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Price competition and reputation in credence goods markets: Experimental evidence*

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Abstract

In credence goods markets, experts have better information about the appropriate quality of treatment than their customers. Because experts provide both the diagnosis and the treatment, there is opportunity for fraud. We experimentally investigate how the intensity of price competition and the level of customer information about past expert behavior influence experts' incentives to defraud their customers when experts can build up reputation. We show that the level of fraud is significantly higher under price competition than when prices are fixed, as the price decline under a competitive-price regime inhibits quality competition. More customer information does not necessarily reduce the level of fraud.

JEL classification: D82; L15.

Keywords: Credence good; expert; fraud; price competition; reputation; overcharging; undertreatment.

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1 Introduction

In the United States, it is estimated that fraud accounts for up to 10% of the over 2 trillion USD in annual healthcare expenditures (Federal Bureau of Investigation, 2007). Such fraud includes upcoding of services, providing and charging for unnecessary services, and supplying insufficient treatment (implying the willingness to risk patient harm). Europe's largest automobile club, the German Automobile Association (ADAC; *Allgemeiner Deutscher Automobil-Club e. V.*), reports that about 5% of auto-repair shops they investigated charged for more work than was actually provided.

The potential for fraud in these markets exists due to asymmetric information between the provider and the customer: The provider is an expert on the quality of the good or service the customer needs or on the surplus from trade and, in most cases, supplies both the diagnosis and the treatment. The customer, in contrast, does not know what level of service she needs and might not be able to verify all relevant aspects of trade (Dulleck and Kerschbamer, 2006). Goods with these properties are termed "credence goods," as the customer is forced to rely on the expert's advice.[1] Experts may potentially undertreat their customers (i.e., provide insufficient quality/treatment), overtreat their customers (i.e., provide a quality/treatment that was not necessary) and/or overcharge their customers (i.e., charge for a treatment that was not provided). Whether an expert can and will exploit his informational advantage crucially depends on the market environment and financial incentives. Providing insufficient treatment and overcharging for his services might be profitable for an expert if he cannot be held (fully) liable and does not risk losing future business. In addition to the healthcare and auto-repair markets, many other service markets exhibit properties of credence goods—in particular, many of the so-called "professional services" (or "liberal professions").[2]

Typically, customers can identify the expert with whom they interact and can obtain some information about expert behavior, either from their own past interactions with the expert or through public information such as personal recommendations or public rating/feedback devices. A prime example of a public feedback platform is *GoogleMaps*. Customers of auto-repair shops can rate the (perceived) quality of the

[1]The seminal paper on expert markets is by Darby and Karni (1973). Dulleck and Kerschbamer (2006) provide a comprehensive survey of the literature and develop a unifying model.

[2]Liberal professions are "occupations requiring special training in the liberal arts or sciences" (Commission of the European Communities, 2004, p. 3). Apart from medical services, these include architectural, engineering, legal, and accounting services, as well as notaries, among other professions.

provided services, allowing other customers to search more effectively for a reliable mechanic.[3]

Experts compete primarily in two dimensions: prices and the quality of the provided credence good. When there is fierce price competition, experts' incentives to provide sufficient quality and to build up a reputation for quality might be impeded. Thus, one possible rationale for regulated/fixed prices (i.e., restricting price competition) in credence goods markets is that price competition is harmful to customers and induces fraudulent expert behavior.

In this paper, we conduct a laboratory experiment to investigate experts' incentives to defraud their customers under price competition and a fixed-price regime when experts have the opportunity to build up reputation. In our set-up, experts can both undertreat (i.e., provide insufficient quality/treatment) and overcharge (i.e., charge for a treatment that was not provided).[4] Whereas overcharging cannot be verified, the customer can observe ex-post whether the treatment was sufficient. We vary the degree of customer information about past expert behavior, implementing private histories and public histories (see *Table 1*).[5] Under private histories, customers are able to identify the experts with whom they interact and have knowledge of their *own* history with each expert (i.e., whether previous treatments were sufficient and what prices were charged), whereas under public histories, customers can observe *all* customers' histories with experts with regard to undertreatment and prices charged.[6]

We find that the level of undertreatment is significantly higher under price competition than when prices are fixed. In the early periods (in which reputational concerns play a role), customers return significantly less often to experts who have undertreated them under fixed prices than under price competition. Furthermore, under price competition, we observe a price pressure that undermines reputation-building in the early periods: Customers choose the cheapest experts in the first period. These undertreat at a relatively high rate, and experts who undertreated in previous periods offer lower

[3] *GoogleMaps* is displayed in *Figure 9* in *Appendix B*. Another example of a public feedback platform is the *Arztnavigator* ("physician navigator") in Germany. Using a standardized questionnaire, the *Arztnavigator* polls patients about their last physician visit and then publishes the results. This allows patients to compare physicians with respect to the quality of services perceived by other patients. The *Arztnavigator* is displayed in *Figure 10* in *Appendix B*.

[4] Note that we refer to experimental "conditions" instead of "treatments" to distinguish between experts' treatments and experimental conditions.

[5] Huck et al. (2012) analyze private versus public histories in trust games.

[6] We thank a referee for pointing out that in the real world, customers might not immediately observe undertreatment. Delayed feedback on undertreatment makes reputation-building on quality even more difficult. Because we consider reputation-building on quality in a credence goods market to be a complex process already, we did not implement a further condition with delayed feedback.

Table 1: Experimental set-up: Conditions.

		Reputation mechanism	
		Private histories	Public histories
Price system	Fixed	*PRH Fixed*	*PUH Fixed*
	Competitive	*PRH Comp*	*PUH Comp*

prices in the following periods, which reduces incentives to treat sufficiently in subsequent periods. Overall, our results indicate that quality reputation equilibria are played under fixed but not competitive prices.

With regard to customer information, we do not find significant differences between private and public histories under either price competition or fixed prices. However, public histories are associated with lower levels of undertreatment compared to private histories when prices are fixed, whereas the opposite is true under price competition. For customers' choices of experts, we find that under price competition, public information about expert undertreatment is less important than customers' private undertreatment histories with experts. Thus, under price competition, the potentially disciplining effect of more quality information at the market level is not observed; instead, customers select experts based on their own histories. Under fixed prices, undertreatment levels are already low so that the additional customer information does not lead to any additional decrease in the undertreatment level.

Results on the second dimension of fraud (overcharging) mirror the results on undertreatment: The level of overcharging is significantly higher under price competition than under fixed prices. Furthermore, under price competition, the level of overcharging is weakly significantly higher under public histories than private histories.

Our results suggest that when customers are price-sensitive, price competition in credence goods markets undermines reputation-building on the quality of the provided service and induces higher levels of fraud than when experts cannot compete in prices. More market information about experts' past behavior does not necessarily lead to an improvement in quality.

Related literature

The seminal experimental article on credence goods is Dulleck et al. (2011). The authors analyze experts' fraudulent behavior in markets with price competition and various institutional features, showing that liability reduces the fraud level, whereas verifiability and reputation with private histories fail to significantly improve the market outcome. We complement and extend their analysis in two important directions. Firstly, we analyze fixed prices in a market in which reputational concerns play a role. This is motivated by the fact that the largest credence goods market in most economies—the healthcare market—is characterized by price regulation and identified experts. Secondly, we implement public histories, whereby customers observe all other customers' histories as well as their own. This reputation mechanism emulates the online feedback platforms frequently observed in the real world.

Dulleck et al. (2012) implement a credence goods experiment with fixed prices but without reputational concerns, investigating whether *good* experts who always treat sufficiently set high prices, or whether it is the high prices that induce sufficient treatment. The authors show that *good* experts signal their type using the price, but that high prices do not induce sufficient treatment. In their setting, endogenous prices lead to a more efficient market result. We show that if customers can identify the expert with whom they are trading (i.e., experts can build up reputation by not undertreating), fixed prices lead to a more efficient market outcome than price competition. The underlying reason is that price competition reduces experts' mark-ups, which makes it less attractive to provide sufficient quality.

Another experimental article investigating the impact of reputation on expert fraud is Grosskopf and Sarin (2010). In their setting, customers have incomplete information about the type of project that maximizes their payoff and the type of expert they are facing. The *good* expert has payoffs in line with those of the customer, whereas the *bad* expert does not. In contrast to customers, experts know which type they are and which type of project will maximize the customer's payoff. Customers meet each expert once in a randomly determined order, observe the expert's past actions if reputation is in place, and decide whether they want to interact. The authors find that reputation-building always increases the expert's payoff—even when theory predicts the opposite. In contrast to Grosskopf and Sarin (2010), where experts do not compete in prices for customers, we focus on how price competition changes experts' incentives to defraud. Furthermore, we allow customers to choose the expert with whom they wish to interact on the basis of the experts' reputations.

The first field experiment on reputation in a credence goods market was conducted by Schneider (2012), who examined whether reputational concerns reduced a mechanic's incentive to defraud his customer. The author intentionally damaged a car and then took it to several different garages. In one treatment, in order to signal repeated interaction, he left a home address close to the garage and stated that he was hoping to find a regular mechanic. In the other treatment, in order to signal a one-time interaction, he announced that he would be moving away soon. Although Schneider (2012) experienced both extensive over- and undertreatment, he concludes that there is no evidence that reputation might alleviate these problems.

A second strand of the experimental literature that is related to our study is the literature on trust games (see, e.g., Berg et al., 1995; Anderhub et al., 2002; Brown et al., 2004). Among these articles, the two contributions by Huck et al. (2012, 2016) are closest to our work. The authors find that the possibility to choose between trustees increases trust, as does price regulation. Introducing public histories only minimally improves trust rates once the free trustee choice is in place, as trust rates under private histories are already very high. The key difference between the trust games in Huck et al. (2012, 2016) and credence goods markets is that there is asymmetric information between customers and experts in credence goods markets, whereas trust games are characterized by symmetric information between trustors and trustees. Whereas price competition by itself cannot eliminate the inefficiencies arising from undertreatment in our market with asymmetric information, it theoretically results in efficient outcomes in the trust games of Huck et al. (2012, 2016).[7] In comparison to symmetric information, asymmetric information impedes reputation-building. In our set-up, customers do not know whether they suffer from a minor or a major problem, nor can they observe the type of treatment they receive. Experts mainly build up reputation by providing sufficient quality. However, customers with a minor problem always receive sufficient quality. Only customers with a major problem may be undertreated. Hence, the observation of an expert providing sufficient quality is a much weaker signal about expert behavior than rewarded trust in trust games, where the observation of rewarded trust perfectly signals that an expert chose to do so.[8] In addition, we consider two dimensions of fraud: undertreatment and overcharging.

Our analysis shows that reputation-building is possible in a credence goods market, but that difficulties in reputation-building are mirrored in the results. In Huck et al. (2016),

[7]In Huck et al. (2012, 2016), the difference between low and high quality in the trust games is purely redistributional.

[8]For example, in the trust game with fixed prices in Huck et al. (2016), full-trust equilibria with high quality up to round 28 of 30 can be sustained if the strategy of any trustee is to simply no longer select a trustor who has not previously rewarded the trustee's trust. Another difference that eases building and rewarding trust in Huck et al. (2016) is that experts can only decide to reward or to exploit all customers that chose to trust. In our credence goods set-up, experts can choose an individual treatment for each customer.

trust is virtually always rewarded under fixed prices and public histories, whereas only three-quarters of customers receive sufficient treatment in our corresponding condition. Additionally, the impairment of quality competition under price competition turns out to be much stronger in the credence goods markets than in the trust games.

The remainder of this paper is organized as follows. The next section provides the market description. In *Section 3*, we present the experimental set-up including the parametrization. In *Section 4*, we identify market equilibria for the given parametrization and derive predictions. The results are discussed in *Section 5*. The final section concludes.

2 Market

We model a credence goods market with the potential for undertreatment and overcharging as in Dulleck et al. (2011). There are four experts and four customers in the market. We assume that each of the customers suffers from either a minor or a major problem. Each customer knows that she has a problem but does not know which type of problem she suffers from. A customer's ex-ante probability of suffering from a major problem is h; the probability of suffering from a minor problem is $1-h$. These ex-ante probabilities are common knowledge. An expert is able to identify the problem by performing a costless diagnosis.[9] Treating the minor problem costs an expert c_L, whereas treating the major problem costs an expert c_H (with $c_H > c_L$). The treatment for the major problem t_H heals both types of problems. The treatment for the minor problem t_L only heals the minor problem. Experts are not liable, as undertreatment is not sanctioned—that is, experts may treat a customer suffering from a major problem with the minor treatment with impunity. The customer cannot observe the treatment, but she can verify the treatment's outcome (i.e., the customer can tell whether the expert has undertreated her). Observing undertreatment is feasible because the customer is aware of whether or not her problem has been resolved (Dulleck and Kerschbamer, 2006). The prices for the treatments are denoted by p_L and p_H, respectively (with $p_L \leq p_H$). Hence, the expert might have an incentive to undertreat and/or to overcharge his customer.

The stage game depends on the experimental condition. In the following paragraphs, we outline the stage game for a market with price competition. We differentiate

[9] We assume zero diagnostic costs in order to make our results comparable to those in Dulleck et al. (2011).

between private and public histories by denoting them in the stage game by $'$ and $''$, respectively. The stage game is played repeatedly for n periods for each condition. The stage game for a market with price competition is as follows:

1. For each of the customers, nature independently draws the type of problem the customer suffers from. A customer suffers from a major problem with probability h and from a minor problem with probability $1 - h$.

2. Each expert posts a price menu (p_L, p_H) for the minor and major treatment.

3.$'$ Each customer observes each expert's price menu posted in the current period as well as her own private history[10] as specified below.

3.$''$ Each customer observes each expert's price menu posted in the current period as well as the public histories as specified below.

4. Each customer chooses an expert or decides not to interact.

5. Each expert observes the type of problem for each customer who chose to interact with him in step 4. Each expert then provides an individual treatment t_L or t_H for (each of) his customer(s).

6. Each expert with an interaction charges (each of) his customer(s) an individual price p_L or p_H.

7. Each expert observes his payoff and each customer observes her payoff from the current period.

The stage game under fixed prices only differs from the above stage game in that experts cannot post prices in step 2. Instead, the exogenously given price sequence over the n periods is common knowledge among the players before the first period starts.

The expert's payoff is determined by the price p_i charged less the cost c_j of the treatment t_j applied ($i, j \in \{L, H\}$), where i and j do not have to coincide. Hence, in a given period, the expert's profit per customer amounts to $\pi_e = p_i - c_j$. If no customer decides to interact with the expert, the expert's payoff amounts to σ. If the customer

[10]Note that a rational customer accumulates a private history over the course of the game and is always aware of her history. However, participants in the experiment might forget or misremember parts of their histories. We therefore display the private history in this step of the stage game as a reminder.

decides to interact and is not undertreated, the customer derives a utility of v. If she decides to interact and is undertreated, she derives a utility of zero. In either case, the customer must pay the price p_i charged by the expert for the treatment. In a given period, the customer's payoff therefore amounts to $\pi_c = v - p_i$ if the customer is not undertreated and $\pi_c = -p_i$ if she is undertreated. If the customer decides not to enter the market, her payoff amounts to σ.

The information customers observe in step 3 of the above stage game depends upon the experimental condition.

Private histories[11]
Under private histories, each customer observes the following for each of the previous periods and for the expert she interacted with in the respective periods: the prices posted by this expert, whether this expert charged the price for the minor or the major treatment, whether this expert undertreated her, and her payoff. A customer does not observe how many customers an expert served in any of the previous periods besides herself.

Public histories
Under public histories, each customer observes the following for each of the previous periods and each of the customers: the expert the customer interacted with, the prices posted by this expert, whether this expert charged the price for the minor or the major treatment, whether the expert the customer interacted with undertreated her, and what the customer's payoff was. Each customer thus also observes how many customers an expert served in any of the previous periods.

3 Experiment

3.1 Design

We apply a 2×2 factorial design. In all four conditions, the parameters are fixed and identical to those in the experiment conducted by Dulleck et al. (2011). The ex-ante probability of a customer having a major problem is $h = 0.5$. The expert's costs are $c_L = 2$ for providing a minor treatment and $c_H = 6$ for a major treatment. The customer derives a utility of $v = 10$ if her problem is resolved. Otherwise, the

[11] Note that the categories of information that customers observe are the same as in Dulleck et al. (2011).

customer's utility amounts to $v = 0$. Should no interaction take place, customers and experts both receive a payoff of $\sigma = 1.6$ (outside option).

The stage game is repeated for 16 periods. In all conditions, we use matching groups of eight players. The assignment of the eight players to a matching group remains unchanged throughout the experiment. Four of the players take on the role of customers; the remaining four take on the role of an expert. The roles are randomly assigned at the beginning of the experiment and do not change throughout the 16 periods. Across conditions, we vary the reputation mechanism between private and public histories and the pricing regime between fixed prices and price competition.

In the conditions with price competition, experts announce prices $\{(p_L, p_H) \in \mathbb{N}^2 | 1 \leq p_L, p_H \leq 11, p_L \leq p_H\}$ in step 2 of the stage game. In the fixed price conditions, we set the exogenously given prices $(p_L, p_H) = (4, 8)$ in periods 1–9 and $(p_L, p_H) = (0, 3)$ in periods 10–16.[12] In periods 1–9, there is no obvious way to choose the fixed prices. We use the price vector of $(p_L, p_H) = (4, 8)$ for two reasons. Firstly, and most importantly, equal mark-ups ensure that the experts' profits do not differ between the two treatments if experts treat and charge honestly such that there is no price vector induced incentive to defraud. Secondly, the two equal mark-up vectors $(4, 8)$ and $(3, 7)$ are the most frequently posted price vectors in the first period in the conditions with price competition. Thus, by choosing one of the two equal mark-up vectors, we approximate the expert pricing behavior observed under price competition.

