditions indicate minimum and maximum absolute efficiency in the respective condition.

As can be seen in Table 3, if the equilibrium of type  $A$  is played after the introduction of the possibility to search for a second opinion, the positive effect of a reduction in overtreatment overcompensates the increase in incurred search costs. This is not the case if after the introduction of second opinions, equilibria of type  $B$  are played.<sup>30</sup> These settings are characterized by large incurred search costs but still high overtreatment levels.

**Hypothesis 3.** *For given search and treatment costs, market efficiency increases with the introduction of second opinions if the reduction in the overtreatment level is large relative to the increase in the search rate.*

## 4 Results

We first provide an overview of the findings (Section 4.1) before discussing the results on overtreatment and second opinions in Section 4.2 and efficiency in Section 4.3.

<sup>30</sup>There is no change in absolute efficiency if the type  $C$  equilibrium is played after the introduction of second opinions.

We report non-parametric test results based on two-tailed *Mann-Whitney U* tests if not stated otherwise. The results are reported to be (weakly) significant if the two-tailed test’s  $p$ -value is smaller than 0.05 (0.10). We consider the average over all individuals in a market and over all periods as one independent observation. The strategy method allows us to evaluate for each physician how many of the six patients in the market the physician would have overtreated given that patients had the minor problem and were matched to the physician. We refer to the average number of patients that would have been overtreated as the level of overtreatment *in strategy*. Note that the *actual* level of overtreatment that patients experience may differ because patients may be matched to physicians that defraud above or below the average level and because patients can search for a second opinion in the  $SO_7$  and  $SO_{13}$  conditions.

## 4.1 Overview

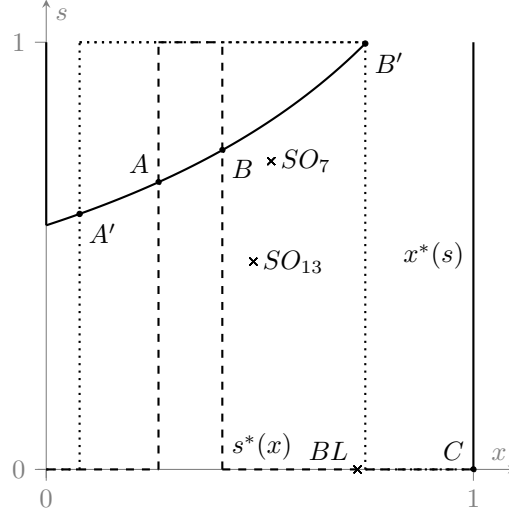
Table 4 summarizes the predictions and realizations for the three main conditions. Figure 5 visualizes the results.

**Table 4:** Experimental predictions and observed realizations (realized overtreatment levels  $x$  are overtreatment levels in strategy).

Condition	Realization	Equilibrium predictions			
		$A$ or $A'$	$B$ or $B'$	$C$	
$BL$	$x^*$	72.92%	–	–	100.00%
	$s^*$	0.00%	–	–	0.00%
$SO_7$	$x^*$	52.70%	7.81%	74.69%	100.00%
	$s^*$	72.18%	59.81%	99.69%	0.00%
$SO_{13}$	$x^*$	48.47%	26.28%	41.21%	100.00%
	$s^*$	48.64%	67.25%	74.75%	0.00%

**Result 1.** *The level of overtreatment in strategy is significantly lower under  $SO_7$  and  $SO_{13}$  than in  $BL$ .*

The level of overtreatment in strategy amounts to 72.92% in the baseline condition but reduces significantly to 52.70% and 48.47% on average when patients can search for a second opinion at low and high search costs, respectively ( $BL$  vs.  $SO_7$ :  $p = 0.0095$ ;  $BL$  vs.  $SO_{13}$ :  $p = 0.0146$ ).



**Figure 5:** Experimental predictions and observed realizations (realized overtreatment levels  $x$  are overtreatment levels in strategy).

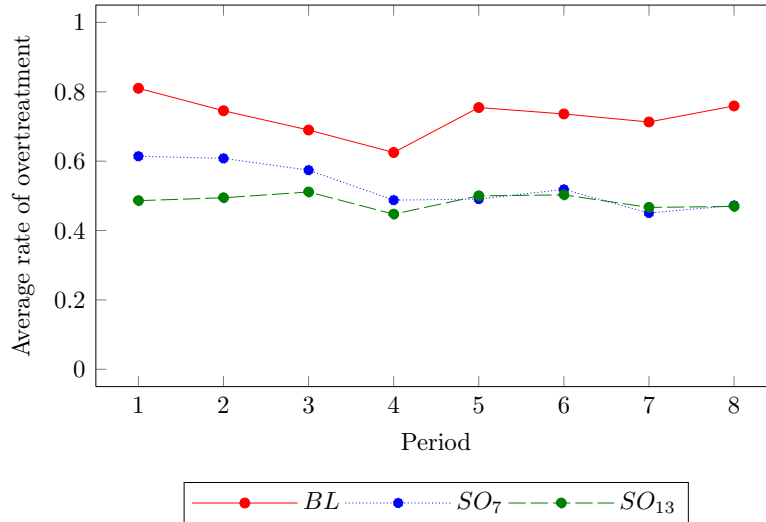
**Result 2.** *Upon receiving a major-treatment recommendation on their first physician visit, patients search significantly more often for a second opinion under  $SO_7$  than under  $SO_{13}$ . Overtreatment levels do not differ significantly between  $SO_7$  and  $SO_{13}$ .*

Upon receiving a major-treatment recommendation on their first physician visit, patients search for a second opinion in almost three quarters of the cases (72.18%) when search costs are low but only in about half (48.64%) of the cases when search costs are high. Hence, a reduction in patients' search costs significantly increases the number of second opinions ( $SO_{13}$  vs.  $SO_7$ :  $p = 0.0143$ ). The overtreatment level in  $SO_7$  is not significantly different from the overtreatment level in  $SO_{13}$  ( $SO_{13}$  vs.  $SO_7$ :  $p = 0.3072$ ).

**Result 3.** *Absolute market efficiency is weakly significantly higher under  $SO_7$  than under  $BL$ . Absolute market efficiency does not differ significantly between  $SO_{13}$  and  $BL$ . Relative market efficiency increases significantly when second opinions are introduced.*

Absolute market efficiency increases weakly significantly (Mann-Whitney  $U$  test:  $p = 0.0516$ ;  $p = 0.030$  according to Panel OLS regression; see *Table 9* in the *Appendix*) when second opinions with low search costs are introduced. There is no significant difference in absolute market efficiency between second opinions with high search costs and the baseline condition, nor between the two conditions with second opinions.





**Figure 6:** Average overtreatment level in strategy.

## 4.2 Overtreatment and second opinions

We first turn to the question of whether second opinions are an effective measure to reduce overtreatment. In a second step, we present the results on the level of second opinions and on how a decrease in search costs impacts the overtreatment level.

### Introduction of second opinions

In accordance with Hypothesis 1, *Result 1* suggests that second opinions may be a feasible instrument to reduce physicians' overtreatment behavior. In fact, we find that physicians reduce their overtreatment level significantly in the following period (by 8.51 percentage points in  $SO_7$  and by 5.65 percentage points in  $SO_{13}$ ) if at least one of their patients searched for a second opinion in the current period (two-tailed sign rank test:  $p < 0.0001$ ). However, the reduction in the overtreatment level only pertains if search costs are sufficiently low, i.e., in the  $SO_7$  condition (see also *Figure 6*). The panel OLS results confirm that the decrease in the level of overtreatment over time in  $SO_7$  is significant (see *Table 8* in the *Appendix*). In the  $SO_{13}$  condition, the level of overtreatment does not vary across time.

The actual level of overtreatment in the baseline condition matches physicians' behavior captured in the strategy method (75.24% vs. 72.92%, see *Table 5*). In the two conditions in which patients can search for a second opinion, the actual level of overtreatment (36.46%) is lower than what we captured with the strategy method

**Table 5:** Overtreatment level in strategy and actual overtreatment level.

Condition	Overtreatment level	
	In strategy	Actual
<i>BL</i>	72.92%	75.24%
<i>SO</i> <sub>7</sub> and <i>SO</i> <sub>13</sub>	50.48%	36.46%

(50.48%) because patients (almost always) only searched for a second opinion if they received a major-treatment recommendation. We can hence conclude from *Table 5* that introducing second opinions leads to an average decrease in the actual overtreatment level of approximately 40 percentage points.

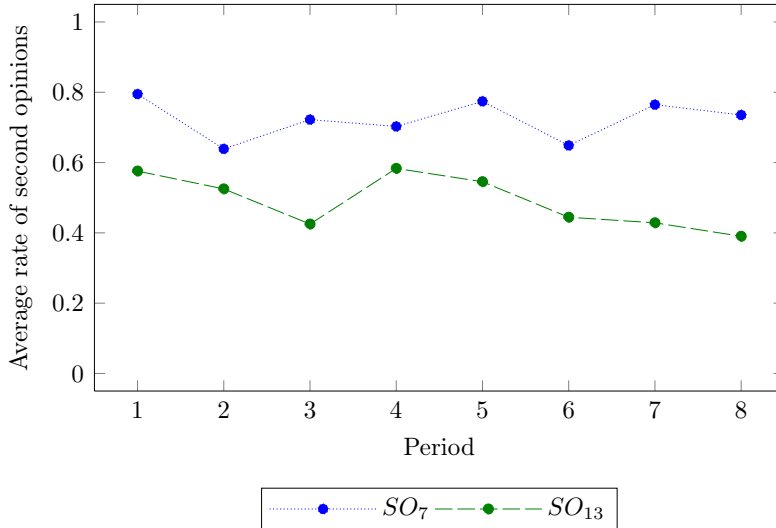
**Very high search costs** Interestingly, the considerable decrease in the level of overtreatment achieved by the introduction of second opinions pertains even when search costs are prohibitively high. In the control condition *SO*<sub>14.5</sub>, we set search costs to  $k = 14.5$ , such that the pure-strategy equilibrium with full overtreatment and no search is the unique equilibrium of the game. Hence, observed physician and patient behavior in our control condition should not differ from the baseline condition. Yet, we find that the overtreatment level in strategy in these two control markets amounts to only 52.77%. The overtreatment level under prohibitively high search costs is thus virtually identical to that found in *SO*<sub>7</sub> and *SO*<sub>13</sub> rather than in *BL*. These results suggest that the mere threat of patients searching for a second opinion may be sufficient to curb physicians' overtreatment behavior.

**Physicians observe # of visit** Thus far, we have assumed that physicians do not know whether patients are on their first or second visit. However, in the health care market, physicians do sometimes know whether patients have previously visited another physician. From a theoretical point of view, physicians should always overtreat patients who are on their second visit because patients will not search for a third opinion in our set-up. Patients anticipate physician behavior and never search for a second opinion. Thus, it is optimal for physicians to always overtreat patients on their first visit as well. Hence, the unique equilibrium of this game is the pure-strategy equilibrium. To investigate the possible implications of physicians knowing which visit patients are on, we conduct the control condition *SO*<sub>7</sub><sup>*Obs*</sup>. We observe that physicians overtreat patients who are on their second visit in 58.16%

of the cases. This is less often than predicted by theory but considerably more often than when a patient is on her first visit (37.33%). Thus, our experimental results again suggest that the threat of searching for a second opinion is sufficient to reduce physicians' overtreatment level.

### **Level of second opinions and the impact of a decrease in search costs on overtreatment**

*Figure 7* shows the average rate of second opinions conditional on major-treatment recommendation over time. Overall, upon receiving a major-treatment recommendation on their first physician visit, patients search for a second opinion in almost three quarters of the cases (72.18%) when search costs are low but only in about half (48.64%) of the cases when search costs are high ( $SO_{13}$  vs.  $SO_7$ :  $p = 0.0143$ ). Note that the patients' search rate in  $SO_7$  is too low compared to the best response to the observed overtreatment level of 52.70%. Conversely, the search rate in  $SO_{13}$  of 48.64% is too high compared to the best response to the observed overtreatment level of 48.47%. However, in ( $SO_{13}$ , the physician's overtreatment level is not far off equilibrium behavior in equilibrium  $B$  (41.21%). Yet, the corresponding search rate in equilibrium  $B$  (74.75%) is higher than the observed search rate. Thus, a careful interpretation is that search rates are too low compared to predictions. Factors that might possibly affect the patients' search rate include risk aversion and retribution. The retribution motive (see, e. g., Boles et al., 2000; Posner, 1980; Abbink et al., 2000) implies that patients punish—despite a loss in expected profits—the recommending physician by searching for a second opinion upon receiving a major-treatment recommendation if they believe to be overtreated. This would thus imply higher search rates, which is not in line with our findings. Patient risk aversion theoretically has the following effects: The acceptance of a major-treatment recommendation leads to the certain costs of  $p_H$ , whereas searching for a second opinion yields the uncertain costs of  $p_L + k$  or  $p_H + k$ . Higher, homogeneous risk aversion is equivalent to an increase in search costs  $k$ . For a sufficiently high level of risk aversion, patients do not search for a second opinion because they prefer to pay the certain treatment costs of  $p_H$ . Note that all patients in the  $SO_7$  condition searched at least once for a second opinion. With heterogeneous risk aversion among patients who might, however, search for second opinions, overtreatment and search levels depend on the composition of patient risk aversion types in the market. Thus, we cannot simply attribute lower search rates to risk aversion.



**Figure 7:** Average rate of second opinions conditional on major-treatment recommendation.

Regarding the effects of a decrease in search costs, *Table 4* shows that patients search for a second opinion under high search costs. In line with Hypothesis 2, we find that a decrease in search costs increases the number of second opinions but does not lead to a decrease in the overtreatment level. Overtreatment in strategy amounts to 48.47% for  $SO_{13}$  and 52.70% for  $SO_7$ , a difference that is not significant ( $p = 0.3072$ ). As mentioned above, in  $SO_{13}$ , the physicians' overtreatment level is not far off the overtreatment level in equilibrium  $B$ . In light of the absolute level of overtreatment and the slightly—but not significantly—higher overtreatment under  $SO_7$  than  $SO_{13}$ , play appears to be closest to the mixed-strategy equilibrium with a high level of overtreatment and many searches for a second opinion on the aggregate level. On an individual market level, the picture is less clear. In none of the markets in  $SO_7$  and in only one of the markets of  $SO_{13}$ , one of the predicted equilibria is played.<sup>31</sup>

**16 periods** One possible conjecture might be that eight periods did not allow players enough time to learn and to coordinate on one of the equilibria. In order to investigate this hypothesis, we conducted the control condition  $SO_7^{16}$  in which patients and physicians interacted for 16 periods. However, we do not find any evidence that coordination behavior improves over time. None of the predicted equilibria was played in either market.