Note that under price competition, equilibria exist in which experts post a price p_H that is below marginal costs for the major treatment (see *Section 4* and *Appendix A.2*). Thus, experts incur losses if they do not undertreat a customer with a major problem. Exogenously inducing expert losses by setting a price that is below costs for the major treatment may increase experts' undertreatment in comparison to a situation in which the price choice is endogenous. Thus, we fix the price above costs for a major treatment in accordance with the criteria given above.

In periods 10–16, the price $p_H = 3$ for the major treatment is derived from the predicted expert pricing behavior.[13] The level of p_H ensures that customers still interact even though they expect to be undertreated and overcharged in equilibrium. Theory does not provide a prediction for the price p_L, as it is never charged in equilibrium.

[12] Recall that the price sequence is common knowledge among the players before the first period starts.

[13] Note that in the theoretical benchmark, a price below marginal costs does not alter the experts' incentive to provide sufficient treatment in the later periods, as experts undertreat independent of the price vector posted.

Since we implement equal mark-up prices in the first nine periods, we approximate the equal mark-up price by setting p_L to the minimum of $p_L = 0$ in periods 10–16. Note that experts under price competition also posted a price for the minor treatment in periods 10–16 that was on average slightly below costs.

In order to counter concerns that our results might be driven by the level of the exogenously set price menu, we perform robustness checks with respect to the implemented prices. As mentioned above, the price vectors observed most often under price competition in the first period were $(p_L, p_H) = (4, 8)$ and $(p_L, p_H) = (3, 7)$. The average price posted for the major treatment under price competition in the first period was 7.39. We again follow the experts' pricing behavior under price competition in our robustness checks by implementing exogenous prices of $(p_L, p_H) = (3, 7)$ for the first nine periods. We thus reduce the experts' profit in the case of sufficient treatment from 2 to 1. We employ four markets in the *PRH Fixed* condition and four markets in the *PUH Fixed* condition for the robustness checks.

3.2 Procedure

The experimental sessions were conducted in the Cologne Laboratory for Economic Research between March and November 2012. A total of 320 participants took part in the experiment. Of these, 256 participants were allocated equally to the four conditions with our main parametrization, such that there were 64 participants in each condition. Hence, there were eight matching groups (markets) per condition. The remaining 64 participants were equally allocated to the eight markets of our robustness checks. We used ORSEE (Greiner, 2015) to recruit participants, and we ran the experiments using z-Tree (Fischbacher, 2007). None of the participants took part in more than one session. The instructions were read aloud at the beginning of each session. A detailed set of control questions followed the instructions in order to ensure that all participants understood the experiment.[14] The average time each session lasted was two hours. On average, participants earned 20.07 Euro.[15]

[14]After the experiment, players' social preferences were coarsely determined by the choice of payoff pairs for themselves and a randomly assigned other person.

[15]More detailed information about payoffs in each of the four conditions is provided in *Appendix D*.

4 Predictions

4.1 Equilibria

Equilibria under price competition are characterized in Dulleck et al. (2011). Under fixed prices, the experts' actions are limited to the treatment and charging decisions. Two types of equilibria might emerge: *no-reputation equilibria* and *reputation equilibria* (see Dulleck et al., 2011).[16] In the no-reputation equilibria, the one-shot Bayesian equilibria are played repeatedly over all 16 periods, whereas reputation equilibria are based on the players' repeated interactions. Reputation equilibria can be sustained when customers punish experts for undertreatment in the early rounds. Reputation equilibria may thereby differ in that they require implicit coordination of the customers' choices of experts or allow for randomization between experts in the first period. The structure of the equilibria is the following: In the later rounds, since there is a last round, experts always undertreat and overcharge. In the early rounds, either there is no reputation-building and experts also undertreat and overcharge, or there is reputation-building and experts do not undertreat and customers stay with non-undertreating experts. The reward for not undertreating in the early rounds are the profits from customers who stay with the expert in the later rounds even when they are undertreated and overcharged. In our parametrization, the potentially reputation-building rounds are rounds 1–9 under both price competition and fixed prices. Since the behavior of experts in the last seven rounds (10–16) is the same across the equilibria characterized in our formal results, we focus the description of the equilibria here and in the results on rounds 1–9. In particular, we consider the types of equilibria depicted in *Table 2* below. The table summarizes whether in the respective types of equilibria experts and customers interact, whether treatment is appropriate as well as experts' charging behavior.

We can now derive the results for the existence of the different types of equilibria in our four experimental conditions.

Lemma 1 (No-reputation)**.** *With regard to no-reputation equilibria, it holds that*

(i) No-Reputation Type 1 *equilibria exist in both experimental conditions with fixed prices, but not in the conditions with price competition, and*

[16] Note that the outlined equilibria are not exhaustive. For example, there also exist equilibria with asymmetric expert behavior, as pointed out by Dulleck et al. (2011). In line with their analysis, we restrict our analysis to equilibria with symmetric expert behavior.

Table 2: Types of equilibria considered.

	Interaction	Treatment	Charging
No-Reputation Type 1	None	Undertreatment	Overcharging
No-Reputation Type 2	Full	Undertreatment	Overcharging
Reputation Type 1	Full	Appropriate	Overcharging
Reputation Type 2	Full	Appropriate	Undercharging

The table lists properties of the different types of equilibria in rounds 1–9. Note that *undercharging* in *Reputation Type 2* describes that on the equilibrium path, customers are charged the price for the minor treatment in the early periods, but the price for the major treatment for the remainder of the game.

(ii) No-Reputation Type 2 *equilibria exist in both experimental conditions with price competition, but not in the conditions with fixed prices.*

Proof. Ad (i): See *Appendix A.1.*
Ad (ii): For the existence part in both experimental conditions with price competition, see the proof for private histories in Dulleck et al. (2011). The argument can easily be extended to public histories; the corresponding proof is therefore omitted. For inexistence under fixed prices, see *Appendix A.1.* □

Under price competition, experts undercut prices to attract customers to such a degree that customers prefer to interact at low prices even though they know they will be undertreated if they have the major problem.[17] In contrast, the prices are not low enough for customers to interact in periods 1–9 under fixed prices.[18]

We next turn to the reputation equilibria.

Lemma 2 (*Reputation Type 1* and *Reputation Type 2* in all conditions)**.** Reputation Type 1 *and* Reputation Type 2 *equilibria exist in all four experimental conditions.*

Proof. See *Appendix A.2* for *Reputation Type 1* equilibria and *Appendix A.3* for *Reputation Type 2* equilibria. □

[17] The posted price for the major treatment is then below marginal costs for the major treatment, see Dulleck et al. (2011).

[18] The customers' outside option of 1.6 is greater than the expected payoff from interacting, which amounts to −3 (when experts always overcharge and undertreat customers with a major problem).

***Reputation Type 1* equilibria** Under public histories, for both price competition and fixed prices, the logic of a *Reputation Type 1* equilibrium is as follows. If customers observe undertreatment and/or a deviation from the price vector, they punish experts by coordinating on a competing expert. If an expert serves sufficiently many customers, he does not undertreat in the early periods, as this implies future profits from both returning and new customers. In contrast to the no-reputation equilibrium, experts post higher prices in the early periods, allowing them to build up reputation by not undertreating. Under public histories, a customer observes all customers' histories with regard to undertreatment and prices charged, as well as whether an expert has served a large number of customers. Hence, customers observe whether experts have the incentive to treat sufficiently in future periods. A customer expects an expert to provide sufficient treatment when the expert has never undertreated any customer (given that he has treated sufficiently many customers). If an expert did not undertreat in the early periods, the customer stays with this expert even in the later periods in which experts will undertreat (periods 10–16). Customers still interact in periods 10–16, as the price for the major treatment is sufficiently low and the expected payoff from interacting thus exceeds the outside option.

Under private histories, customers only observe their own history of undertreatments and prices charged. Here, the logic of choosing or switching to an expert who is expected to treat sufficiently (because he has served sufficiently many customers previously and has not undertreated) that applies under public histories does not apply, as the relevant information is lacking. However, a *Reputation Type 1* equilibrium still exists in which customers coordinate their expert visits such that an expert serves sufficiently many customers and therefore has incentives not to undertreat.

***Reputation Type 2* equilibria** Experts build up their reputations in the early periods by always charging the price of the minor treatment p_L on top of not undertreating their customers in *Reputation Type 2* equilibria. These experts make low profits in the early periods. In later periods (periods 8 and 9 in our construction), experts make higher profits by charging the customers for the major treatment but still providing sufficient treatment. Thus, the logic is that experts are rewarded for charging low prices (and providing sufficient treatment) in the early periods by customers who stay loyal to them throughout, allowing experts to charge the major treatment price in later periods (and then provide the minor treatment in the last rounds of the game). This works as the major treatment price is sufficiently high under fixed prices. Under price competition, higher prices can be supported by customers' out-of-equilibrium belief that experts posting lower prices will undertreat with probability one.[19] Again, private histories require a lot of ex-ante coordination on an expert, as customers cannot switch based on market undertreatment and charging behavior during the game.

4.2 Hypotheses

In this section, we derive hypotheses for the differences in the level of undertreatment and the level of overcharging between the four conditions.

4.2.1 Level of undertreatment

The first hypothesis relates to the difference between the conditions with price competition and those with fixed prices. According to *Lemma 1*, an equilibrium with undertreatment and interaction in rounds 1–9 (*No-Reputation Type 2*) does not exist under fixed prices. Thus, if we observe interaction under fixed prices, full undertreatment is not predicted. Under price competition, however, *No-Reputation Type 2* equilibria with interaction and full undertreatment exist. Furthermore, the absence of price as an additional strategic variable, focusing attention on quality of treatment under fixed prices, might facilitate coordination on reputation equilibria, either of *Type 1* or *Type 2*, under fixed prices. Thus, we can state the following hypothesis:

Hypothesis 1 (Price competition vs. fixed prices: undertreatment)**.** *For both the private histories and the public histories regime, the level of undertreatment in periods 1–9 under price competition is equal to or higher than that under fixed prices.*

Next, we turn to the difference in the level of undertreatment between private and public histories. According to *Lemma 2*, there is no difference between private and public histories regimes with regard to the existence of the two reputation equilibria without undertreatment, *Reputation Type 1* and *Reputation Type 2*. However, we conjecture that reputation equilibria are more likely to be played under public than under private histories, as reputation equilibria require a lot of coordination and are

[19] Under private histories, if a customer is charged the price for the major treatment in the early periods but treated sufficiently, a customer might not want to switch to another expert—who might undertreat her—or abstain from trade if she believes that the expert charging the major treatment price will treat her sufficiently in the subsequent rounds up to round 9. However, the customer can still effectively punish the expert by not returning in rounds 10–16, as she is indifferent between experts in these rounds.

therefore more plausible under public than under private histories. Thus, we can state the following hypothesis:

Hypothesis 2 (Private vs. public histories: undertreatment)**.** *For both the fixed-price and the competitive-price regime, the level of undertreatment in periods 1–9 under private histories is equal to or higher than that under public histories.*

4.2.2 Level of overcharging

Except for *Reputation Type 2* equilibria, all considered equilibria feature full overcharging. Furthermore, from *Lemma 2* we know that *Reputation Type 2* equilibria with no overcharging in the early rounds exist in all four regimes. However, similar to our line of argument regarding undertreatment, the absence of price as an additional strategic variable and the absence of price pressure—that lowers expert margins—might facilitate coordination on *Reputation Type 2* equilibria under fixed prices compared to competitive prices. Regarding the prediction of private versus public histories, *Reputation Type 2* equilibria require a lot of coordination among customers and seem therefore more plausible under public than under private histories. Thus, we can state the following hypotheses:

Hypothesis 3 (Price competition vs. fixed prices: overcharging)**.** *For both the private histories and the public histories regime, the level of overcharging in periods 1–9 under price competition is equal to or higher than that under fixed prices.*

Hypothesis 4 (Private vs. public histories: overcharging)**.** *For both the fixed-price and the competitive-price regime, the level of overcharging in periods 1–9 under private histories is equal to or higher than that under public histories.*

5 Results

In this section, we present the experimental results for the levels of undertreatment and overcharging. We restrict our analysis to the first nine periods in which reputational concerns may play a role. For each result, we first describe the findings based on our main parametrization. We then discuss the result in light of the robustness check.

We primarily analyze the data on the basis of non-parametric tests. We hereby make use of the two-tailed Mann-Whitney U test (MWU) for independent sample observations. We complement these results with the Robust Rank-Order test (RRO) (Fligner and Policello, 1981) in order to account for the fact that higher moments of the two underlying distributions might not necessarily be the same.[20] Paired sample test results are based on the two-tailed Wilcoxon sign-rank (WSR) test, complemented by the sign (S) test. Test results are reported to be (weakly) significant if the two-tailed test's p-value is less than 0.05 (0.1). We consider the average per market over individuals and over the first nine periods as one independent observation. Thus, our non-parametric test results are based on eight independent observations per condition. We complement the non-parametric test results with parametric tests in form of regressions. Following Dulleck et al. (2011), we make use of the random-effects panel probit regression with standard errors clustered at the individual level.

5.1 Level of undertreatment

The descriptive experimental results for the level of undertreatment are presented in *Table 3*. As the design of *PRH Comp* is the same as *CR/N* in Dulleck et al. (2011), their corresponding results are also shown. We can reproduce their results and obtain very similar levels of undertreatment, prices posted, and prices paid. *Table 3* also shows the level of undertreatment for two additional conditions in Dulleck et al. (2011): *R/N*, in which customers can identify experts but there is no expert competition for customers,[21] and *C/N*, in which customers cannot identify experts but experts set prices and compete for customers. These conditions will allow us to draw some further conclusions on the impact of competition on undertreatment.[22]

In our panel probit regressions on the level of undertreatment, we control for the period in which an interaction takes place, the conditions, and the interaction effect between the conditions. The basic specification is as follows:

$$\begin{aligned} undertreatment_{it} = \beta_0 + \beta_1 period_{it} + \beta_2 private\_histories_{it} + \beta_3 fixed\_prices_{it} \\ + \beta_4 private\_histories_{it} \cdot fixed\_prices_{it} + c_i + u_{it}, \end{aligned}$$

[20]Note that for sample sizes less than twelve, p-values of the RRO test need to be inferred from the table provided in Fligner and Policello (1981), as asymptotic p-values may be misleading. Because critical values for the one-sided test are published only up to a significance level of 0.01, the highest significance level we can report when comparing individual conditions is $p < 0.02$.

[21]Each expert was randomly matched with exactly one customer.

[22]In order to be able to compare the results in *Table 3*, we calculate the undertreatment level in Dulleck et al. (2011) for the first nine periods. The data are publicly available at `https://www.aeaweb.org/aer/data/april2011/20090648_data.zip`.

Table 3: Percentage of undertreatment in periods 1–9.

		Reputation mechanism				
		This paper		Dulleck et al. (2011)		
		Private histories	Public histories	*R/N*	*C/N*	*CR/N*
Price system	Fixed	31.43%	24.41%	–	–	–
	Competitive	58.47%	63.46%	49.25%	61.18%	59.22%

R/N: Customers can identify experts. Matching is random and one-to-one. *C/N*: Customers cannot identify experts. Customers can choose among experts. *CR/N*: Customers can identify experts and choose among them.

where c_i denotes the random intercept of individual i and u_{it} denotes the idiosyncratic error term for individual i in period t.[23] *Table 4* displays our regression results.

Result 1 (Price competition vs. fixed prices: undertreatment)**.** *For both the private histories and the public histories regime, the level of undertreatment in periods 1–9 under price competition is significantly higher than that under fixed prices.*

Our experimental results are in line with our first hypothesis. The level of undertreatment is significantly higher in the price-competition regime than in the fixed-price regime for both types of histories (see model (3) in *Table 4*; MWU: $p < 0.001$/RRO: $p < 0.001$).[24] The average difference in the level of undertreatment amounts to 33.2 percentage points. Prices posted by experts under price competition[25] are significantly lower than the exogenously given prices in the fixed-price condition (MWU: $p < 0.001$/RRO: $p < 0.001$ for both treatment prices).[26] *Figure 1* illustrates the average rate of undertreatment for each of the four conditions over time. Note that in all four treatments, we observe interaction rates above 70%. Moreover, in three out of four treatments, interaction rates are even above 85%.

In the following, we have a closer look at the data to substantiate that (i) under fixed prices experts build up reputation on quality whereas (ii) under price competition, price pressure inhibits reputation building. We support our analysis by (iii) showing that customers choose their expert based on the price for the major treatment under

[23] Panel OLS estimates can be found in the working paper.

[24] Note that we restrict the analysis and report results only for periods 1–9 in which reputation-building on quality is relevant. However, *Result 1* also holds when we include all periods.

[25] The mean prices paid by customers can be found in the working paper.

[26] The difference in the level of undertreatment holds for both types of reputation mechanisms: private histories (MWU: $p = 0.009$/RRO: $p < 0.02$) and public histories (MWU: $p = 0.006$/RRO: $p < 0.02$).

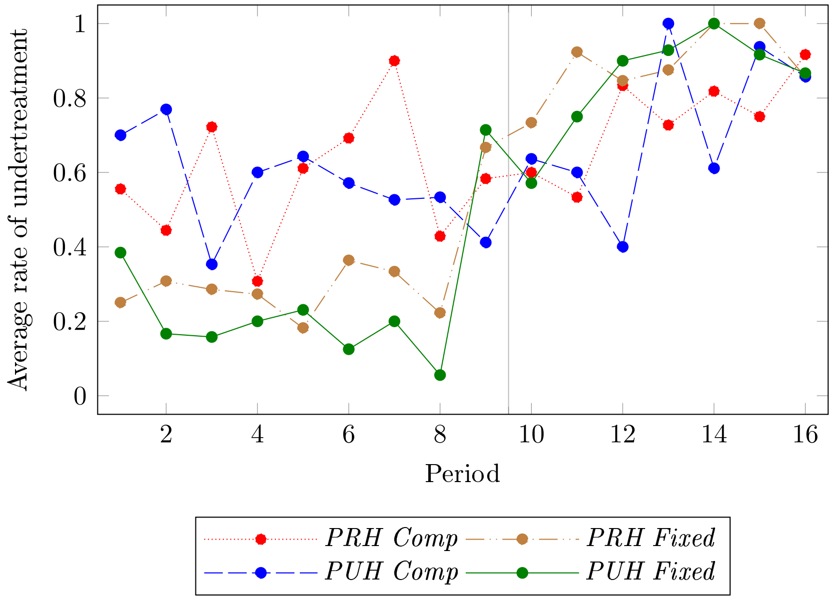

Figure 1: Average rate of undertreatment for each condition. The vertical line indicates where the theoretical predictions enter a new phase.

Table 4: Random-effects panel regressions on undertreatment in periods 1–9.

	Panel probit			
Undertreatment	(1)	(2)	(3)	(4)
Period	0.046*	0.047*	0.044*	0.044*
	(0.027)	(0.027)	(0.026)	(0.026)
Private histories		0.134	0.068	−0.133
		(0.187)	(0.155)	(0.216)
Fixed prices			−0.955***	−1.161***
			(0.160)	(0.227)
Private histories · fixed prices				0.415
				(0.312)
Intercept	−0.375**	−0.446**	0.064	0.171
	(0.161)	(0.190)	(0.187)	(0.204)
$R^2_{M\&Z}$	0.029	0.033	0.184	0.190
Observations	454	454	454	454

Standard errors are clustered on the individual level and are reported in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. p-values are based on two-tailed tests. In order to evaluate the model fit, we report the McKelvey and Zavoina $R^2_{M\&Z}$ (McKelvey and Zavoina, 1975).

price competition whereas customers focus on quality under fixed prices. In a next step, we (iv) show that our results on undertreatment are robust to changes in fixed prices. We then (v) shortly discuss the implications of the different undertreatment levels on efficiency before (vi) comparing our results to the literature.

(i) Fixed prices: Experts build-up reputation on quality Our results are consistent with coordination on the reputation equilibria under fixed prices in several markets.[27] Experts build up reputations by treating customers sufficiently in the early periods. The average rate of undertreatment under fixed prices amounts to 27.59% in the first nine periods (and only 22.97% in the first eight periods). Examining individual markets more closely, we find that in six out of the eight markets under public histories, undertreatment is below 20%; for three markets, undertreatment is even below 10%. *Figure 2* shows the undertreatment levels for individual markets. In later periods, experts undertreat. The average rate of undertreatment rises to 86.70% under fixed prices in periods 10–16. *Figure 1* clearly shows experts' switching behavior in defrauding. Note that the increase in the level of undertreatment is predicted given the change in fixed prices from period 10 onwards. In both types of reputation equilibria, experts do not undertreat until period 9 and switch to undertreating in period 10. In the experimental data, we observe that experts switch after period 8.

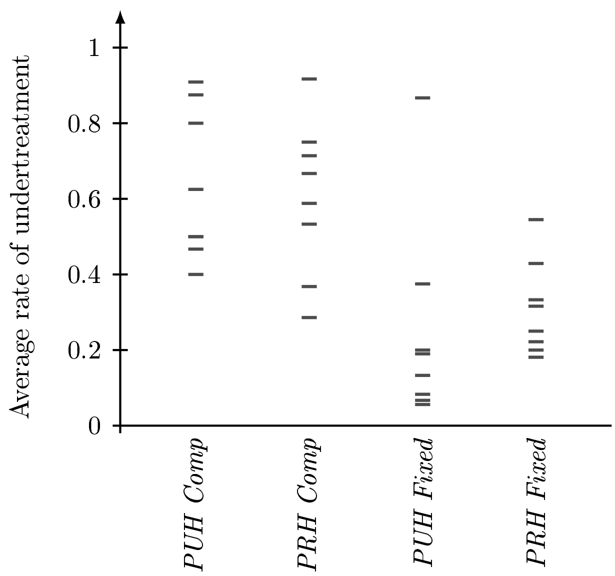

Figure 2: Average rate of undertreatment per market and condition in periods 1–9.

(ii) Price competition: Price pressure inhibits reputation building on quality Under price competition, the average rate of undertreatment amounts to 60.81% in the first nine periods and rises to 77.78% in periods 10–16. We chose the fixed prices on the basis of the most frequently posted price vector under price competition in the first period. Thus, the most frequently posted prices are the same across

[27] Note that we also find evidence of the customer coordination that is required for the existence of the reputation equilibrium under fixed prices. In fact, 40% of the customers chose expert $A1$ in the first period.

conditions; however, under price competition, customers choose the cheapest expert in the first period, in which there is no treatment history (compare *Figure 3* and *Appendix F*). This price competition effect in the first period is accompanied by higher undertreatment levels than under fixed prices. As illustrated by *Figure 3*, the prices posted for the major treatment decline over time if prices are flexible. Price competition thus undermines reputation-building on quality in the first nine periods. We even observe that experts who undertreated in previous periods attempt to offset their bad reputation by offering low prices in the following periods. In fact, we find that the average price posted for the major treatment prior to an expert's first undertreatment amounts to 6.837; this price significantly declines to 5.731 on average after an expert's first undertreatment (WSR: $p < 0.001$/S: $p < 0.001$). These lower prices then give experts a lower incentive to provide high quality. Hence, observed behavior under price competition is best explained by *No-Reputation Type 2* equilibria.[28]

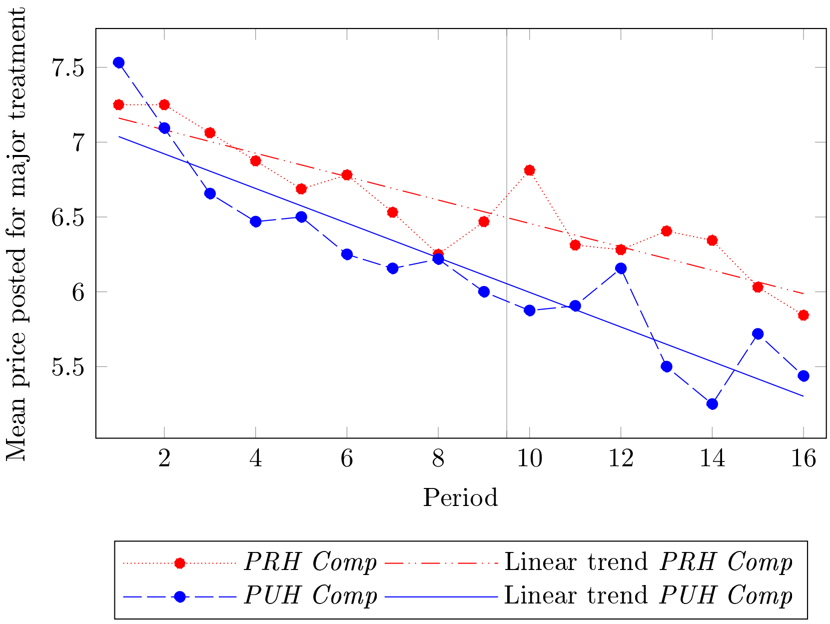

Figure 3: Average price posted for the major treatment in conditions with price competition.

[28] An alternative explanation to competitive pressure in the form of non-price (quality) versus price competition is that there are differences between the conditions in terms of how well the customers manage to coordinate on experts that are of the no-undertreatment type. However, we find that only nine out of the 128 experts never undertreat a customer. There is also no evidence that customers coordinate on these no-undertreatment experts. Furthermore, other-regarding preferences may have played a role in the experts' behavior. We find that 55.56% of the customers suffering from a major problem that interact with an expert serving a single customer are undertreated under competitive prices in the early periods. See Kerschbamer et al. (2016) for a comprehensive analysis of social preferences in credence goods market.

(iii) Customers' choice of experts: Based on price under competitive prices and quality under fixed prices We observe that customers punish undertreating experts more often under fixed prices than under price competition. Specifically, customers return significantly less often to the undertreating expert under fixed prices than under price competition in the early periods (MWU: $p < 0.001$/RRO: $p < 0.001$). We therefore analyze each customer's expert choice in terms of motives, differentiating between cheapest expert, least undertreating expert (over the previous periods), and other motives.[29] The least undertreating expert can be defined by a customer's individual history or (for the public histories condition) at the market level, i.e., for all customers. Of course, the least undertreating expert and the cheapest may coincide. For the analysis of customer expert choice, we concentrate on periods 5–9 to allow for some reputation-building as well as learning on the part of the customer. We find that customers visit the cheapest but not least undertreating expert significantly less often under fixed than under flexible prices (MWU: $p = 0.001$/RRO: $p < 0.001$; see *Figures 4a* and *4b*).[30] A further interesting result is that in the later periods (periods 10–16), we find that customers interact significantly more with the expert that undertreated them least under fixed prices than under flexible prices (MWU: $p = 0.004$/RRO: $p < 0.001$), thus rewarding the expert in line with the strategy that sustains both types of reputation equilibria. Thus, the observed behavior under fixed prices is closer to reputation equilibria being played than behavior under competitive prices.

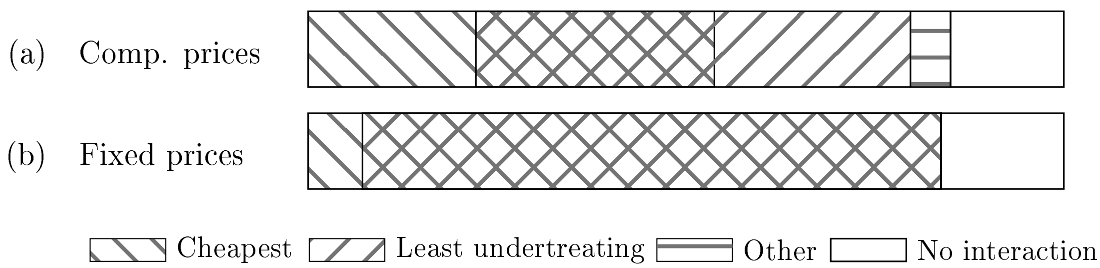

Figure 4: Customers' choices of experts in periods 5–9 based on individual undertreatment.

(iv) Results: Robust to lower fixed prices One possible concern with respect to the lower level of undertreatment under fixed prices than under price competition might be that the level of the exogenous prices is driving the results. Of course, there

[29] The cheapest expert(s) is/are defined as the expert(s) posting the lowest price for the major treatment.

[30] The analysis is based on an individual customer's level for defining the least undertreatment. For least undertreatment under public histories on the market level, the results are even stronger (MWU: $p < 0.001$/RRO: $p < 0.001$).

Table 5: Robustness in the percentage of undertreatment in periods 1–9.

		Reputation mechanism	
		Private histories	Public histories
Price system	Fixed $(p_L, p_H) = (4, 8)$	31.43%	24.41%
	Fixed $(p_L, p_H) = (3, 7)$	28.07%	33.33%
	Competitive	58.47%	63.46%

is a price level effect, as the absence of price competition means significantly higher prices over the first nine periods (MWU: $p < 0.001$/RRO: $p < 0.001$). However, we find that the level of undertreatment under fixed prices $(p_L, p_H) = (3, 7)$ remains similar to the set-up with fixed prices $(p_L, p_H) = (4, 8)$ (see *Table 5*). The level of undertreatment under fixed prices $(p_L, p_H) = (3, 7)$ is again significantly lower than under price competition (MWU: $p = 0.001$/RRO: $p < 0.001$). Hence, our *Result 1* is robust to changes in the exogenously given prices to $(3, 7)$. In fact, we do not find a significant increase in the level of undertreatment when changing prices from $(p_L, p_H) = (4, 8)$ to $(p_L, p_H) = (3, 7)$ (MWU: $p = 0.283$/RRO: $p = 0.267$).[31] The average prices posted are similar under fixed and competitive prices in the early periods. Due to price competition, the average prices posted decline over time. Also due to price competition, the prices actually paid are significantly lower under competitive than fixed prices from the first period on, as customers start out by selecting the cheapest experts in the first round. We furthermore observe a reduction in posted prices following undertreatment by experts in the competitive settings, which should not be the case if the results are driven by a pure price level effect. Furthermore, in the later periods in which prices under fixed prices are lower than under flexible prices, there is no significant difference in the level of undertreatment. Thus, although the price level clearly plays a role, the results are not driven by a pure price level effect.

(v) Efficiency: Higher under fixed than competitive prices The lower level of undertreatment under fixed prices leads to a significantly higher rate of efficiency (MWU: $p = 0.008$/RRO: $p = 0.001$). We define efficiency as the sum of customer and expert surplus per possible interaction less the outside option for both players, and normalize the values to the interval $[0, 1]$ based on the distribution of customer types

[31] Note that prices in periods 10–16 are significantly higher under flexible prices than under fixed prices. However, we find no significant difference in either the level of undertreatment or the level of efficiency. Hence, the results are clearly not driven by the price level effect alone.

in the respective market. We again focus on periods 1–9. Undertreatment decreases market efficiency because the expert's treatment induces costs while no customer benefit is generated.[32] As the rate of undertreatment does not increase when lowering the fixed prices to $(p_L, p_H) = (3, 7)$, efficiency remains at a significantly higher level under fixed than under competitive prices. Thus, price competition may be detrimental not only to the quality provided but also to market efficiency in expert markets.

Table 6: Efficiency in periods 1–9.

		Reputation mechanism	
		Private histories	Public histories
Price system	Fixed $(p_L, p_H) = (4, 8)$	70.30%	83.59%
	Fixed $(p_L, p_H) = (3, 7)$	76.80%	76.07%
	Competitive	58.59%	62.93%

Efficiency is defined as the sum of customer and expert surplus per possible interaction less the outside option for both players, normalized to the interval $[0, 1]$ based on the distribution of customer types on the market level.

(vi) Comparing our results to the literature Comparing our results to those of Dulleck et al. (2011) shows that the level of undertreatment in *R/N* (reputation but no competition between experts) is non-significantly lower than when experts compete for customers under competitive prices (MWU: $p = 0.332$/RRO: $p > 0.1$), but weakly significantly higher than under fixed prices (MWU: $p = 0.052$/RRO: $p < 0.05$). This suggests that both, experts' endogenous price choices and their competition for customers, crowd out quality competition. Interestingly, the undertreatment level does not differ between *C/N* and *PRH Comp* or between *C/N* and *PUH Comp*. These results again suggest that experts do not focus on building a reputation under competitive prices.

Comparing our results to those of Huck et al. (2016) demonstrates that despite asymmetric information, when prices are fixed in our credence goods market, experts build up reputations by not undertreating. Yet, whereas Huck et al. (2016) observe, without asymmetric information, virtually comprehensive reward of trust under fixed prices, about one-fourth of customers are undertreated in our set-up. This difference may be attributed to the more complex reputation-building process in credence goods mar-

[32] Note that overcharging is a pure redistribution between the two parties and hence does not influence efficiency.

kets, in which sufficient treatment is not a perfect signal of the reputational concern or trustworthiness of the expert. A second important observation is that the effect of price competition is much stronger under asymmetric than symmetric information. Huck et al. (2016) report a decrease in rewarded trust of 14 percentage points between fixed and flexible prices, whereas we find a difference in undertreatment of 33.2 percentage points.

Result 2 (Private vs. public histories: undertreatment)**.** *For both the fixed-price and the competitive-price regime, the level of undertreatment in periods 1–9 under private histories is not significantly different from that under public histories.*

Neither under fixed nor under competitive prices do we find that more customer information significantly decreases undertreatment (see model (4) in *Table 4*; for price competition: MWU: $p = 0.916$/RRO: $p > 0.1$; for fixed prices: MWU: $p = 0.103$/RRO: $p > 0.1$). That there is no significant difference between private and public histories is in line with *Hypothesis 2*.

In the following, we have a closer look at the data. There are no differences in the levels of undertreatment between private and public histories because (i) under price competition customers do not take the additional information under public histories into account whereas (ii) under fixed prices undertreatment levels are already low under private histories. Lastly, we discuss (iii) differences in interaction rates between private and public histories under fixed prices.

(i) Price competition: No differences in undertreatment between histories because customers focus on their own history Under flexible prices, the competition in posted prices under public histories is more intense than that under private histories, as customers can observe all customers' histories. A comparison of the prices posted by experts in periods 1 and 10 indicates that the decline in the price for the major treatment under public histories is greater than that under private histories (MWU: $p = 0.045$/RRO: $p < 0.05$). However, the lower prices posted do not translate into a change in the level of undertreatment. The analysis of customer choices of experts reveals a possible explanation for why there is no difference in undertreatment levels between private and public histories when prices are competitive: A customer's choice of experts is driven by her own history rather than public histories. *Figure 5a* illustrates customers' motives for expert choices under *PRH Comp*, and *Figures 5b* and *5c* depict the motives under *PUH Comp*. In *Figure 5b*, the least undertreating expert in previous rounds is selected at the individual customer level, whereas in *Fig-*

ure 5c, the least undertreating expert in previous rounds is chosen at the market level. Note that when "least undertreating" is defined at the individual customer level, *PRH Comp* and *PUH Comp* exhibit a fairly similar pattern: The cheapest expert is chosen in 51.87% of cases under *PRH Comp* and 55.62% under *PUH Comp*; the least undertreating expert is chosen in 53.13% under *PRH Comp* and 61.87% under *PUH Comp*. There is no significant difference in the choice of the least undertreating expert between *PRH Comp* and *PUH Comp* at the individual level (MWU: $p = 0.207$/RRO: $p > 0.1$). When the least undertreating expert in previous rounds is chosen at the market level, in only 29.37% of choices, the least undertreating expert is selected, as illustrated in *Figure 5c*. The difference between the individual and the market level for "least undertreating" in *PUH Comp* is significant (MWU: $p = 0.002$/RRO: $p < 0.02$). Public information about expert undertreatment is less important for customers' choices of experts than their private undertreatment histories with experts. Thus, the fact that customers' choices of experts are driven primarily by their own histories with experts even under public histories can explain why we do not observe significant differences in undertreatment levels between private and public histories when prices are flexible.