<sup>31</sup>We allow for 10 percentage points deviation between  $s^*$  and  $s$ , and  $x^*$  and  $x$ . In the market in which one of the predicted equilibria is played, it is equilibrium  $B$ .

### 4.3 Efficiency

Market efficiency depends on actual overtreatment and search rates as well as treatment and search costs. We find that the absolute market efficiency increases significantly from 2573 ECU to 2709 ECU when second opinions with low search costs are introduced. The efficiency gain due to the reduction in the overtreatment level exceeds the efficiency loss caused by patients' searches for a second opinion. Different from that, there is no significant difference in absolute market efficiency between the baseline condition and second opinions with high search costs (2573 ECU vs. 2646 ECU). This might seem surprising at first glance, since both, the level of overtreatment in strategy and the search rate, are actually lower under  $SO_{13}$  than  $SO_7$ . However, given that search costs of 13 in  $SO_{13}$  are almost double the search costs in  $SO_7$ , the total incurred search costs per market under  $SO_{13}$  are actually 196 compared to 164 under  $SO_7$ . With similar reductions in the overtreatment level and thus efficiency gains, the larger total incurred search costs under  $SO_{13}$  thus lead to no overall increase in absolute efficiency under  $SO_{13}$ , whereas efficiency increases under  $SO_7$ . Note that Hypothesis 3, relating the reduction in the overtreatment level to an increase in the search rate, was for *given* search and treatment costs. Our results show that under low search costs, the reduction in the overtreatment level is indeed sufficient compared to the increase in the search rate, whereas under high search costs, it is not. It is still remarkable that the absolute efficiency level in  $SO_{13}$  is considerably higher than predicted in any of the equilibria. This is driven by the fact that patients search less often for a second opinion than the theory predicts for equilibria with search, while the overtreatment level is sufficiently low. We do not find a significant increase in absolute efficiency under  $SO_{13}$  from  $BL$ —even though the level of absolute efficiency is actually higher than in the "good" equilibrium  $A$ —due to the fact that actual overtreatment in baseline is lower than predicted by 25 percentage points.<sup>32</sup>

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<sup>32</sup>Regarding the predictions, note that there is a significant difference in efficiency between equilibria  $C$  and  $A$ .

**Table 6:** Efficiency.

Conditions	Efficiency	Realization	Equilibrium predictions		
			<i>A</i> or <i>A'</i>	<i>B</i> or <i>B'</i>	<i>C</i>
<i>BL</i> [2400–3120 ECU]	Pred. abs. eff.	2573 ECU	–	–	2400
	Obs. abs. eff.		–	–	0.00%
	Pred. rel. eff.	24.76%	–	–	0.00%
	Obs. rel. eff.		–	–	0.00%
<i>SO<sub>7</sub></i> [2064–3136 ECU]	Pred. abs. eff.	2709 ECU	2863 ECU	2247 ECU	2400 ECU
	Obs. abs. eff.		75.64%	17.36 %	31.82%
	Pred. rel. eff.	60.21%	75.64%	17.36 %	31.82%
	Obs. rel. eff.		60.21%	17.36 %	31.82%
<i>SO<sub>13</sub></i> [1776–3104 ECU]	Pred. abs. eff.	2646 ECU	2511 ECU	2357 ECU	2400 ECU
	Obs. abs. eff.		54.70%	43.21 %	46.43%
	Pred. rel. eff.	65.49%	54.70%	43.21 %	46.43%
	Obs. rel. eff.		65.49%	43.21 %	46.43%

Absolute efficiency values (Abs. eff.) refer to total average surplus per market over all periods. Relative efficiency values (Rel. eff.) are normalized to the interval  $[0, 1]$ . Relative efficiency of 0 (1) corresponds to the minimum (maximum) absolute efficiency for the respective condition. Numbers in brackets below conditions indicate minimum and maximum absolute efficiency in the respective condition. "Pred." refers to predicted efficiency values whereas "Obs." refers to the observed values.

Relative market efficiency increases significantly from 24.76% to 62.99% on average when the possibility to consult a second physician is introduced (*BL* vs. *SO<sub>7</sub>* and *SO<sub>13</sub>*;  $p < 0.001$ ; see *Table 6*). The difference in relative efficiency between the baseline condition and the conditions with second opinions is more pronounced than the difference in absolute efficiency because the minimum absolute efficiency level decreases when second opinions are introduced.

## 5 Discussion

We conducted our experiment in a general credence goods framing, and only a very small number of subjects had a medical background. In the following section, we will first discuss the role of social preferences in the general credence goods framing before turning to a discussion of how a different subject pool with medical students and a health care framing might affect our results.

**Credence goods framing and social preferences** The level of overtreatment in strategy in our baseline condition is almost 30 percentage points lower than the predicted level (see *Table 4*). The predicted level of full overtreatment is based on the standard assumption that an expert’s objective is to maximize his own payoff. Note that in the baseline condition, full overtreatment, which maximizes the physician’s payoff, also (1) minimizes the patient’s payoff, (2) leads to a patient payoff that is lower than the physician’s payoff, and (3) is the worst outcome in terms of efficiency as unnecessary treatment costs are incurred. This provides a clear-cut analysis of the impact of social preferences in the baseline condition.<sup>33</sup> Anti-social other-regarding preferences do not lead to a worse outcome than predicted under standard preferences whereas pro-social other-regarding preferences such as inequality aversion (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000), efficiency loving (e.g., Charness and Rabin, 2002), and an aversion to recommending a treatment that does not correspond to the actual problem—which is akin to lie aversion (Gneezy, 2005; Brandts and Charness, 2003)—will tend to reduce overtreatment.<sup>34</sup> A strong form of this last aversion would manifest itself in the data in the form of honest types. However, we do not find any evidence of a significant share of honest physician types in our data. Only two out of the 150 physicians never chose to overtreat in strategy, and the overtreatment level in strategy was below 10% for only eight out of the 150 physicians.

To further distinguish between inequality aversion and efficiency loving on the one hand—both of which pertain to allocations per se—and an aversion to recommending an unnecessary treatment on the other—which is specific to the credence goods set-up—, we conducted the control conditions  $BL^{\text{Frame}}$  and  $SO_7^{\text{Frame}}$ .<sup>35</sup> In these conditions, we framed the physicians’ decision as an allocation decision rather than a credence goods context in which physicians “take an action to solve a problem”. Thus, in the control conditions, social preferences with respect to allocations but not the aversion to recommending a treatment that does not correspond to the actual problem should be present. We find that the level of overtreatment rises

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<sup>33</sup>For an analysis of the manifestation of social preferences in a credence goods set-up with and without verifiability and a test for heterogeneity in preferences, see Kerschbamer et al. (2015). The authors find that less than one fourth of their participants behave according to standard preferences; the behavior of a large majority is consistent with either a taste for efficiency or inequality aversion, while a minority behaves spitefully or competitively.