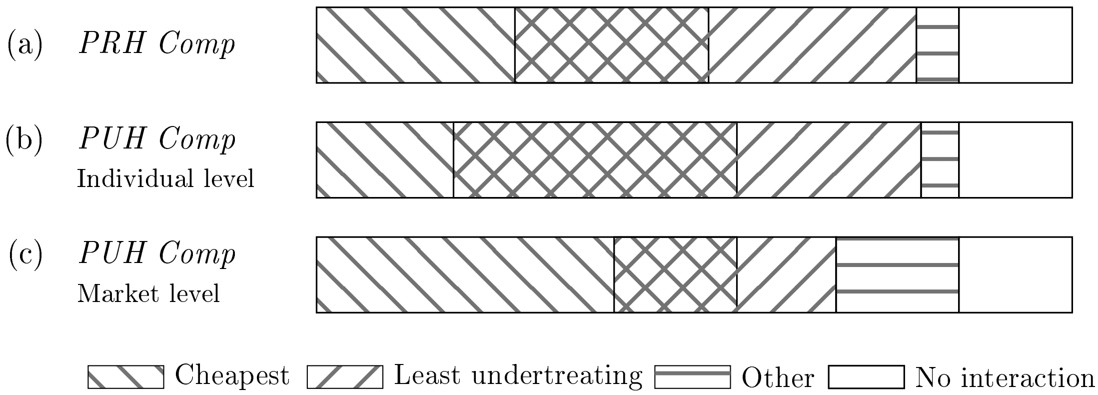

Figure 5: Customers' choices of experts in periods 5–9 under competitive prices.

(ii) Fixed prices: No difference between histories as undertreatment level is already low Under fixed prices, the analysis of a customer's choice of experts shows that the vast majority of customers visit the cheapest and least undertreating expert both under private histories and public histories (see *Figure 6*).[33] As experts only seldom undertreat in the first nine periods, the individually least undertreating expert for a customer differs little from the least undertreating expert on the market level under public histories (MWU: $p = 0.546$/RRO: $p > 0.1$).

[33]The fact that customers visit the cheapest expert does not reveal any additional information: Prices are fixed and hence each expert is the cheapest expert.

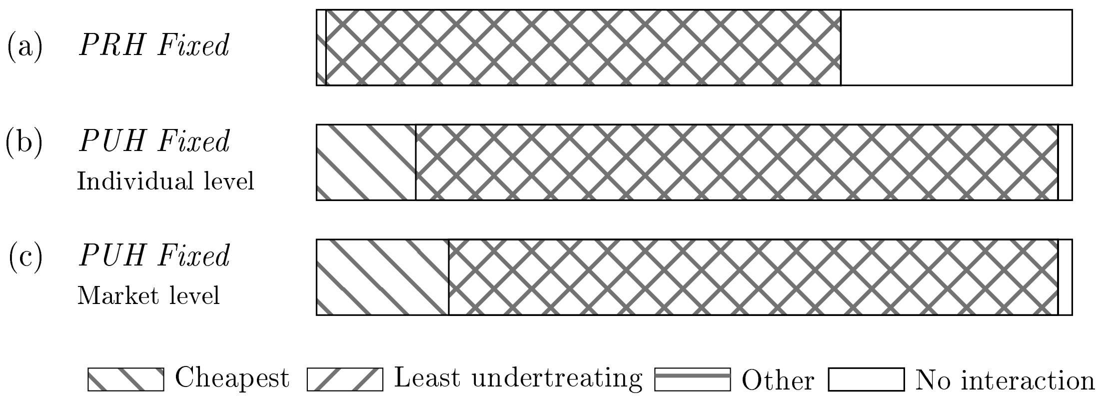

Figure 6: Customers' choices of experts in periods 5–9 under fixed prices.

Note that Huck et al. (2012) do not find a significant difference between private and public histories in their corresponding condition, as the free choice of the trustee already boosts the reward of trust to more than 85%. Thus, with very high trust rates even under private histories in Huck et al. (2012), there is little scope for additional customer information to increase the reward of trust further.

(iii) Interaction: Lower under private histories when prices are fixed Whereas the level of undertreatment is not significantly different between private histories and public histories, we observe a significantly lower customer participation under private histories than under public histories if prices are fixed (see *Figure* 6 and *Table 7*; MWU: $p = 0.042$/RRO: $p < 0.1$).

Table 7: Average interaction rates per condition across periods 1–9.

		Reputation mechanism	
		Private histories	Public histories
Price system	Fixed	73.26%	96.18%
	Competitive	85.07%	88.89%

Figure 7 shows that interaction rates climb to virtually full interaction under *PUH Fixed* within the first two periods and remain on a constantly high level up to the last periods. Opposed to *PUH Fixed*, interaction rates in *PRH Fixed* decline over the first nine periods. By period 9, there is a gap of more than 35 percentage points between the two fixed-price conditions. The decline in participation is surprising at least for the first five periods in which the undertreatment level is at a constantly low level.

From period 6 on, the undertreatment level increases which leads to a lagged decrease in interactions up to period 9. In contrast to the fixed-price conditions, we observe neither a time trend nor differences in the level of interaction between private and public histories under price competition (MWU: $p = 0.6322$/RRO: $p > 0.1$). The rate of interaction under price competition is high with more than 85% in first nine periods under both types of histories (see *Table 7*).

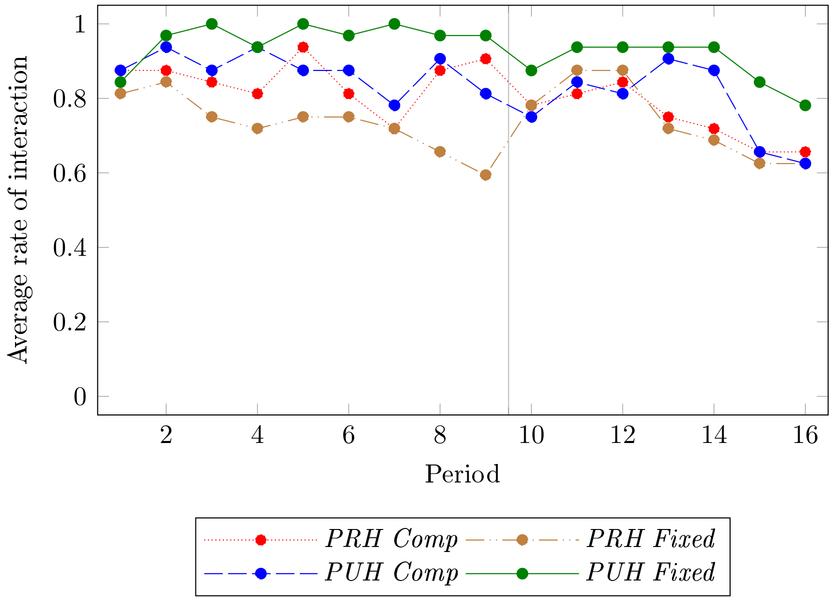

Figure 7: Average interaction rates for each condition.

Summarizing the results with respect to customer information, we do not find significant differences in undertreatment between private and public histories under price competition or under fixed prices. For price competition, we observe a stronger decline in posted prices under public than private histories; however, this does not translate into a significant difference in undertreatment levels. Under fixed prices, undertreatment levels are already low, such that the additional customer information does not lead to a significant decrease in the undertreatment level.

5.2 Level of overcharging

In the following section, we present the results relating to the level of overcharging. *Table 8* provides an overview of the level of overcharging across the four conditions.[34]

Result 3 (Price competition vs. fixed prices: overcharging)**.** *For the public histories regime, the level of overcharging under price competition in periods 1–9 is significantly*

[34] The regression analysis is relegated to *Appendix E*.

Table 8: Percentage of overcharging in periods 1–9.

		Reputation mechanism	
		Private histories	Public histories
Price system	Fixed	71.11%	41.24%
	Competitive	77.84%	86.54%

higher than that under fixed prices. For the private histories regime, the level of overcharging under price competition in periods 1–9 is not significantly different from that under fixed prices.

In line with *Hypothesis 3*, we find that overcharging under price competition is significantly higher than that under fixed prices when histories are public (MWU: $p = 0.006$/RRO: $p < 0.02$). When histories are private, there is no significant difference in the level of overcharging between price competition and fixed prices (MWU: $p = 0.834$/RRO: $p > 0.1$).

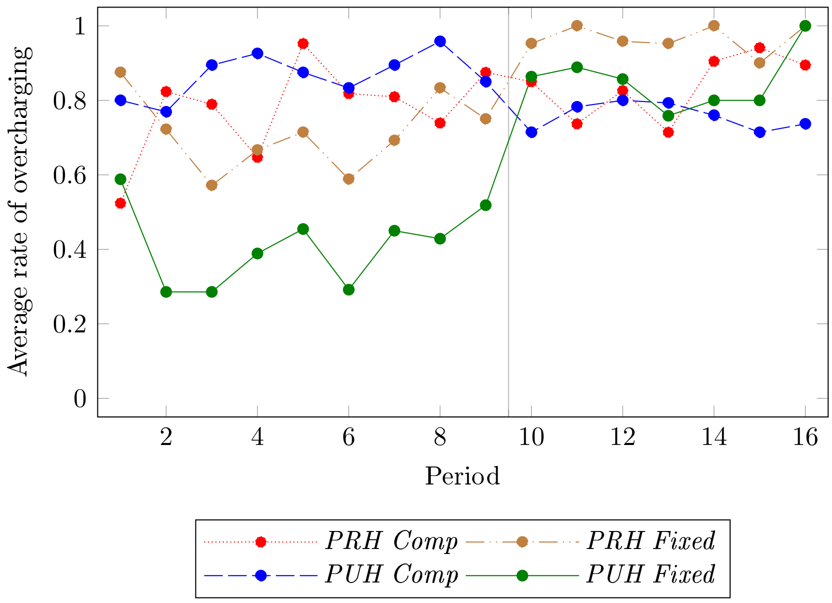

Figure 8: Average rate of overcharging for each condition.

One possible explanation as to why experts overcharge more often under public histories and price competition than under public histories and fixed prices may be that experts try to compensate for their lower profits due to lower prices by overcharging. As can be seen in *Figure 3*, the average price posted for the major treatment declines over time for both histories. Price competition is more intense under public histories than under private histories, leading to a higher incentive to overcharge. Our conjecture of experts compensating for lower profits under public histories is also supported by the fact that a reduction in fixed prices from $(p_L, p_H) = (4, 8)$ to $(p_L, p_H) = (3, 7)$ results in a considerable increase in the level of overcharging under public histories (see *Table 9*). Under private histories, there are no differences in experts' overcharging behavior between the two pricing regimes.

Table 9: Robustness in the percentage of overcharging in periods 1–9.

		Reputation mechanism	
		Private histories	Public histories
Price system	Fixed $(p_L, p_H) = (4, 8)$	71.11%	41.24%
	Fixed $(p_L, p_H) = (3, 7)$	68.42%	70.45%
	Competitive	77.84%	86.54%

Result 4 (Private vs. public histories: overcharging)**.** *For the competitive-price regime, the level of overcharging in periods 1–9 is weakly significantly lower under private than under public histories. By contrast, for the fixed-price regime, the level of overcharging in periods 1–9 is weakly significantly higher under private than under public histories.*

We find evidence that, in contrast to *Hypothesis 4*, the level of overcharging is lower under private than under public histories when experts compete in prices (MWU: $p = 0.093$/RRO: $p = 0.010$).[35] Experts already overcharge at high rates under public histories in the early periods (see *Figure 8*). Over time, the overcharging rates slightly increase. Under private histories, the overcharging level also increases but is more volatile over time than under public histories.

In contrast to the competitive-price regime, we find more overcharging under private than under public histories when prices are fixed (MWU: $p = 0.066$/RRO: $p < 0.1$), which is in line with *Hypothesis 4*.[36] The difference in the level of overcharging between public and private histories under fixed prices is due to the fact that under public histories, customers can observe whether other experts charged the price for the minor or the major treatment in previous periods. If experts' mark-up is sufficiently high, as it

[35]Note that the panel probit regression supports this result on a 5% significance level.

[36]Although the difference in the descriptives between the two conditions amounts to almost 25 percentage points, the significance level is rather low, as there are three markets under public histories that exhibit a high level of overcharging.

is under prices $(p_L, p_H) = (4, 8)$, experts charge honestly in the early periods. However, if experts' mark-up is low, such as under fixed prices $(p_L, p_H) = (3, 7)$ or competitive prices, the experts' incentive to charge honestly vanishes even under public histories. Whereas overcharging is significantly reduced under fixed prices $(p_L, p_H) = (4, 8)$ and public histories, we do not find undercharging as predicted in *Reputation Type 2* equilibria in any of the four conditions. Customers' punishment of experts who treat sufficiently but charge p_H does not differ between conditions either. In approximately half of the cases, customers switch to a different expert after being charged p_H, whereas in the other half of the cases, customers stay with the same expert. Yet, customers reward experts who treat sufficiently and charge p_L by visiting the same expert in the next period again across all conditions.

Based on the overcharging levels, the observed behavior under fixed prices $(p_L, p_H) = (4, 8)$ and public histories is closest to *Reputation Type 2* equilibria although no undercharging is observed. Behavior in the other fixed-price conditions appears consistent with *Reputation Type 1* equilibria. Under competitive prices, the results suggest that *No-Reputation Type 2* equilibria are played.

6 Conclusion

We analyze the level of fraud in a credence goods market with repeated interactions and reputation-building in which experts either compete in prices or face fixed prices in the market. We find that the level of fraud—both undertreatment and overcharging—is significantly higher in a scenario with competitive prices compared to a situation in which prices are fixed. Under price competition, customers return significantly more often to undertreating experts than under fixed prices in the early periods. Furthermore, we observe price pressure that undermines reputation-building in the early periods. Experts who undertreated in previous periods offer lower prices in the following periods under price competition. In all, our results suggest that players tend to coordinate on a no-reputation equilibrium under price competition, whereas reputation equilibria are played under fixed prices.

With respect to customer information about experts' past behavior, we do not find significant differences between private and public histories under either price competition or fixed prices. In the customers' choices of experts, we find that under price competition, public information about expert undertreatment is less important than customers' private undertreatment histories with experts. Thus, the potentially disciplining effect of more undertreatment information at the market level has little impact under price competition, as customers prefer to choose according to their own histories. Results on the second dimension of fraud (overcharging) are slightly more pronounced. Under price competition, the level of overcharging is weakly significantly higher under public than under private histories. By contrast, under fixed prices, the level of overcharging under public histories is weakly significantly lower than that under private histories.

Our results provide a possible rationale for why prices are often regulated in several important credence goods markets. In light of the general perception that price regulation in markets induces inefficient outcomes, our findings suggest that a more differentiated view is warranted. In markets in which the potential welfare loss from undertreatment, or the provision of low quality, is substantial and liability cannot ensure high quality levels, reducing price competition might be an adequate means to ensure that fraud occurs less frequently. Implicitly forcing experts to focus on the quality provided instead of price competition may alleviate the problems arising from information asymmetry. Of course, the price levels must be chosen carefully. A level of regulated prices so low that reputation-building is not profitable is unlikely to reduce the problems in expert markets.

Reputation-building is one possible way to constrain experts' fraudulent behavior in credence goods markets. Several other instruments also have potential in this regard, such as the opportunity for customers to seek second opinions. Market design to improve outcomes in credence goods markets remains an important topic for future research.

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Appendix

A Proofs

The equilibrium concept we apply is Perfect Bayesian Equilibrium (PBE). Note that for the whole analysis, we restrict attention to symmetric equilibria and assume that if customers are indifferent between visiting and not visiting an expert, the customer chooses to visit the expert. Likewise, those experts who are indifferent between undertreating and not undertreating do not undertreat. Our proofs are constructive: we start by describing customers' and experts' strategies and then check whether they form an equilibrium. Note that the experts in all conditions are referred to and identifiable by customers as expert $A1$, $A2$, $A3$, and $A4$. We will use this in some of the constructions.

A.1 Proof of *Lemma 1*

Proof of existence of *No-Reputation Type 1* equilibria under fixed prices

Customers' beliefs Each customer believes to always receive the minor treatment and to always be charged p_H.

Customers' strategy Customers do not interact in periods 1–9. In periods 10–16, customers randomize between experts in each period.

Experts' strategy Experts always provide the minor treatment and always charge p_H.

Verification We now verify that the above outlined strategies and beliefs form a perfect Bayesian equilibrium. Customers' behavior is rational because their expected payoff from interaction in periods 1–9 amounts to $0.5 \cdot (10 - 8) + 0.5 \cdot (0 - 8) = -3$ which is less than the outside option of 1.6.
In periods 10–16, if customers interact, they receive an expected payoff of $0.5 \cdot (10 - 3) + 0.5 \cdot (0 - 3) = 2$ which is larger than their outside option of 1.6. Given the customers' behavior, experts' strategies are optimal because their payoff from always providing the minor treatment at the price p_H is larger than treating sufficiently.

Proof of inexistence of *No-Reputation Type 1* equilibria under competitive prices

Assume to the contrary that such an equilibrium with no interaction exists. The per-period payoff for a customer and for an expert from abstaining from interaction is equal to the outside option of 1.6. Given that experts always overcharge and undertreat customers with a major problem, it must hold that the expected payoff from interaction, which is equal to $0.5 \cdot (10 - p_H) + 0.5 \cdot (0 - p_H) = 5 - p_H$, must be lower than the outside option. Hence, in equilibrium, experts must charge a price $p_H \geq 4$. In this case, however, it is optimal for an expert to deviate and charge a price $p_H = 3$ instead. At this price, all four customers would visit the expert posting $p_H = 3$ who would receive an expected payoff of $4 \cdot (0.5 \cdot (3 - 2) + 0.5 \cdot (3 - 2)) = 4 > 1.6$.

Proof of inexistence of *No-Reputation Type 2* equilibria under fixed prices

Assume to the contrary that such an equilibrium with full interaction exists. The expected payoff for a customer from interaction is -3 given that experts always overcharge and undertreat customers with a major problem. This is lower than the customer's outside option of 1.6. Thus, a customer receives a higher payoff without interaction, which is a contradiction.

A.2 Proof of *Lemma 2*: Existence of *Reputation Type 1* in all four conditions

A.2.1 Public histories

Public histories and competitive prices (*PUH Comp*)

For competitive prices under public histories, we refer to the strategies and beliefs as well as the corresponding proof for the reputation equilibrium in Dulleck et al. (2011). Customers initially randomize between experts. To sustain no undertreatment in periods 1–9, customers' strategies condition on the number of customers served by experts, which determines whether a given expert is expected to treat sufficiently and therefore a customer's switching to and from experts.[37]

Public histories and fixed prices (*PUH Fixed*)

The exogenously set price vector $(4, 8)$ in periods 1–9 does not allow for initial randomization between experts as in Dulleck et al. (2011). However, the strategies can

[37] As it turns out, the proof in Dulleck et al. (2011) requires public histories while their experimental game is one with private histories.

easily be adjusted by specifying in the customers' strategy that each customer visits expert $A1$ (or any other predetermined expert) in the first period. In periods 10–16, our exogenously set price vector corresponds to the price vector in the strategies in the proof for the reputation equilibrium in Dulleck et al. (2011). We need to check whether, given the higher prices in our fixed price condition, customers want to interact in periods 1–9. A customer's expected payoff from visiting an expert that is expected to treat sufficiently $10 - 8 = 2$ which is larger than the outside option (1.6). Hence, customers interact in periods 1–9.[38]

A.2.2 Private histories

Under private histories, customers observe only their own history with experts with whom they interacted. A customer does not observe how many customers an expert served in the past and whether other customers were treated sufficiently. Thus, under private histories, it cannot be specified in a customer's strategy that customers switch to and from experts based on the number of customers that experts served and treatments provided to other customers, which is part of the construction in the proof in Dulleck et al. (2011). We therefore provide our own proofs for the private histories regime. In these, customers coordinate *ex ante* on an expert, and a customer does not visit an expert again who has undertreated her, such that the expert has enough incentives to always provide a sufficient treatment in periods 1–9.

Private histories and fixed prices (*PRH Fixed*)

Customers' beliefs Each customer expects to be charged p_H in all periods. Each customer believes to be treated sufficiently if and only if (i) she was never undertreated before, and (ii) the game is in periods 1–9. Otherwise, each customer believes to receive a minor treatment.

Customers' strategy Each customer visits expert $A1$ in the first period. In periods 2–9, if the customer interacted with an expert in the previous period and was not undertreated in any previous period by this expert, the customer returns to the expert. Otherwise, the customer refrains from interacting. In periods 10–16, if the customer interacted with an expert in period 9 and was not undertreated in any previous period by this expert, the customer visits this expert that she interacted with in period 9. Otherwise, the customer randomizes between experts who did not undertreat her in any period 1–9 with equal probability in periods 10–16. If there is no expert who never undertreated her, she randomizes between all experts with equal probability in periods 10–16.

[38]In periods 10–16, with a major treatment price $p_H = 3$, a customer's payoff from interacting is at least $0.5 \cdot 10 - 3 = 2$ which is larger than the outside option (1.6).

Experts' strategy Each expert treats his customers sufficiently in periods 1–9 if he serves all four customers; otherwise, he provides the minor treatment. In periods 10–16, experts always provide the minor treatment. Experts always charge p_H.

Verification We now verify that the strategies and beliefs described above form a PBE. First note that customers' beliefs reflect experts' strategy. On the equilibrium path, customers visit expert A1 in periods $1-16$. Customers are treated sufficiently and charged p_H in periods $1-9$, and treated with the minor treatment and charged p_H in periods $10-16$.
We first show that customers' strategies are rational. In periods 10–16, if customers interact, they receive an expected payoff of $0.5 \cdot (10-3) + 0.5 \cdot (0-3) = 2$ which is larger than their outside option of 1.6. In periods 1–9, given the behavior of the experts and the other customers, it is optimal for a customer to interact when she has never been undertreated, as the expected payoff from being treated sufficiently and charged p_H, $10-8=2$, is larger than that from not interacting (1.6).
With regard to the experts' strategy, we need to show that there is no profitable deviation. In periods 10–16, it is optimal to always provide the minor treatment and charge p_H, as future customer behavior is not affected.
We need to check deviations in periods 1–9. First note that since $p_H \geq p_L$, and since customers' strategies do not condition on charging, it is optimal to always charge p_H. Thus, it remains to check whether in period 1–9 an expert serving all four customers would deviate by undertreating one or several of his customers.[39] From the customers' strategy, if a customer interacted in period 9 and was undertreated in this period, she does not return to the expert in periods $10-16$.[40] When an expert serves four customers in period 9, conditional on treating at least one customer sufficiently, the per customer additional future payoff of treating sufficiently is $7 \cdot (3-2) = 7$ which is larger than the per customer maximum additional current payoff from deviating which amounts to $(8-2)-(8-6) = 4$.[41] Thus, conditional on treating at least one customer sufficiently, an expert serving four customers would not deviate by undertreating the other customers. Due to the expert's outside option which he receives when no customer visits him, we need to check whether the expert would undertreat all four customers. The additional future payoff when treating all customers sufficiently amounts to $7 \cdot (4(3-2)-1.6) = 16.8$, whereas the maximum additional current payoff from deviating is $4 \cdot ((8-2)-(8-6)) = 16$. Thus, in period 9, an expert serving four customers does not undertreat. In periods 1–8, the future payoff from treating sufficiently per customer and period for all periods up to period 9 is $8-(0.5\cdot 2+0.5\cdot 6) = 4$ such that deviation incentives are lower. Hence, there is no profitable deviation.

[39] From the customers' strategy with ex ante coordination on an expert, regarding expert deviations we only need to consider the situation where one expert serves all four customers.

[40] Note that, if the expert has four customers in period 9, then a customer cannot have been undertreated by all other three experts (since then she would not interact) such that she then does not return to the expert if he undertreats her.

[41] The payoff from deviating is largest when the customer has the major problem.

Private histories and competitive prices (*PRH Comp*)

In the following, we provide a proof where experts post a price menu $(n.d., 5)$ in periods $1 - 9$ and customers are not undertreated in periods $1 - 9$. We could, of course, construct an equilibrium with the prices from our fixed price regime. However, we want to show that a Reputation Type 1 equilibrium exists under private histories with lower prices than those in our fixed price regime, and where the price for the major treatment is below the marginal costs of the major treatment.

Customers' beliefs Each customer believes to be charged p_H in any of the periods. Each customer believes to be treated sufficiently if and only if (i) she is treated under a price menu $(n.d.5)$, (ii) she was never undertreated before, and (iii) the game is in periods 1–9. Otherwise, each customer believes to receive the minor treatment.

Customers' strategy In period 1, each customer visits among the experts that post a price menu $(n.d., 5)$ the expert with the lowest expert number (i.e., expert $A1$ if expert $A1$ posted $(n.d., 5)$; expert $A2$ if expert $A1$ did not post $(n.d., 5)$, but expert $A2$ posted $(n.d., 5)$; and so forth). If there is no expert posting $(n.d., 5)$, a customer interacts with an expert posting a price vector with $p_H \leq 3$[42]; otherwise, the customer does not interact.
In periods 2–9, if the customer interacted with an expert in the previous period and was not undertreated in any previous period by this expert and the expert posted $(n.d., 5)$, the customer returns to the expert. If the customer was undertreated by an expert in the previous period and there is at least one expert who posts a price of $p_H = 3$ or lower for the major treatment[43] and never undertreated her under a price vector $(n.d., 5)$, the customer randomizes between those experts posting the lowest price for the major treatment among those who never undertreated her under a price vector $(n.d., 5)$; if among experts posting a price of $p_H = 3$ or lower for the major treatment there is no expert who never undertreated her under a price vector $(n.d., 5)$, she randomizes with equal probability among all experts posting the lowest price for the major treatment; otherwise, the customer does not interact.
In periods 10–16, if the customer interacted with an expert in period 9 and was not undertreated in any previous period by this expert, and the expert posts $(n.d., 3)$, the customer visits this expert with whom she interacted in period 9 (in all periods 10–16). If the customer was undertreated by the expert with whom she interacted in period 9 in any of the previous periods, or the expert posts a price for the major treatment higher than 3, and there is at least one expert who posts a price of 3 or lower for the major treatment and who never undertreated her in any period $1 - 9$, the customer randomizes between those experts posting the lowest price for the major treatment among those who never undertreated her in any period $1 - 9$. If among

[42]A customer chooses the expert posting the lowest price among experts that post a price for the major treatment that is smaller or equal to 3, and randomize with equal probability between those experts if there are several experts posting the lowest price.
[43]Recall that prices in the experiment are restricted to $p_L \leq p_H$.

experts posting a price of $p_H = 3$ or lower for the major treatment there is no expert who never undertreated her in any period $1-9$ she randomizes with equal probability among all experts posting the lowest price for the major treatment; if there is no expert posting a price of $p_H = 3$ or lower for the major treatment, the customer does not interact.

Experts' strategy Experts post price vectors $(n.d., 5)$ in periods 1–9 and $(n.d., 3)$ in periods 10–16. Each expert treats his customers sufficiently in periods 1–9 if he serves all four customers; otherwise, he provides the minor treatment. In periods 10–16, experts always provide the minor treatment. Experts always charge p_H.

Verification We now verify that the strategies and beliefs described above form a PBE. First note that customers' beliefs reflect experts' strategy. On the equilibrium path, customers visit expert A1 in periods $1-16$. Customers are treated sufficiently and charged $p_H = 5$ in periods $1-9$, and treated with the minor treatment and charged $p_H = 3$ in periods $10-16$.
We first show that customers' strategies are rational. In periods 10–16, if customers interact, they receive an expected payoff of $0.5 \cdot (10-3) + 0.5 \cdot (0-3) = 2$ which is larger than their outside option of 1.6. In periods 1–9, given the behavior of the experts and the other customers, it is optimal for a customer to interact when she has never been undertreated, as the expected payoff from being treated sufficiently and charged p_H, $10-5=5$, is larger than that from not interacting (1.6).
With regard to the experts' strategy, we need to show that there is no profitable deviation. In periods 10–16, it is optimal to always provide the minor treatment and charge p_H, as future customer behavior is not affected. Regarding the posting of prices in periods 10–16, expert A1 would loose all four customers if posting a higher price of 3 for the major treatment and he prefers serving all four customers at the price of 3 to his outside option. All other experts do not serve any customer and are therefore indifferent between posting $p_H = 3$ for the major treatment or a higher price.[44]
We need to check deviations in periods 1–9. First note that since $p_H \geq p_L$, and since customers' strategies do not condition on charging, it is optimal to always charge p_H. We first check deviations by undertreating, we consider deviations by posting different price vectors below. Thus, we need to check whether in periods 1–9 an expert who posts $(n.d., 5)$ and serves all four customers would deviate by undertreating one or several of his customers.[45] From the customers' strategy, if a customer interacted with an expert in period 9 and was undertreated by this expert in any previous period, she does not return to the expert in periods $10-16$.[46] When an expert serves four customers in period 9, conditional on treating at least one customer sufficiently, the per customer

[44]Note that, if expert A1 deviated such that customers randomize with equal probability among the remaining experts, the payoff for an expert would not be lower than the outside option.

[45]From the customers' strategy with ex ante coordination on an expert, regarding expert undertreating deviations we only need to consider the situation where one expert serves all four customers.

[46]Note that, if the expert has four customers in period 9, then a customer cannot have been undertreated by all other three experts under a price vector $(n.d., 5)$ such that she then does not return to the expert if he undertreats her.

additional future payoff of treating sufficiently is $7 \cdot (3-2) = 7$ which is larger than the per customer maximum additional current payoff from deviating which amounts to $(5-2)-(5-6) = 4$.[47] Thus, conditional on treating at least one customer sufficiently, an expert serving four customers would not deviate by undertreating the other customers. Due to the expert's outside option which he receives when no customer visits him, we need to check whether the expert would undertreat all four customers. The additional future payoff when treating all customers sufficiently amounts to $7 \cdot (4(3-2)-1.6) = 16.8$, whereas the maximum additional current payoff from deviating is $4 \cdot ((8-2)-(8-6)) = 16$. Thus, in period 9, an expert serving four customers does not undertreat. In periods 1–8, the future payoff from treating sufficiently per customer and period for all periods up to period 9 is $5-(0.5 \cdot 2+0.5 \cdot 6) = 1$ such that deviation incentives are lower. Hence, there is no profitable deviation.
With regard to the posting of prices in periods 1–9, no expert can profitably deviate by posting a higher price than 5 for the major treatment, as then customers do not interact, nor by posting a price of $p_H = 3$ for the major treatment in periods $1-9$, since customers do not derive a higher expected payoff from interacting with an expert who posts the price of $p_H = 3$ for a major treatment and therefore do not switch to this expert.

A.3 Proof of existence of *Reputation Type 2* equilibria in all four conditions

A.3.1 Private histories and fixed prices (*PRH Fixed*)

Customers' beliefs Each customer believes to be treated sufficiently if and only if (i) she was never undertreated before, and (ii) the game is in periods 1–9. Otherwise, each customer believes to receive the minor treatment. Each customer believes to be charged p_L if (i) she was never undertreated before, and (ii) the game is in periods 1–7. Otherwise, each customer believes to be charged p_H.

Customers' strategy Each customer visits expert $A1$ in the first period. In periods 2–9, if the customer interacted with an expert in the previous period and was not undertreated in any previous period by this expert, the customer returns to the expert. Otherwise, the customer refrains from interacting. In periods 10–16, if the customer interacted with an expert in period 9 and was not undertreated in any previous period by this expert and was charged p_L in every period 1–7, the customer visits this expert that she interacted with in period 9. Otherwise, in periods 10–16 the customer randomizes with equal probability between experts who did not undertreat her in any period 1–9 and did not charge her p_H in periods $1-7$. If there is no such expert she randomizes between all experts with equal probability in periods 10–16.

[47]The payoff from deviating is largest when the customer has the major problem.

Experts' strategy In periods 1–9, each expert treats his customers sufficiently and charges each customer p_L in periods 1–7 and p_H in periods 8 and 9 if he serves all four customers; otherwise, he provides the minor treatment with charging p_H. In periods 10–16, experts always provide the minor treatment and charge p_H.

Verification We now verify that the strategies and beliefs described above form a PBE. First note that customers' beliefs reflect experts' strategy. On the equilibrium path, customers visit expert A1 in periods $1-16$. Customers are treated sufficiently and charged p_L in periods $1-7$, treated sufficiently and charged p_H in periods $8-9$ and treated with the minor treatment and charged p_H in periods $10-16$.
We first show that customers' strategies are rational. In periods 10–16, if customers interact, they receive an expected payoff of $0.5 \cdot (10-3) + 0.5 \cdot (0-3) = 2$ which is larger than their outside option of 1.6. In periods 1–9, given the behavior of the experts and the other customers, it is optimal for a customer to interact when she has never been undertreated, as the expected payoff from being treated sufficiently is at least $10-8=2$, which is larger than that from not interacting (1.6).
With regard to the experts' strategy, we need to show that there is no profitable deviation. In periods 10–16, it is optimal to always provide the minor treatment and charge p_H, as future customer behavior is not affected.
We start with checking deviations in periods 8–9. First note that since $p_H \geq p_L$, and since customers' strategies do not condition on charging in periods 8–9, it is optimal to always charge p_H. Thus, it remains to check whether in period 8–9 an expert serving all four customers would deviate by undertreating one or several of his customers.[48] From the customers' strategy, if a customer interacted in period 9 and was undertreated in this period, she does not return to the expert in periods $10-16$.[49] When an expert serves four customers in period 9, conditional on treating at least one customer sufficiently, the per customer additional future payoff of treating sufficiently is $7 \cdot (3-2) = 7$ which is larger than the per customer maximum additional current payoff from deviating which amounts to $(8-2)-(8-6) = 4$.[50] Thus, conditional on treating at least one customer sufficiently, an expert serving four customers would not deviate by undertreating the other customers. Due to the expert's outside option which he receives when no customer visits him, we need to check whether the expert would undertreat all four customers. The additional future payoff when treating all customers sufficiently amounts to $7 \cdot (4(3-2)-1.6) = 16.8$, whereas the maximum additional current payoff from deviating is $4 \cdot ((8-2)-(8-6)) = 16$. Thus, in period 9, an expert serving four customers does not undertreat. In periods 8, the payoff from treating sufficiently per customer in round 9 is $8-(0.5 \cdot 2 + 0.5 \cdot 6) = 4$ such that deviation incentives are lower. Hence, there is no profitable deviation.
Next, we need to check a deviation in periods 1–7. We first check deviations with undertreatment and overcharging. Again, we only need to consider the case that

[48]From the customers' strategy with ex ante coordination on an expert, regarding expert deviations, we only need to consider the situation where one expert serves all four customers.