<sup>34</sup>Note that this is not exactly lie aversion, as the physician does not explicitly lie by stating an incorrect problem that the patient faces. Nevertheless, recommending an action that does not correspond to the problem is fairly close to lying about the actual problem.

<sup>35</sup>We will discuss the possible effects of a health care framing separately in the second part of this section.

to 79.17% under  $BL^{\text{Frame}}$  in comparison to 72.92% under  $BL$  (see *Table 7*). Thus, the allocation framing increases overtreatment in strategy but not to the level of 100%. This suggests that, on aggregate, about three-quarters of the difference in the baseline condition between the observed overtreatment and the predicted overtreatment for physicians who only maximize their own material payoff may be attributed to pro-social other-regarding preferences such as inequality aversion and a taste for efficiency. One fourth of the difference might instead be attributed to an aversion to recommending an action that does not correspond to the patient’s problem, which is similar to lie aversion.

**Table 7:** Comparison of overtreatment levels in strategy between credence goods and allocational framing.

Condition	Overtreatment level in strategy	
	Credence goods framing	Allocational framing
Baseline	72.91%	79.17%
Low search costs	52.70%	62.85%

**Subject pool and credence goods versus health framing** Since we conducted our experiment in a general credence goods framing and only a small number of the subjects (eight out of 420) had a medical background, one important concern is how the results and consequently the implications might differ with (i) a subject pool consisting of medical students and (ii) a health care framing in which “solve a problem” is replaced by “cure an illness”.

However, we expect no qualitatively different results or implications with either medical students as subjects and/or a health care framing due to a crucial feature of our experiment: Overtreatment in our set-up means that the patient pays an excessively high price to resolve her problem and that treatment costs are inefficiently high. However, the problem does get solved and the patient’s *health* benefits are not reduced by overtreatment. In particular, the (positive) health benefits do not vary with the amount of services; only payment and efficiency do. Thus, our set-up covers all those cases in which by providing too much, the physician makes a higher profit, but neither harms nor further increases the health benefits of the patient. There are plenty of examples where this is the case, e.g., the use of more expensive materials



than necessary when replacing crowns in dentistry. A fully ceramic crown has the same medical and visual properties as a veneered ceramic crown but is up to four times more expensive.<sup>36</sup> A consequence of our set-up is that (medical) students, if they decide to overtreat, would neither violate the Hippocratic Oath nor the World Medical Association's Declaration of Geneva ("The health of my patient will be my first consideration."). Our set-up is thus in contrast to most other experiments on health care markets where there is no clear separation between the benefits from treatment (health benefits) and payment.

As healths benefit are not affected by overtreatment, we do not expect a qualitative change in results when either medical students are decision makers or the framing is "illness" (which is always cured) rather than "problem" (which is always solved). Kesternich et al. (2015) analyze the effect of the Hippocratic Oath but also vary the framing (medical versus neutral) and the receiver (student versus hospice) with medical students as subjects. They report that the decisions of medical students are similar to those of other types of subjects and that "provision of the good is not, on average, higher in a medical framing" (p. 2) in their dictator games. They do find a strong and positive effect of the Hippocratic Oath on the average amount of the good provided, but only in the medical framing. Note, however, that in light of the above reasoning, we expect the Hippocratic Oath to have a negligible effect in our set-up.

Regarding the subject pool, five recent experimental studies compare medical and non-medical students with respect to the provision of health care services in the lab. In all five studies, patient *health* benefits are affected by the provision decision of physicians. Furthermore, the studies are conducted under a health care framing. Hennig-Schmidt and Wiesen (2014) and Brosig-Koch et al. (2015a) show that in a fee-for-service (FFS) scenario, medical students overprovide patients significantly less often than non-medical students. Furthermore, Brosig-Koch et al. (2015b) show that non-medical students provide significantly more services than medical students under an FFS.<sup>37</sup> In contrast, Brosig-Koch et al. (2013) find almost no significant differences between medical and non-medical students' provision behavior under FFS.<sup>38</sup> Kairies and Krieger (2013) find a significantly

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<sup>36</sup>See, e.g., <http://www.zahnersatzguenstig.com/Kosten-Zahnkrone.html>.

<sup>37</sup>Under a capitation payment system (CAP), neither Brosig-Koch et al. (2015a) nor Brosig-Koch et al. (2015b) find significant differences in subject behavior. Only Hennig-Schmidt and Wiesen (2014) show that medical students underprovide patients significantly less often than non-medical students.

<sup>38</sup>The only exception is one weak significant difference for one out of three disease severities under an FFS. Again, under a CAP, differences between subject pools are not significant.

higher quality of care provided by medical students in comparison to non-medical students, but only under public and not under private feedback.<sup>39</sup> The physicians in our experiment privately observe after each period the number and type of patients that have accepted or rejected their treatment recommendation. Hence, our set-up is closer to the private feedback condition of Kairies and Krieger (2013). Taken together, although several studies show differences between medical and non-medical students, the evidence is still inconclusive and might be sensitive to the specific setting. In particular, as provision affects patient health benefits in all five of these studies, it is not clear whether differences should be observed if overprovision does not affect patient health benefits, which is the case in our setting.

## 6 Conclusion and implications

We conduct a laboratory experiment to analyze the consequences of second opinions in markets for expert services such as health care markets. In our set-up, physicians may increase their own payoff by inducing demand and overtreating their patients. We show that introducing the possibility that patients may reject the first treatment recommendation and receive a second opinion (at a positive cost) significantly reduces physicians' overtreatment. Compared to the situation in which patients have to accept the first treatment recommendation, second opinions reduce the actual overtreatment level by nearly 40 percentage points. Interestingly, results from our control conditions suggest that just the threat of second opinions already helps to curb physician-induced demand. Lowering the costs of obtaining a second opinion leads to significantly more searches for second opinions; however, the overtreatment level does not decrease. Regarding efficiency, we find that the introduction of second opinions under low but not under high search costs increases absolute efficiency in the market. Under low search costs, the positive efficiency effect of the reduction in overtreatment outweighs the negative effect of incurred search costs. Of course, with opposing efficiency effects, the precise magnitudes of treatment cost reductions and search costs (i.e., the parameter choices in the experiment) play an important role in the analysis of and conclusions regarding efficiency gains.

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<sup>39</sup>Feedback refers to a physician's rank with respect to the difference between the provided quantity and the optimal quantity. Under private feedback, each physician observes his rank privately, whereas ranks are published under public feedback.

We have focused on patients' costs of getting a second opinion. Note that the model and experimental set-up allow for a careful further interpretation. Instead of search costs, patients' insurance coverage for the service provided by the physician could be considered. Theoretically, a situation with full insurance coverage is equivalent to the one without second opinions/prohibitively high search costs; an increase in the patient's coinsurance rate mirrors a decrease in (moderate) search costs. Thus, our results on the effect of a decrease in search costs could carefully be interpreted as indicating the effect of an increase in patient co-payments in health care settings when patients can get a second opinion.