[49]Note that, if the expert has four customers in period 9, then a customer cannot have been undertreated by all other three experts (since then she would not interact) such that she then does not return to the expert if he undertreats her.

[50]The payoff from deviating is largest when the customer has the major problem.

an expert serves all four customers. Note that an expert's incentive to deviate is largest in period 1 and not in period 7. This is because an expert makes zero profits in periods 1–7 when playing according to the strategy specified above, whereas a deviation leads to a profit of 1.6 per period (outside option). In period 1, when serving four customers, conditional on treating at least one customer sufficiently, it is not profitable to deviate on one or more customers for a similar reasoning as above for period 9. Due to the expert's outside option which he receives when no customer visits him, we need to check whether the expert would undertreat and overcharge all four customers. The expert's maximum profit from charging p_H but providing the minor treatment to all four customers amounts to $4 \cdot ((8-2)-(4-6))+8 \cdot 1.6 = 44.8$, whereas the expected future payoff from charging p_L and treating sufficiently amounts to $2 \cdot 4 \cdot (0.5 \cdot (8-6) + 0.5 \cdot (8-2)) + 7 \cdot 2.4 = 48.8$.[51].
It remains to check an expert deviation in periods 1–7 by treating sufficiently, but charging p_H when an expert serves four customers. If treated sufficiently, customers stay with the experts in periods $8-9$, but the customers' strategy specifies that a customer does not return to an expert in periods 10–16 if the customer was charged p_H by the expert in any round 1–7. Conditional on charging at least one customer p_L (and treating the customer sufficiently), the per customer additional future payoff of treating sufficiently is $7 \cdot (3-2) = 7$ which is larger than the per customer additional current payoff from deviating by charging p_H instead of p_L which amounts to $8-4=4$. Due to the expert's outside option which he receives when no customer visits him, we need to check whether the expert would charge p_H instead of p_L all four customers. His payoff from deviating is $4 \cdot 4 = 16$, whereas the expected future payoff from charging p_L is $7 \cdot 2.4 = 16.8$. Thus, an expert cannot profitably deviate by treating sufficiently but charging p_H. As a consequence, there is no profitable deviation by an expert.

A.3.2 Public histories and fixed prices (*PUH Fixed*)

For public histories and fixed prices, consider the strategies and beliefs as well as the corresponding proof as for *PRH Fixed* above. On the equilibrium path, customers visit expert $A1$ in periods 1–16 and are treated sufficiently in periods 1–9, charged p_L in periods 1–7 and p_H in periods 8–9, and then receive the minor treatment and are charged p_H in periods 10–16. It remains to show that any deviation that is based on information that was not available under private histories above cannot be profitable. Note that, since there is no information about experts other than $A1$ on the equilibrium path, and since with fixed prices, experts cannot deviate by posting lower prices to attract customers, there is no profitable deviation by an expert.

[51]In periods 1–9, the expert sticking to the equilibrium strategy gives up the outside option of 1.6. In periods 8 and 9, an expert charges all four customers the major treatment although in expectation only two customers need the major treatment. In periods 10–16, the expert's additional expected future profit amounts to $7 \cdot (4-1.6) = 16.8$.

A.3.3 Private histories and competitive prices (*PRH Comp*)

Customers' beliefs Each customer believes to be treated sufficiently if and only if (i) she is treated under a price vector $(4, 8)$, (ii) she was never undertreated before, and (iii) the game is in periods 1–9. Otherwise, each customer believes to receive the minor treatment. Each customer believes to be charged p_L if (i) she is treated under a price vector $(4, 8)$, (ii) she was never undertreated before, and (iii) the game is in periods 1–7. Otherwise, each customer believes to be charged p_H.

Customers' strategy In period 1, each customer visits among the experts that post a price menu $(4, 8)$ the expert with the lowest expert number (i.e., expert $A1$ if expert $A1$ posted $(4, 8)$; expert $A2$ if expert $A1$ did not post $(4, 8)$, but expert $A2$ posted $(4, 8)$; and so forth). If there is no expert posting $(4, 8)$, a customer interacts with an expert posting a price vector with $p_H \leq 3$[52]; otherwise, the customer does not interact.

In periods 2–9, if the customer interacted with an expert in the previous period and was not undertreated in any previous period by this expert and the expert posted $(4, 8)$, the customer returns to the expert. If the customer was undertreated by an expert in the previous period and there is at least one expert who posts a price of $p_H = 3$ or lower for the major treatment and never undertreated her under a price vector $(4, 8)$, the customer randomizes between those experts posting the lowest price for the major treatment among those who never undertreated her under a price vector $(4, 8)$; if among experts posting a price of $p_H = 3$ or lower for the major treatment there is no expert who never undertreated her under a price vector $(4, 8)$, she randomizes with equal probability among all experts posting the lowest price for the major treatment; otherwise, the customer does not interact.

In periods 10–16, if the customer interacted with an expert in period 9, was not undertreated in any previous period by this expert, was charged the price $p_L = 4$ in periods 1–7 by this expert and a price not higher than 8 in periods 8–9, and the expert posts $(n.d., 3)$, the customer visits this expert with whom she interacted in period 9 (in all periods 10–16). If the customer was undertreated by the expert with whom she interacted in period 9 in any of the previous periods or charged a price higher than $p_L = 4$ in periods 1–7, or the expert posts a price for the major treatment higher than 3, and there is at least one expert who posts a price of 3 or lower for the major treatment and who never undertreated her in any period $1 - 9$ and never charged her p_H in periods $1 - 7$, the customer randomizes between those experts posting the lowest price for the major treatment among those who never undertreated her in any period $1 - 9$ and never charged her p_H in periods $1 - 7$. If among experts posting a price of $p_H = 3$ or lower for the major treatment there is no expert who never undertreated her in any period $1 - 9$ and never charged her p_H in periods $1 - 7$, she randomizes with equal probability among all experts posting the lowest price for the major treatment;

[52] A customer chooses the expert posting the lowest price among experts that post a price for the major treatment that is smaller or equal to 3, and randomize between those experts if there are several experts posting the lowest price.

if there is no expert posting a price of 3 or lower for the major treatment, the customer does not interact.

Experts' strategy Each expert posts a price vector $(4, 8)$ in periods 1–9 and $(n.d., 3)$ in periods 10–16. Each expert treats his customers sufficiently in periods 1–9 if he serves all four customers; otherwise, he provides the minor treatment. In periods 10–16, experts always provide the minor treatment. An expert charges p_L in periods 1–7 if he serves all four customers and p_H otherwise.

Verification Note that the price vectors specified are the same as in the fixed-price regimes. Thus, we can refer to the verification for *PRH Fixed*.
Additionally, we need to show that there is no profitable deviation by an expert posting different price vectors. Regarding the posting of prices in periods 10–16, expert A1 would loose all four customers if posting a higher price of 3 for the major treatment and he prefers serving all four customers at the price of 3 to his outside option. All other experts do not serve any customer and are therefore indifferent between posting $p_H = 3$ for the major treatment or a higher price.[53] For periods 1–9, note that a customer believes to receive the minor treatment if she is treated under a price vector other than $(4, 8)$. Then, customers would only switch to an expert posting a different price vector if they receive a payoff larger than 2 which is their minimum payoff from visiting an expert who is expected to treat sufficiently. Thus, a deviating expert would have to post a price lower than $p_H = 3$ for the major treatment. In this case, however, the expert prefers his outside option. Thus, there is no profitable deviation by posting a different price vector in periods 1–9.

A.3.4 Public histories and competitive prices (*PUH Comp*)

For public histories and competitive prices, consider the strategies and beliefs as well as the corresponding proof for *PRH Comp* above. On the equilibrium path, customers visit expert $A1$ in periods 1–16 and are treated sufficiently in periods 1–9, charged p_L in periods 1–7 and p_H in periods 8–9, and then receive the minor treatment and are charged p_H in periods 10–16. It remains to show that any deviation that is based on information that was not available under private histories above cannot be profitable. Note that, since there is no information about experts other than $A1$ on the equilibrium path, and since there is no profitable deviation by posting lower prices to attract customers as shown in the proof for *PRH Comp*, there is no profitable deviation by an expert.

[53] Note that, if expert A1 deviated such that customers randomize with equal probability among the remaining experts, the payoff for an expert would not be lower than the outside option.

B Screenshots of feedback systems

B.1 Feedback system in a market with price competition

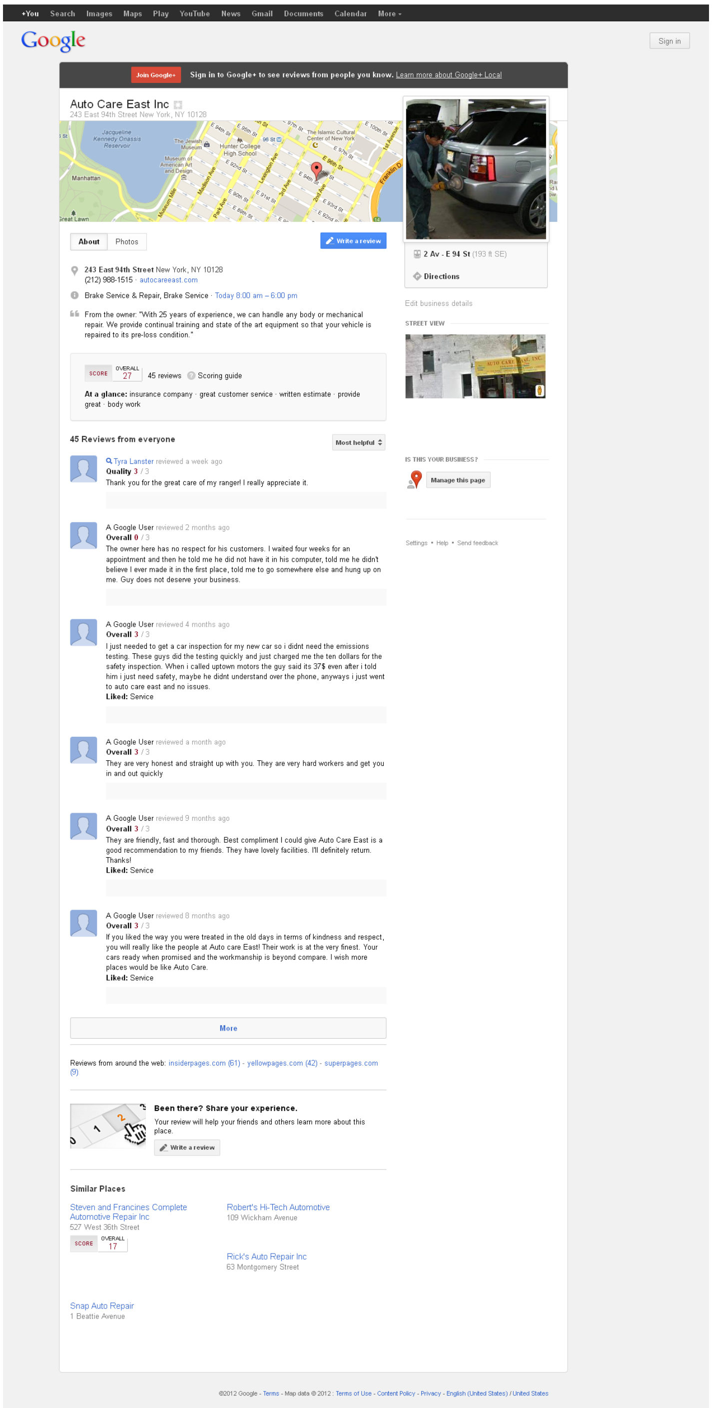


Figure 9: Car repair shop rating at *Google Maps*.
Source: `https://plus.google.com/109459300714062123468/about?gl=US&hl=en` accessed on July 18, 2012.

B.2 Feedback system in a fixed price market

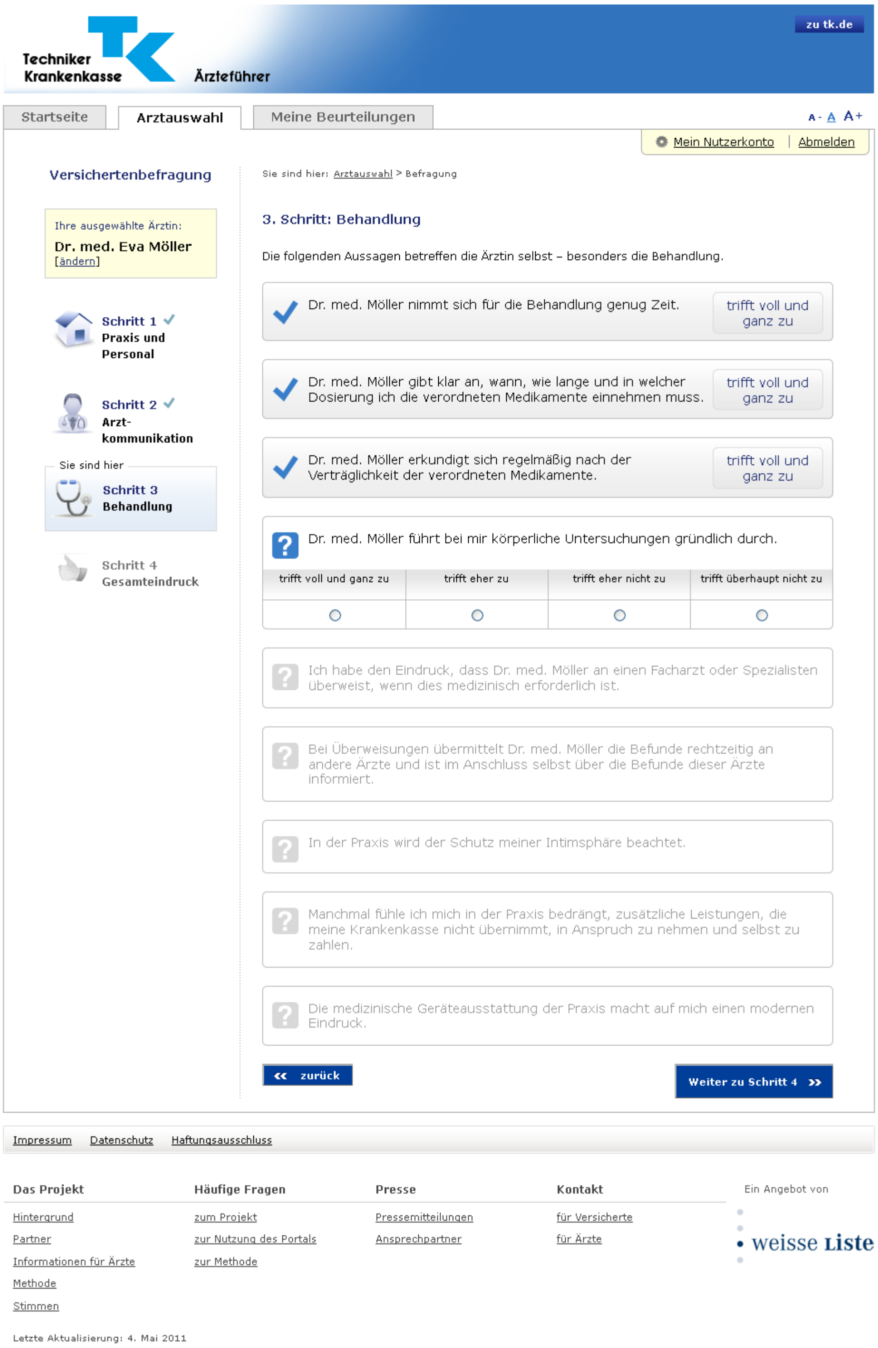


Figure 10: Patient feedback at the *Arztnavigator*.
Source: `https://weisse-liste.arzt-versichertenbefragung.tk.de/` accessed on July 18, 2012.

C Instructions

In the following, we present the instructions for the public histories under price competition condition. We provide both the original German version as well as an English version. The instructions are taken from Dulleck et al. (2011) and have been adapted for our purposes.

C.1 Original instructions: German version

ANLEITUNG ZUM EXPERIMENT

Herzlichen Dank für Ihre Teilnahme am Experiment. Bitte sprechen Sie bis zum Ende des Experiments nicht mehr mit anderen Teilnehmern.

2 Rollen und 16 Runden

Dieses Experiment besteht aus **16 Runden**, die jeweils die gleiche Abfolge an Entscheidungen haben. Die Abfolge der Entscheidungen wird unten ausführlich erklärt.
Es gibt im Experiment 2 Rollen: **Spieler A** und **Spieler B**. Zu Beginn des Experiments bekommen Sie eine dieser Rollen zufällig zugelost und behalten diese Rolle für das gesamte Experiment. Auf dem ersten Bildschirm des Experiments sehen Sie, welche Rolle Sie haben. Diese Rolle bleibt für alle Spielrunden gleich.
In Ihrer Gruppe sind 4 Spieler A und 4 Spieler B. Die Spieler jeder Rolle bekommen eine Nummer. Sind Sie ein Spieler B, dann sind Ihre potentiellen Interaktionspartner die Spieler A1, A2, A3 und A4. Sind Sie hingegen ein Spieler A, dann sind Ihre potentiellen Interaktionspartner die Spieler B1, B2, B3 und B4.
Die Nummern der **Spieler** sind **fix**. Das heißt, dass zum Beispiel hinter der Nummer „A1“ oder hinter der Nummer „B3“ immer dieselbe Person steht. Spieler A erfährt zu keinem Zeitpunkt, mit welchem/welchen Spieler/n B (B1-B4) er interagiert.

Alle Experimentteilnehmer erhalten die gleichen Informationen bezüglich der Regeln des Spiels, inklusive der Kosten und Auszahlungen an beide Spieler.

Überblick über die Entscheidungen in einer Runde

Jede einzelne Runde besteht aus maximal 4 Entscheidungen, die hintereinander getroffen werden. Die Entscheidungen 1, 3 und 4 werden von Spieler A getroffen; die Entscheidung 2 wird von Spieler B getroffen.

Ablauf der Entscheidungen einer Runde (kurz gefasst)

1. Die Spieler A wählen Preise für die Aktionen 1 und 2.
2. Jeder Spieler B erfährt die von den 4 Spielern A (A1 bis A4) gewählten Preise. Dann entscheidet Spieler B, ob er mit einem Spieler A interagieren möchte. Es ist nur möglich, mit *einem* Spieler A zu interagieren. Falls Spieler B mit keinem Spieler A interagiert, endet diese Runde für ihn.

Falls Spieler B mit einem Spieler A interagiert ...

3. Der jeweilige Spieler A erhält die Information, ob einer oder mehrere Spieler B mit ihm interagieren. Es können maximal alle 4 Spieler B mit einem bestimmten Spieler A interagieren. Spieler A erfährt dann, welche Eigenschaften die Spieler B haben, die mit ihm interagieren. Es gibt zwei mögliche Eigenschaften: Eigenschaft 1 oder Eigenschaft 2. Diese Eigenschaft muss nicht identisch sein für die betreffenden Spieler B. Spieler A muss für jeden Spieler B, mit dem er interagiert, eine Aktion wählen: entweder Aktion 1 oder Aktion 2.
4. Spieler A verlangt von Spieler B den in Entscheidung 1 festgelegten Preis für eine der beiden Aktionen. Dabei muss der verlangte Preis nicht gleich dem Preis der in Entscheidung 3 gewählten Aktion sein, sondern es kann auch der Preis der anderen Aktion sein. Außerdem kann Spieler A von verschiedenen Spielern B unterschiedliche Preise verlangen.

Detaillierte Darstellung der Entscheidungen und ihrer Konsequenzen hinsichtlich der Auszahlungen

Entscheidung 1

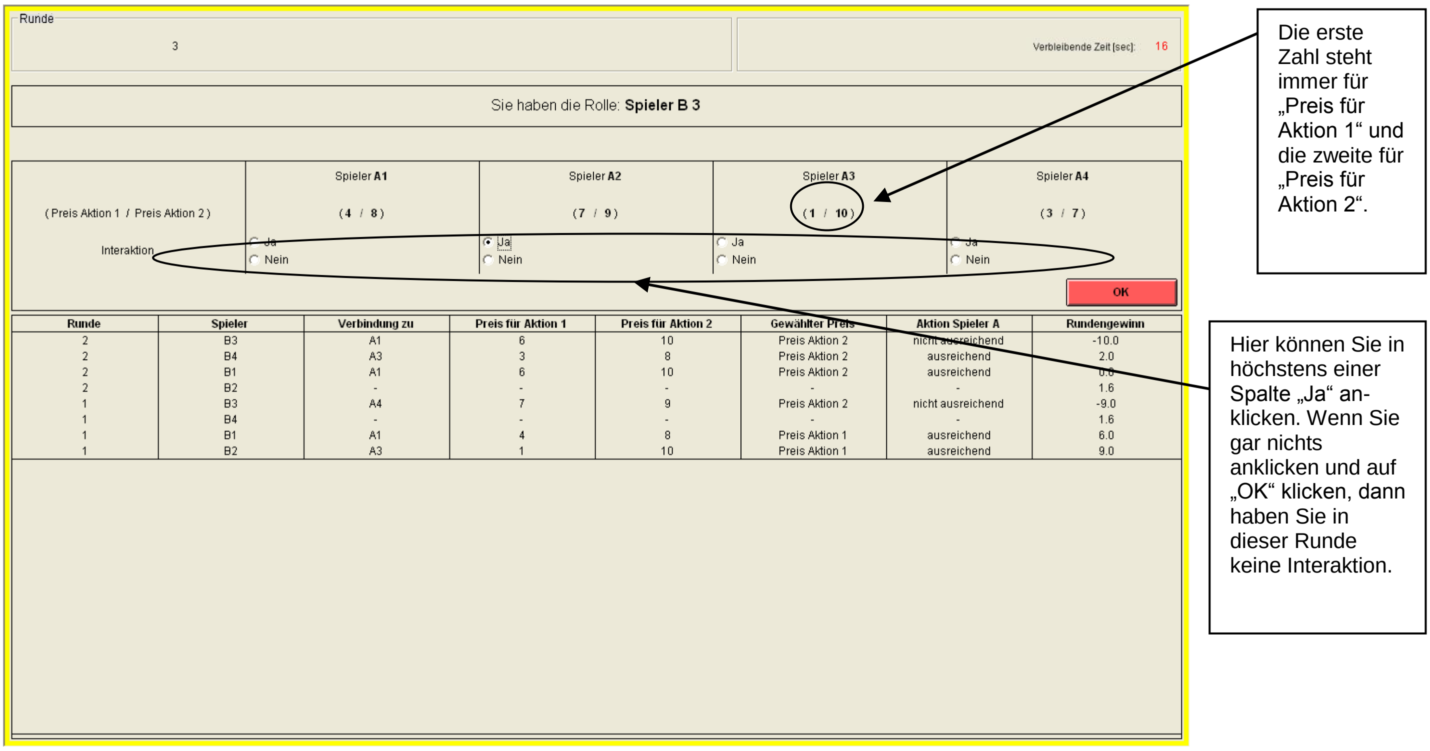
Jeder Spieler A hat in Entscheidung 3 für den Fall einer Interaktion zwischen zwei Aktionen zu wählen, einer Aktion 1 und einer Aktion 2. Jede gewählte Aktion verursacht Kosten, die folgendermaßen fixiert sind:
Die **Aktion 1** verursacht **Kosten von 2 Punkten** (= experimentelle Währungseinheit) für Spieler A.
Die **Aktion 2** verursacht **Kosten von 6 Punkten** für Spieler A.
Für diese Aktionen kann Spieler A von jenen Spielern B, die mit ihm interagieren wollen, Preise verlangen. In **Entscheidung 1** muss jeder Spieler A diese **Preise für beide Aktionen festlegen**. Nur

(strikt) positive Preise in vollen Punkten von 1 Punkt bis maximal 11 Punkte sind möglich. D.h. die zulässigen Preise sind 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 oder 11.
Beachten Sie, dass der Preis für die Aktion 1 den Preis für die Aktion 2 nicht übersteigen darf.

Entscheidung 2
Spieler B erfährt die von allen 4 Spielern A in Entscheidung 1 gesetzten Preise. Dann entscheidet Spieler B, ob er mit einem der Spieler A interagieren möchte, und wenn ja, mit welchem.
Falls ja, dann bedeutet das, dass der entsprechende Spieler A in den Entscheidungen 3 und 4 eine Aktion wählen und dafür einen Preis verlangen kann (siehe unten). Spieler B wird aber **nicht** beobachten können, welche Aktion Spieler A wählt.
Falls nein, dann **endet** diese Runde für diesen Spieler B und er erhält als **Auszahlung für diese Runde 1,6 Punkte**.
Falls **keiner der Spieler B** mit einem bestimmten **Spieler A** interagieren möchte, erhält auch der betreffende Spieler A als **Auszahlung für diese Runde 1,6 Punkte**.

Auf der Folgeseite sehen Sie einen **exemplarischen Bildschirm** für die Entscheidung 2. Wenn Sie eine Interaktion mit einem bestimmten A-Spieler wünschen, dann klicken Sie bitte in der entsprechenden Spalte auf „Ja“ und bestätigen die Eingabe mit „OK“ (Sie müssen bei den anderen 3 A-Spielern dann nicht auf „Nein“ klicken). Wenn Sie überhaupt keine Interaktion wollen, dann müssen Sie nicht 4 Mal auf „Nein“ klicken, sondern können einfach OK bestätigen. (siehe Bildschirmerklärung).
In der unteren Hälfte des Bildschirms sehen Sie alle bisherigen Runden (aktuell ist Runde 3). Die Spalten bedeuten Folgendes:

- Runde: In welcher Runde etwas passiert ist
- Spieler: Um welchen Spieler B es sich handelt
- Verbindung zu: Hier sehen Sie, mit welchem Spieler A der jeweilige Spieler B interagiert hat (z.B. B4 in Runde 2 mit A3; „-“ falls keine Interaktion stattgefunden hat).
- Preis für Aktion 1: welchen Preis der jeweilige Spieler A für Aktion 1 festgesetzt hat (falls Sie eine Interaktion hatten; sonst steht „-“ wie z.B. bei B4 in Runde 1).
- Preis für Aktion 2: welchen Preis der jeweilige Spieler A für Aktion 2 festgesetzt hat.
- Gewählter Preis: „Preis Aktion 1“ bedeutet, dass der Preis für die Aktion 1 gewählt wurde (z.B. in Runde 1 von A1). „Preis Aktion 2“ bedeutet, dass der Preis für Aktion 2 gewählt wurde (z.B. in Runde 2 von A3). „-“ wird angezeigt bei keiner Interaktion.
- Aktion Spieler A: „ausreichend“ oder „nicht ausreichend“ (falls Interaktion stattgefunden hat) bzw. „-“ (falls keine Interaktion stattgefunden hat – wie in Runde 2 bei Spieler B2). (zur Erklärung siehe unten)
- Rundengewinn: Ihr Gewinn in Punkten in der betreffenden Runde. (zur Berechnung siehe unten)



Entscheidung 3

Vor der Entscheidung 3 (falls Spieler B in Entscheidung 2 „Ja“ gewählt hat) wird dem Spieler B zufällig eine Eigenschaft zugelost. **Spieler B** kann 2 Eigenschaften haben: **Eigenschaft 1** oder **Eigenschaft 2**. Die Eigenschaft wird **jede Runde neu** und auch für jeden Spieler B **unabhängig** zufällig bestimmt. Jeder Spieler B hat mit einer Wahrscheinlichkeit von **50% die Eigenschaft 1** und mit einer Wahrscheinlichkeit von **50% die Eigenschaft 2**. Stellen Sie sich in jeder Runde für jeden Spieler B einen Münzwurf vor. Wenn beispielsweise „Kopf“ kommt, dann hätte der entsprechende Spieler B die Eigenschaft 1, falls „Zahl“ kommt, hätte er die Eigenschaft 2.

Jeder Spieler A erfährt *vor* seiner Entscheidung 3 die **Eigenschaften aller jener Spieler B**, die mit diesem Spieler A interagieren wollen. Dann wählt Spieler A eine Aktion für jeden Spieler B, entweder Aktion 1 oder Aktion 2. Dabei kann die Aktion bei mehreren Spieler B auch unterschiedlich sein.
Eine **Aktion** ist unter folgenden Bedingungen für einen bestimmten Spieler B **ausreichend**:

a) Spieler B hat die Eigenschaft 1 und Spieler A wählt entweder die Aktion 1 oder die Aktion 2.
b) Spieler B hat die Eigenschaft 2 und Spieler A wählt die Aktion 2.

Eine Aktion ist **nicht ausreichend**, wenn Spieler B die Eigenschaft 2 hat, aber Spieler A die Aktion 1 wählt.

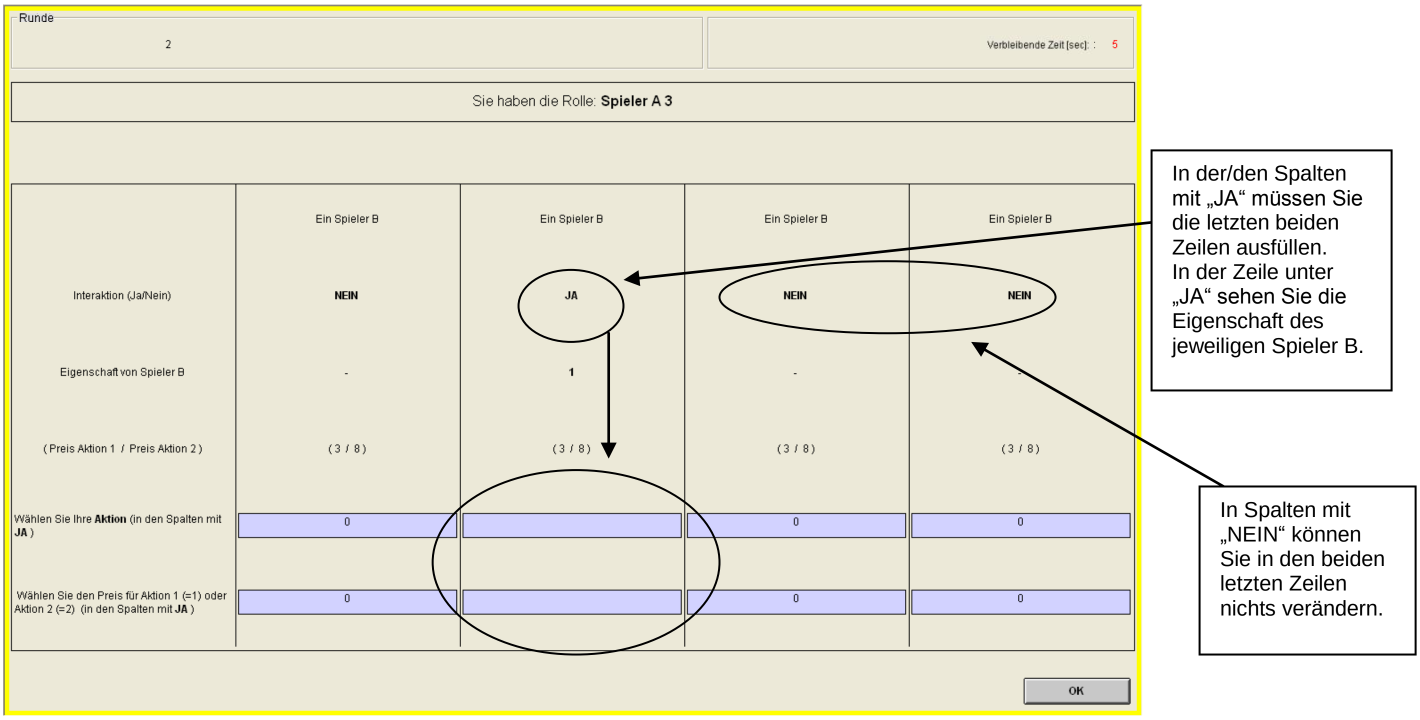
Spieler B erhält **10 Punkte**, wenn die von Spieler A gewählte **Aktion ausreichend** ist. **Spieler B** erhält **0 Punkte**, wenn die von Spieler A gewählte **Aktion nicht ausreichend** ist. In beiden Fällen ist noch der entsprechende Preis zu bezahlen (siehe unten bei „Auszahlungen“).

Spieler B wird zu **keiner** Zeit auf dem Computerbildschirm darüber informiert, ob er/sie in einer Runde die Eigenschaft 1 oder die Eigenschaft 2 hatte bzw. welche Aktion Spieler A gewählt hat.

Entscheidung 4

Spieler A **verlangt** von jedem Spieler B, der mit ihm interagiert, den in Entscheidung 1 festgelegten **Preis** für eine der beiden Aktionen. Dabei **muss** der verlangte Preis **nicht** gleich dem Preis der in Entscheidung 3 gewählten Aktion sein, sondern es kann auch der Preis der anderen Aktion sein. Auch kann Spieler A von unterschiedlichen Spielern B (wenn mehrere Spieler B mit ihm interagieren) unterschiedliche Preise verlangen.

Im Folgenden sehen Sie einen exemplarischen Bildschirm für die Entscheidungen 3 und 4. Jeder Spieler A erfährt für jeden der 4 zufällig gereihten Spieler B, ob der betreffende Spieler B mit ihm interagieren möchte oder nicht (erste Zeile). Falls „JA“, dann steht in der entsprechenden Spalte die Eigenschaft von Spieler B. Darunter sind zur Wiederholung die Preise angegeben, die Spieler A in Entscheidung 1 festgesetzt hat.
Die beiden letzten Zeilen sind dann für jene Spalten auszufüllen, in denen bei Interaktion „JA“ steht. In der vorletzten Zeile muss für jeden Spieler B eine Aktion gewählt werden (1 oder 2) und in der letzten Zeile muss angegeben werden, welchen Preis Spieler A verlangen möchte (1 steht für den Preis für die Aktion 1; 2 steht für den Preis für die Aktion 2). Auf dem Beispielsbildschirm wollte ein Spieler B mit dem betrachteten Spieler A interagieren und für diese Spalten muss Spieler A seine Entscheidungen eingeben (d.h. die „0“-en ersetzen).



<u>Auszahlungen</u>

Keine Interaktion

Wenn **Spieler B** in Entscheidung 2 mit keinem Spieler A interagiert (*Entscheidung „**Nein**" für alle 4 Spieler A*), dann erhält er in dieser Runde **1,6 Punkte**.
Wenn kein Spieler B mit einem bestimmten Spieler A interagiert, dann erhält dieser **Spieler A** in dieser Runde auch **1,6 Punkte**.