Our results suggest that the threat of second opinions in the market might be a valid instrument to incentivize physicians to overtreat less often. Of course, a direct reduction in overtreatment incentives via the price system by the implementation of equal mark-up prices would be superior from a theoretical perspective. Generally speaking, an optimal price system for health care services has to account for and balance incentives for investment in ability and technology, diagnosis and treatment effort, referral decisions, cost efficiency, and many other factors. However, it is precisely the complex nature of physician services and treatment choices and the plethora of different information problems as well as affordability and equity concerns that make the implementation of an optimal price system quite difficult in practice. For example, equal mark-up prices might imply high mark-ups on minor treatments, which could be perceived as unfair. Excessively low mark-ups on major treatments might raise concerns with regard to investments in specialization and technology adoption. Given the problem of implementing optimal prices, second opinions, although inherently inefficient without information problems, are an additional instrument capable of affecting treatment choices. For treatments for which it is known that overtreatment is more of a concern than undertreatment, such as knee or hip joint replacements or caesarians, regulators or managed care organizations should set equal mark-up reimbursements. If this is not feasible, for health problems and treatments where the potential gain from an improvement in the treatment decision is large relative to the costs of obtaining a second opinion, incentivizing second opinions could be a viable option.

In our experiment, physicians are able to perfectly diagnose the patients' problem at no cost. This precludes the possibility of mis-diagnosing due to low diagnosis effort or general diagnosing mistakes. In Pesendorfer and Wolinsky (2003), physicians have to exert effort in order to provide a correct diagnosis. In a market framework similar to that in Wolinsky (1993), Pesendorfer and Wolinsky (2003) show that a price floor

may be efficiency-enhancing. Without a price floor, physicians may free ride on the diagnosis effort provided by other physicians and ensure themselves the service by slightly undercutting the price. An interesting avenue for further research would be to experimentally analyze whether and to what extent price floors are an effective measure to improve physicians' diagnosis efforts as well as outcomes in competitive markets for physician services.

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## A Tables

### A.1 Random effects panel OLS regression: Overtreatment

Table 8: Random effects panel OLS clustered at market level: Overtreatment

Overtreatment	Panel OLS
Period	−0.003 (0.006)
$SO_7$	−0.111 (0.074)
$SO_{13}$	−0.246*** (0.076)
Period* $SO_7$	−0.020** (0.009)
Period* $SO_{13}$	0.000 (0.011)
Constant	0.743*** (0.066)
$R^2$	0.0796
Observations	1200

Standard errors (reported in parentheses) are robust and clustered on the market level. \*:  $p < 0.1$ , \*\*:  $p < 0.05$ , \*\*\*:  $p < 0.01$ .  $p$ -values are based on two-tailed tests.

## A.2 Random effects panel OLS regression: Efficiency

**Table 9:** Random effects panel OLS clustered at market level: Efficiency

Absolute efficiency	Panel OLS
Period	0.272** (0.121)
$SO_7$	2.831** (1.228)
$SO_{13}$	1.508 (1.434)
Constant	52.386*** (1.064)
$R^2$	0.0120
Observations	1200

Standard errors (reported in parentheses) are robust and clustered on the market level. \*:  $p < 0.1$ , \*\*:  $p < 0.05$ , \*\*\*:  $p < 0.01$ .  $p$ -values are based on two-tailed tests.

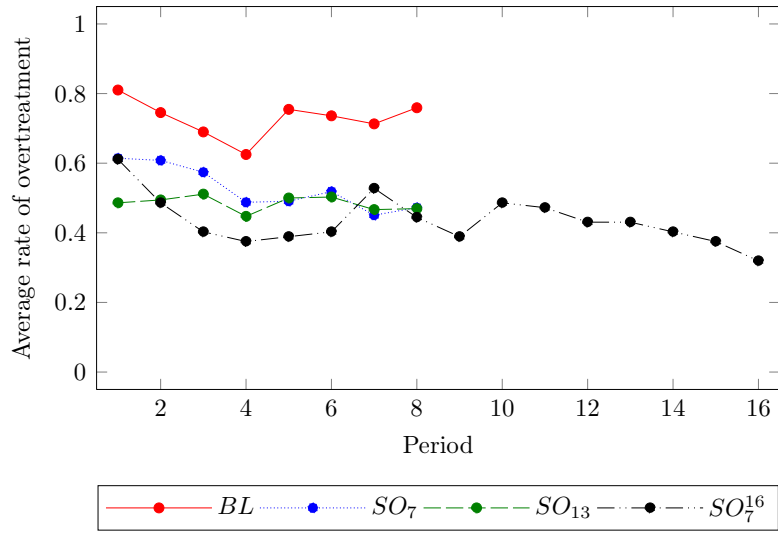
### A.3 Random effects panel OLS regression: Overtreatment including control conditions

**Table 10:** Random effects panel OLS clustered at market level: Overtreatment including control conditions.

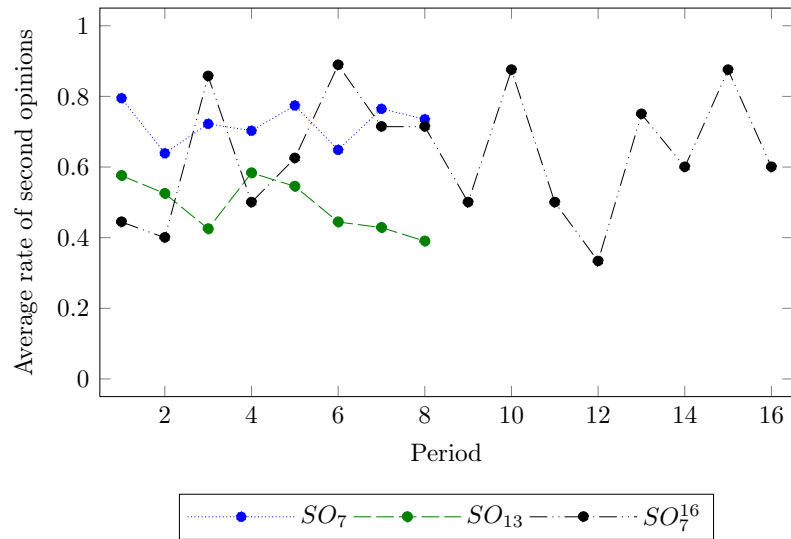
Overtreatment	Panel OLS
Period	-0.010*** (0.004)
$SO_7$	-0.202*** (0.059)
$SO_{13}$	-0.244*** (0.070)
Control $SO_7^{16}$	-0.254*** (0.065)
Control $SO_7^{\text{Obs.}}$	-0.356*** (0.113)
Control $SO_{14.5}$	-0.201*** (0.062)
Control $BL^{\text{Frame}}$	0.063 (0.099)
Control $SO_7^{\text{Frame}}$	-0.101* (0.052)
Constant	0.776*** (0.054)
$R^2$	0.0907
Observations	1776

Standard errors (reported in parentheses) are robust and clustered on the market level. \*:  $p < 0.1$ , \*\*:  $p < 0.05$ , \*\*\*:  $p < 0.01$ .  $p$ -values are based on two-tailed tests.

## B Figures



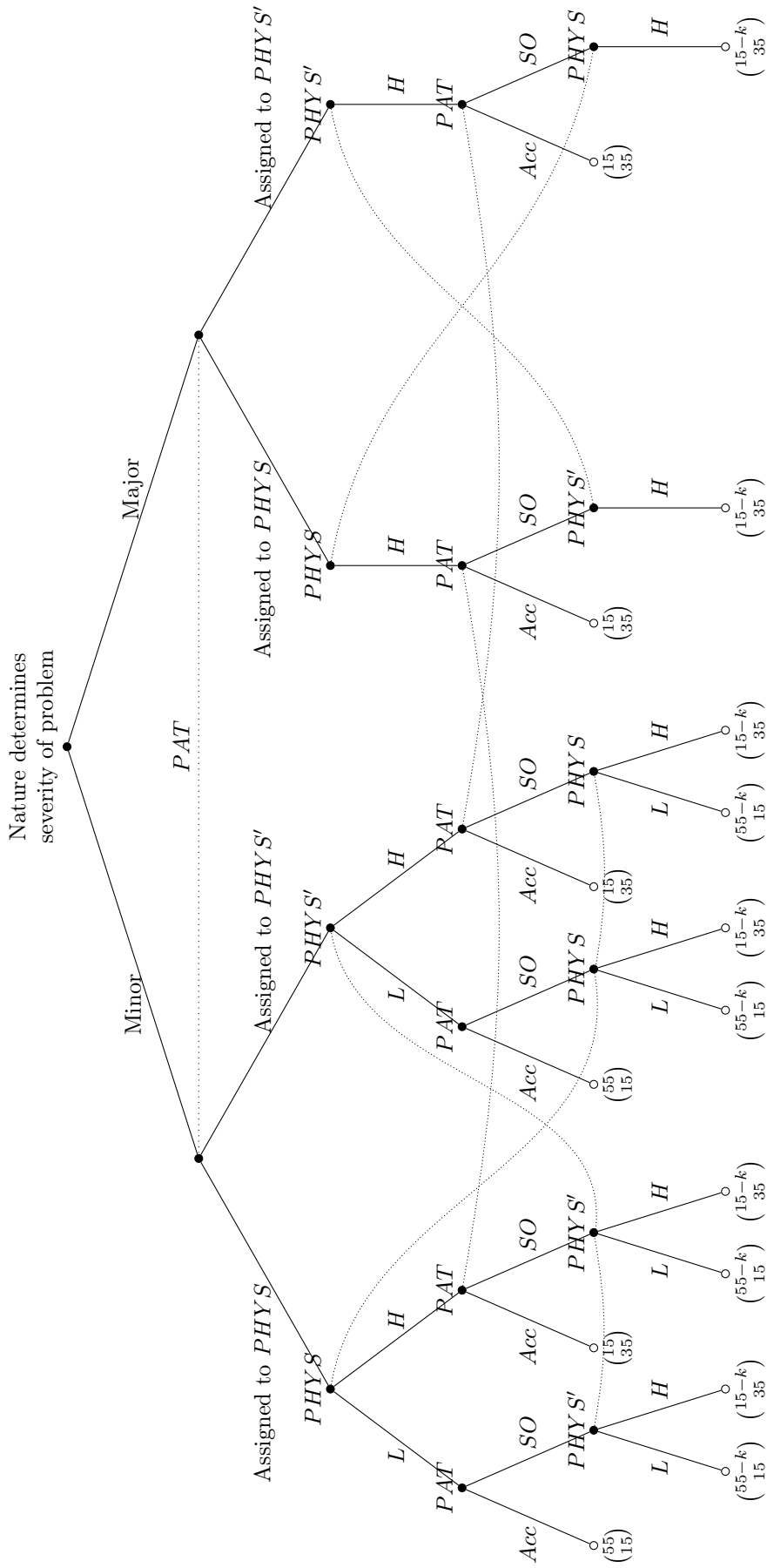
(a) Average level of overtreatment in strategy.



(b) Average rate of second opinions conditional on major-treatment recommendation.

**Figure 8:** Results from the control condition with 16 periods in comparison to results from the main conditions.

## C Game tree



Note: The game tree depicts the stage game for two physicians where patients are randomly matched with a physician (whom they have not visited before).  
Legend: *PAT* = patient, *PHYS* = physician 1, *PHYS'* = physician 2, *L* = low treatment recommendation, *H* = high treatment recommendation, *Acc* = treatment recommendation accepted, *SO* = treatment recommendation rejected; second opinion, *k* = search costs.

## D Instructions

In this section, we present the instructions for the baseline condition. Paragraphs where the instructions for the different experimental condition(s) differ from the baseline condition are put in brackets. The alternative formulations of the baseline condition are listed in blue. A second (third) alternative formulation of the baseline condition is presented in red (green). A minor variation within an alternative formulation is presented in magenta (gray). For all variations, we note the experimental condition(s) to which they apply.

\*\*\*

Thank you for participating in this experiment. Please do not talk to any other participant until the experiment is over. If you have a question, please raise your hand. The experimenter will come to you to answer your question. All participants receive the same information regarding the experiment.

You can earn money depending on your decisions during the experiment. In the experiment, the currency ECU (experimental currency unit) is used. At the end of the experiment, you will be paid according to the following exchange rate:

$$1 \text{ ECU} = 5 \text{ euro cent.}$$

### Groups and roles

There are 24 participants in today's experiment. The participants are randomly divided into two groups that remain unchanged throughout the experiment. In every group, there are six players  $A$  and six players  $B$ . At the beginning of the experiment, you are randomly assigned the role of player  $A$  or  $B$ . You keep this role throughout the experiment. You are informed about your role on the first screen.

### Sequence of decisions in each round

This experiment consists of [eight]  $[SO_7^{16}: 16]$  rounds, each of which consists of an identical sequence of decisions. During these [eight]  $[SO_7^{16}: 16]$  rounds, you only interact with the other members in your group. In each round, player  $B$  has exactly one of two problems: either [problem]  $[BL^{Frame}/SO_7^{Frame}: attribute]$  1

or [problem]  $[BL^{Frame}/SO_7^{Frame}: attribute]$  2. In each round, player  $B$ 's [problem]  $[BL^{Frame}/SO_7^{Frame}: attribute]$  is determined randomly and independently of the other players' [problems]  $[BL^{Frame}/SO_7^{Frame}: attributes]$ . With a probability of 75%, player  $B$  has [problem]  $[BL^{Frame}/SO_7^{Frame}: attribute]$  1 and with a probability of 25%, player  $B$  has [problem]  $[BL^{Frame}/SO_7^{Frame}: attribute]$  2. At no point in time does player  $B$  learn whether he has [problem]  $[BL^{Frame}/SO_7^{Frame}: attribute]$  1 or 2.

[Player  $A$  must solve player  $B$ 's problem by choosing one of the two possible actions (action 1 or action 2). Player  $A$ 's choice set depends on player  $B$ 's problem. If player  $B$  has problem 1, then player  $A$  can solve it by opting for either action 1 or 2, i.e., player  $A$ 's action does not have to match player  $B$ 's problem. If player  $B$  has problem 2, then player  $A$  must choose action 2 to solve it. Player  $B$  can observe the action chosen by player  $A$ , but he cannot tell which problem he has. Action 1 results in costs of 60 ECU for player  $A$ , and action 2 leads to costs of 80 ECU.

The price for action 1 is fixed at 75 ECU; the price for action 2 is fixed at 115 ECU.]

*$[BL^{Frame}/SO_7^{Frame}: Player A can choose between two payoff scenarios (payoff scenario 1 or 2) if player B has attribute 1. If player A selects payoff scenario 1, player A receives 15 ECU and player B receives 15 ECU. If player A chooses payoff scenario 2, player A receives 35 ECU and player B receives 55 ECU. If player B has attribute 2, player A must choose payoff scenario 2, i.e., player A receives 35 ECU and player B receives 15 ECU.]$*

### *$[SO_7^{Obs}: Overview of decisions in each round$*

*In each round, three decisions are made.*

- 1. Player  $A$  chooses an action for every player  $B$  with problem 1 who is initially assigned to him.*
- 2. Player  $A$  chooses an action for every player  $B$  with problem 1 who is assigned to him after switching players  $A$ .*
- 3. Player  $B$  observes the action chosen by player  $A$  and decides whether he accepts the action or switches to another player  $A$  (= second opinion).*

### *Detailed description of decisions and the resulting payoffs in each round/*

[At the beginning of each round, player  $A$  chooses an action for every player  $B$  in case he interacts with this player  $B$  and player  $B$  has problem 1 (see the screenshot



at the top of the following page).]  $[SO_7^{obs.}]$ : At the beginning of each round, player  $A$  makes two decisions for all six players  $B$  (see screenshot 1).

1. Player  $A$  chooses an action for every player  $B$  with problem 1 who is initially assigned to him.
2. Player  $A$  chooses an action for every player  $B$  with problem 1 who is assigned to him after switching players  $A$ .]

$[BL^{Frame}/SO_7^{Frame}]$ : At the beginning of each round, player  $A$  chooses a payoff for every player  $B$  in case he interacts with this player  $B$  and player  $B$  has attribute 1 (see the screenshot at the top of the following page).]

When making these decisions, player  $A$  does not know for which of the six players  $B$  he is choosing [an action]  $[BL^{Frame}/SO_7^{Frame}]$ : a payoff scenario]. The allocation of players  $B$  in the table is random. This means that player  $A$ 's first decision applies to the interaction with player  $B1$  with a probability of  $1/6$ , with player  $B2$  with a probability of  $1/6$ , with player  $B3$  with a probability of  $1/6$ , etc.

Next, every player  $B$  is randomly assigned to a player  $A$ . The probability that a certain player  $B$  is assigned to a certain player  $A$  equals  $1/6$ .

[Player  $B$  observes whether the player  $A$  he interacts with has chosen action 1 or 2 for him (see screenshot 2). Player  $B$  receives the action offered. Player  $B$  pays player  $A$  the price for the action chosen. Hence, player  $B$  does not make any decision throughout the entire experiment. At the end of each round, both players  $A$  and  $B$  are informed of their respective profits (see below).

Player  $A$  additionally observes the number of players  $B$  who were assigned to him, which action he chose for the player(s)  $B$  he interacted with, and which problem player(s)  $B$  had.]  $[SO_7/SO_7^{16}]$ : Player  $B$  observes whether the player  $A$  he is interacting with has chosen action 1 or 2 for him (see screenshot 2). Then, player  $B$  decides whether he accepts the action or switches to another, randomly assigned player  $A$  at a cost of [7 ECU]  $[SO_{13}: 13 \text{ ECU}]$   $[SO_{14.5}: 14.5 \text{ ECU}]$ . The probability of being assigned to one particular remaining player  $A$  equals  $1/5$ .

If player  $B$  accepts the action, he receives the action offered. Player  $B$  pays player  $A$  the price for the action chosen. If player  $B$  switches to another player  $A$   $[SO_7^{obs.}]$  (= second opinion)], he receives the action chosen by that player  $A$  in advance for the respective player  $B$  (depending on the problem). Player  $B$  can observe the action

player A uses to solve the problem. However, player B still does not know which type of problem he had. Player B must pay the price for the action taken by player A. At the end of each round, both players A and B are informed of their respective profits (see below).]

[At the end of each round, player A additionally observes the number of players B who were assigned to him (= sum of players B initially assigned to player A and those who decided to switch players A and were then assigned to this player A), which action he chose for the player(s) B he interacted with, and which problem player(s) B had.] [SO<sub>7</sub><sup>obs.</sup>: At the end of each round, player A additionally observes the number of players B who were initially assigned to him, which action he chose for the player(s) B he interacted with, and which problem player(s) B had. Also, player A observes the number of players B who were assigned to him after switching players A, which action he chose for the player(s) B he interacted with, and which problem player(s) B had.] Moreover, player A observes how many players B did not accept his proposed action and switched to another player A. For any player B who switched players A, player A observes which action he would have chosen, and which problem player(s) B had (see screenshot 3).]

[BL<sup>Frame</sup>: Player B observes which payoff scenario player A has chosen (see screenshot 2). Hence, player B does not make any decision throughout the entire experiment. At the end of each round, both players A and B are informed of their respective profits (see below).

Player A additionally observes the number of players B who were assigned to him, which payoff scenario he chose for the player(s) B he interacted with, and which attribute player(s) B had.]

[SO<sub>7</sub><sup>Frame</sup>: Player B observes which payoff scenario player A has chosen (see screenshot 2). Then, player B decides whether he accepts the action or switches to another, randomly assigned player A at a cost of 7 ECU. The probability of being assigned to any particular remaining player A equals 1/5.

If player B accepts the action, he receives the payoff chosen. If player B switches to another player A, he receives the payoff chosen by that player A in advance for the respective player B (depending on the attribute). Player B can observe the payoff. However, player B still does not know whether he had attribute 1 or 2.

At the end of each round, player A additionally observes the number of players B who were assigned to him (= sum of players B initially assigned to player A and those who decided to switch players A and were then assigned to this player A),

*which payoff scenario he chose for the player(s) B he interacted with, and which attribute player(s) B had. Moreover, player A observes how many players B did not accept his proposed payoff and switched to another player A. For any player B who switched players A, player A observes which payoff scenario he would have chosen, and which attribute player(s) B had (see screenshot 3).]*

## **Payoffs**

[The profit per round for player A is the sum of profits from every player B which are equal to:

$$\text{price} - \text{costs.}]$$

*[BL<sup>Frame</sup>: The profit per round for player A is the sum of payoffs from every player B.]*

[The profit per round for player B is as follows:

$$[130 \text{ ECU} - \text{price.}]$$

*[SO<sub>7</sub>/SO<sub>13</sub>/SO<sub>7</sub><sup>16</sup>/SO<sub>7</sub><sup>Obs.</sup>/SO<sub>14.5</sub>/SO<sub>7</sub><sup>Frame</sup>: 130 ECU – price – switching costs (if applicable).]*

*[BL<sup>Frame</sup>: The profit per round for player B is equal to his payoff per round.]*

The profits from each round are summed up for every player and paid out in cash. You also receive a show-up fee of 2.50 euro and 2.50 euro for answering the control questions.

\*\*\*

## Screenshots baseline:

Period		2 of 8				Remaining time [sec]: 23	
Price.action 1/Price action 2	A Player B	A Player B	A Player B	A Player B	A Player B	A Player B	
	(75 / 115)	(75 / 115)	(75 / 115)	(75 / 115)	(75 / 115)	(75 / 115)	
Choose your action in case that this player B has problem 1 and is assigned to you [1=action 1,2=action 2]	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="button" value="OK"/>							

Figure 9: Screenshot 1.

Period		2 of 8				Remaining time [sec]: 0	
<b>Please decide now!</b>							
<b>You have received action 2 and made a profit of 15ECU.</b>							
<input type="button" value="OK"/>							

Figure 10: Screenshot 2.

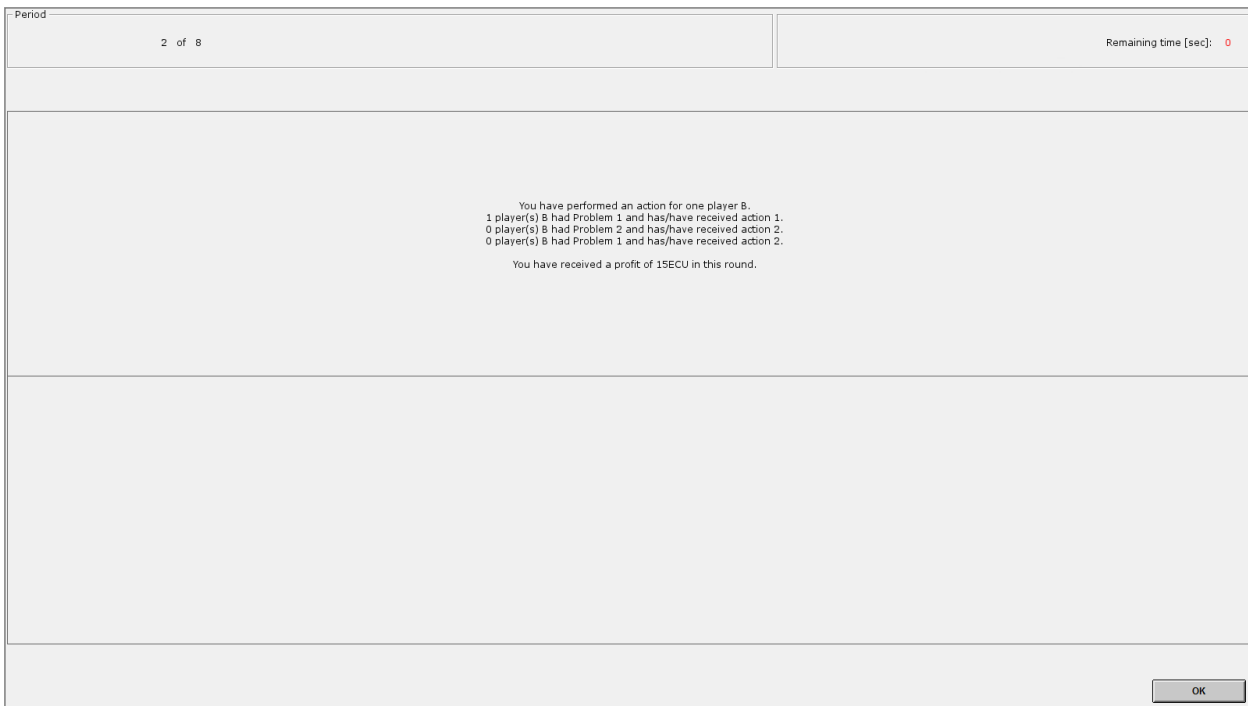


Figure 11: Screenshot 3.

## Screenshots in conditions with second opinions (here $SO_7$ ):

Period 2 of 8 Remaining time [sec]: 23

	A Player B	A Player B	A Player B	A Player B	A Player B	A Player B
Price action 1/Price action 2	(75 / 115)	(75 / 115)	(75 / 115)	(75 / 115)	(75 / 115)	(75 / 115)
Choose your action in case that this player B has problem 1 and is assigned to you [1=action 1, 2=action 2]	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

OK

Figure 12: Screenshot 1.

Period 2 of 8 Remaining time [sec]: 0 Please decide now!

You are recommended action 2.  
Would you like to obtain a second opinion?

Yes  
 No

OK

Figure 13: Screenshot 2.

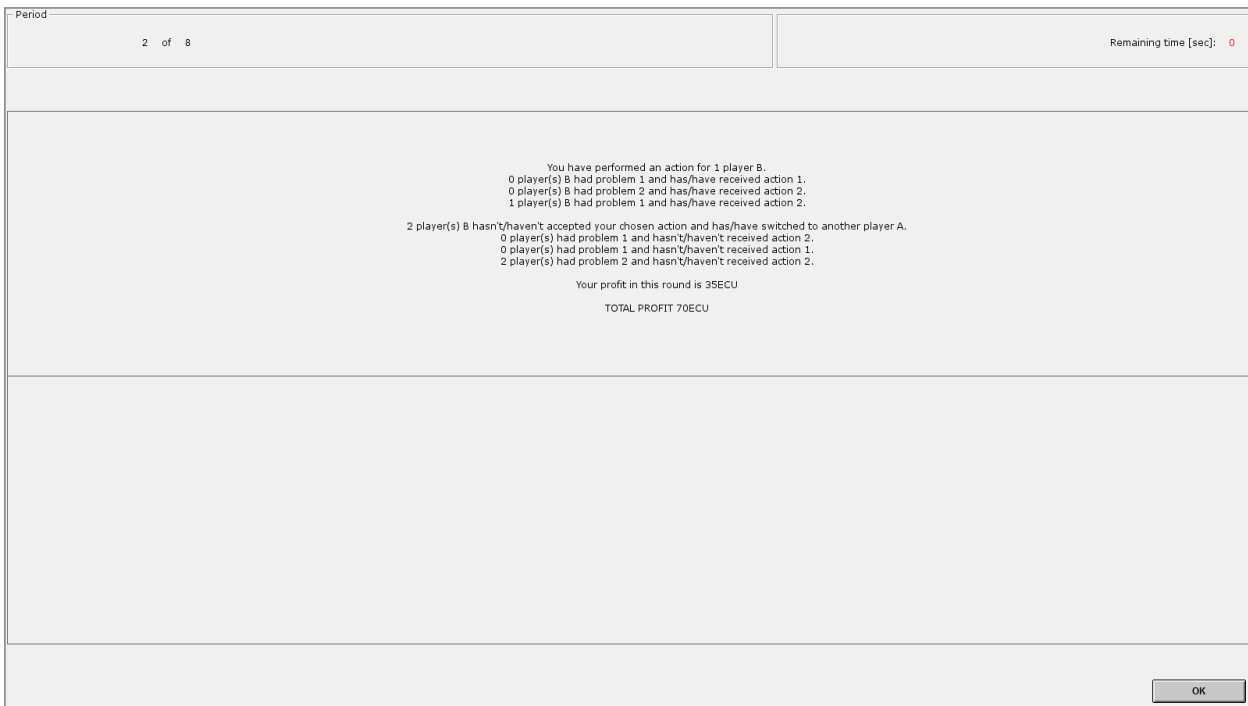


Figure 14: Screenshot 3.

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