Ansonsten (*Entscheidung „Ja" von Spieler B*) sind die Auszahlungen wie folgt:

Interaktion

Spieler A erhält für jeden Spieler B, der mit ihm interagiert, seinen in Entscheidung 4 gewählten **Preis** (in Punkten) **abzüglich** der **Kosten** (siehe Seite 1 unten) für die in Entscheidung 3 gewählte Aktion. D.h. die Auszahlung eines Spielers A setzt sich aus allen Interaktionen zusammen, die ein Spieler A in einer bestimmten Runde hat.

Für **Spieler B** hängt die Auszahlung davon ab, ob die vom betreffenden Spieler A in Entscheidung 3 gewählte Aktion ausreichend war.

a) Die Aktion von Spieler A war ausreichend. **Spieler B** erhält **10 Punkte abzüglich** des in Entscheidung 4 verlangten **Preises**.
b) Die Aktion von Spieler A war nicht ausreichend. **Spieler B** muss den in Entscheidung 4 verlangten Preis bezahlen.

Zu Beginn des Experiments erhalten Sie eine **Anfangsausstattung von 6 Punkten**. Außerdem erhalten Sie durch das Beantworten der Kontrollfragen 2 Euro (entspricht **8 Punkten**). Aus diesen Anfangsausstattungen können Sie auch mögliche Verluste in einzelnen Runden bezahlen. Verluste sind aber auch durch Gewinne aus anderen Runden ausgleichbar. Sollten Sie am Ende des Experiments in Summe einen Verlust gemacht haben, müssen Sie diesen Verlust an den Experimentleiter bezahlen. Mit Ihrer Teilnahme am Experiment erklären Sie sich mit dieser Bedingung einverstanden. Beachten Sie aber bitte, dass es in diesem Experiment **immer** eine Möglichkeit gibt, Verluste mit Sicherheit zu vermeiden.

Für die Auszahlung werden die Anfangsausstattungen und die Gewinne aller Runden zusammengezählt und mit folgendem Umrechnungskurs am Ende des Experiments in bares Geld umgetauscht:

1 Punkt = 25 Euro-Cent
(d.h. 4 Punkte = 1 Euro).

C.2 English version

Below we provide a translation from German of the original instructions that we used in the experiment.

Thank you for participating in this experiment. Please do not to talk to any other participant until the experiment is over.

2 roles and 16 rounds
This experiment consists of **16 rounds**, each of which consists of the same sequence of decisions. This sequence of decisions is explained in detail below.
There are 2 kinds of roles in this experiment: **player A** and **player B**. At the beginning of the experiment, you will be randomly assigned to one of these two roles and you will keep this role for the rest of the experiment. On the first screen of the experiment, you will see which role you are assigned to. Your role remains the same throughout the experiment.
In your group, there are 4 players A and 4 players B. The players of each role get a number. If you are a player B, your potential interaction partners are the players A1, A2, A3, and A4. In case you are a player A, your potential interaction partners are the players B1, B2, B3, and B4. The numbers of all **players** are **fixed**, i.e., the same number always represents the same person, e.g., "A1" or "B3". A player A does not know at any point of time which player(s) B (B1–B4) he interacts with.

All participants receive the same information on the rules of the game, including the costs and payoffs of both players.

Overview of the sequence of decisions in a round
Each round consists of a maximum of 4 decisions which are made consecutively. Decisions 1, 3, and 4 are made by player A; decision 2 is made by player B.

Short overview of the sequence of decisions in a round

1. Players A set prices for action 1 and action 2.
2. All players B observe the prices chosen by the 4 players A (A1 to A4). Then, player B decides whether he wants to interact with one of the players A. It is only possible to interact with *one* player A. If player B does not interact with any player A, this round ends for him.

If player B interacts with one player A...

3. Player A observes whether one or more player(s) B decided to interact with him. A maximum of all 4 players B can interact with a particular player A. Then, each player A is informed about the types of all players B who decided to interact

with him. There are two possible types of player B: he is of either type 1 or type 2. This type is not necessarily identical for all players B. Player A has to choose an action for each player B interacting with him: either action 1 or action 2.

4. Player A charges player B the price specified in decision 1 for one of the two actions. The price charged does not have to match the action chosen in decision 3; it may be the price for the other action. Also, player A may charge different players B different prices.

Detailed illustration of the decisions and their consequences regarding payoffs

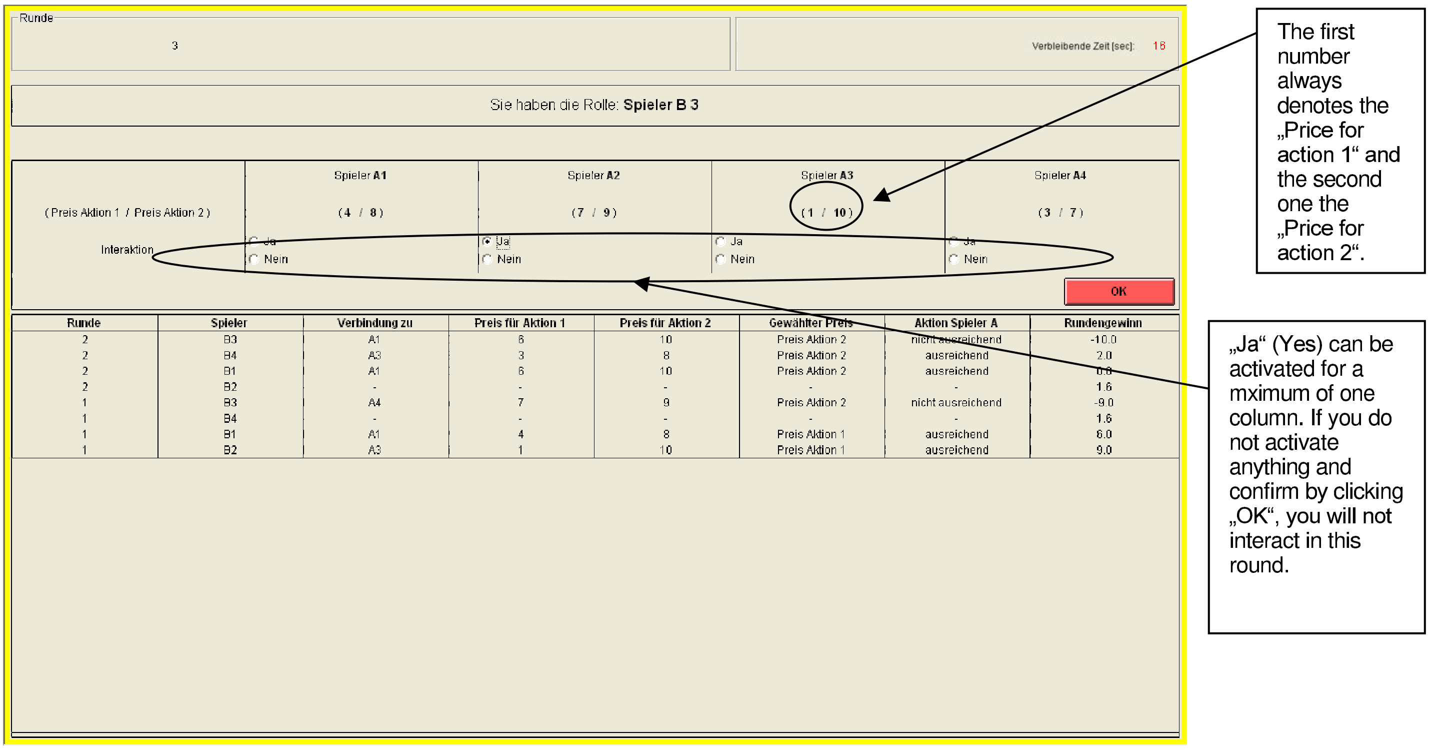
Decision 1
In case of an interaction, **each player A** has to choose between two actions (action 1 and action 2) at decision 3. Each chosen action causes costs which are given as follows:
Action 1 results in **costs of 2 points** (= currency of the experiment) for player A.
Action 2 results in **costs of 6 points** for player A.
Player A can charge prices for these actions from all those players B who decide to interact with him. At **decision 1**, each player A has to **set the prices for both actions**. Only (strictly) positive integer numbers are possible, i.e., only 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11 are valid prices.
Note that the price for action 1 must not exceed the price for action 2.

Decision 2
Player B observe the prices set by each of the 4 players A at decision 1. Then, player B decides whether he wants to interact with one of the players A and—if he wants to do so—with which one.
If he wants to interact, player A can choose an action at decision 3 and charge a price for that action at decision 4 (see below). Player B will **not** be able to observe the action chosen by player A.
If he does not want to interact, this round ends for this player B and he gets a **payoff of 1.6 points for this round**.
In case **none of the players B** wants to interact with a certain **player A**, this player A gets a **payoff of 1.6 points for this round** as well.

Below is an **exemplary screen** which shows decision 2. In case you wish to interact with a certain player A, please click "Ja" (Yes) in the corresponding column and confirm your entry by clicking "OK" (you do not have to click "Nein" [No] for the other players A). If you do not want to interact at all, you just have to click "OK" (you do not have to click "Nein" for all players A). See the explanation on the screen.
In the lower half of the screen, you can see all previous rounds (on the exemplary screen, the current round is round 3). The columns are defined as follows:

- "Runde" (Round): the round in which something happened
- "Spieler" (Player): the player B who has to make the decision(s)

- “Verbindung zu” (Interaction with): shows which player A player B interacted with (e.g., B4 with A3 in round 2; “–” if there was no interaction)
- “Preis für Aktion 1” (Price for action 1): the price which was set by player A for action 1 (in case of interaction; in case you did not have an interaction, this field shows “–” as for B4 in round 1)
- “Preis für Aktion 2” (Price for action 2): the price which was set by player A for action 2
- “Gewählter Preis” (Chosen price): “Preis Aktion 1” (Price action 1) means that the price for action 1 was chosen (e.g., in round 1 by A1); “Preis Aktion 2” (Price action 2) means that the price for action 2 was chosen (e.g., in round 2 by A3); “–” is shown if there is no interaction
- “Aktion Spieler A” (Action player A): “ausreichend” (sufficient) or “nicht ausreichend” (not sufficient) (if interaction took place); “–” (in case of no interaction as for play B2 in round 2) (see the explanation below)
- “Rundengewinn” (Profit per round): your earnings in each particular round denoted in points (the calculation is explained below)



Decision 3

Before decision 3 is made (in case player B chose “Ja” at decision 2), a type is randomly assigned to player B. **Player B** can be one of the two types: type 1 or **type 2**. This type is determined for each player B in each new round randomly and independent of the other players’ types. With a probability of **50%**, player B is of **type 1** and with a probability of **50%**, he is of **type 2**. Imagine that a coin is tossed for each player B in each round. For example, if the result is "heads", player B is of type 1, if the result is "tails", he is of type 2.

Every player A observes the **types of all players B** who interact with him *before* he makes his decision 3. Then player A chooses an action for each player B, either action 1 or action 2. In case he interacts with more than one player B, these actions are allowed to differ. An action is **sufficient** for a player B in the following cases:

a) Player B is type 1 and player A either chooses action 1 or action 2.

b) Player B is type 2 and player A chooses action 2.

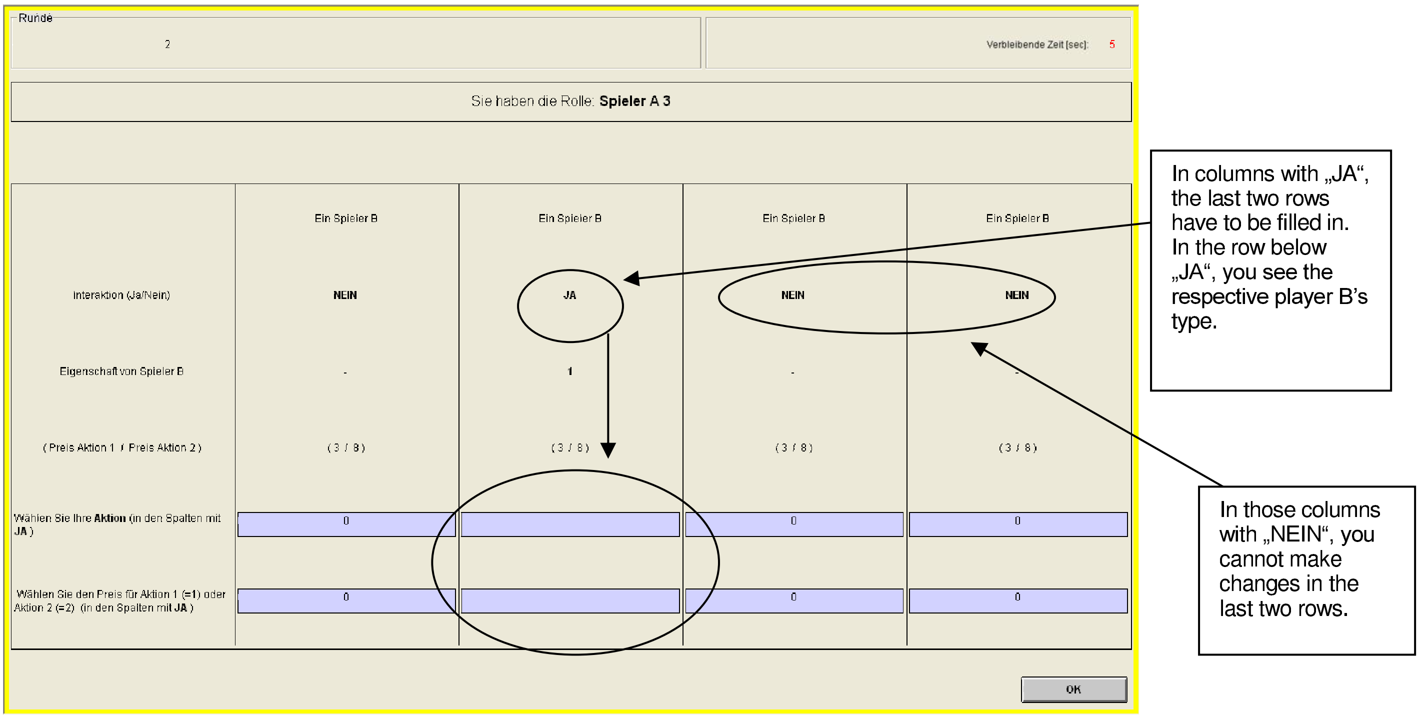
An action is **not sufficient** when player B is type 2 but player A chooses action 1.

Player B receives **10 points** if the **action** chosen by play A is **sufficient**. **Player B** receives **0 points** if the **action** chosen by player A is **not sufficient**. In both cases, player B has to pay the price charged (see section on payoffs below).

At no time player B will be informed whether he is of type 1 or type 2. Player B will also not be informed about the action chosen by player A.

Decision 4
Each player B that interacts with player A is **charged** the **price** (which he determined at decision 1) for one of the two actions by player A. The price charged **does not have to** match the price of the action chosen at decision 3 but may be the price for the other action. In case more players B interact with play A, he may charge different players B different prices.
Below you can see an exemplary screen which shows decisions 3 and 4. Every player A gets to know which of the 4 players B placed in a random order decided to interact with him and which did not (first row). If a player B interacts with the player A under consideration ("JA"), then the type of player B is displayed in the corresponding column. The two prices which player A set at his decision 1 are shown again.
The last two rows have to be filled out for each player who agreed to interact (the row for interaction shows "JA"). For each of these interacting players B an action has to be chosen (1 or 2) in the second to last row. In the last row, player A must indicate the price he wants to charge ("1" stands for the price for action 1; "2" stands for the price for action 2). On the exemplary screen, a player B wanted to interact with the particular player A and hence, player A needs to enter the decisions for these columns (i.e., replace each "0").

Payoffs
No interaction
If **player B** chose not to interact with any of the players A (*decision "No" for all 4 players A*), he gets **1.6 points** for this particular round.
If no player B decided to interact with a certain **player A**, this player A gets **1.6 points** for this particular round as well.



Otherwise (*decision "Ja" by player B*) the payoffs are as follows:

Interaction
For each player B he interacts with, **player A** receives the according **price** (denoted in points) he charged at his decision 4 **minus** the **costs** (see page 1) for the action chosen at decision 3, i.e., the payoff of a player A consists of all interactions he had within this round.

The payoff for **player B** depends on whether the action chosen by player A at decision 3 was sufficient:

a) The action was sufficient. **Player B** receives **10 point minus** the **price** charged at decision 4.

b) The action was not sufficient. **Player B** must pay the price charged at decision 4.

At the beginning of the experiment, you receive an **initial endowment of 6 points**. In addition you received 2 Euro (equals **8 points**) for filling out the questionnaire. With this endowment, you are able to cover losses that might occur in some rounds. Losses can also be compensated by gains in other rounds. If your total payoff sums up to a loss at the end of the experiment, you will have to pay this amount to the supervisor of the experiment. By participating in this experiment you agree to this term. Please note that there is **always** a possibility to avoid losses in this experiment.

To calculate the final payoff, the initial endowment and the profits of all rounds are added up. This sum is then converted into cash according to the following exchange rate:

1 point = 25 Euro cents
(i.e., 4 points = 1 Euro).

D Detailed information on payoffs per condition

Each invited individual showing up for the experiment received a show-up fee of 2.50 Euro. Each participant received 2 Euro for answering the control questions correctly and an additional flat payment of 1.50 Euro. The latter two were the initial endowment for the experiment and enabled players to balance possible losses.

Taking the above payments and the profits from the experiment yields the following payoffs per condition:

Table 10: Average payoff per condition in periods 1-16.

		Reputation mechanism	
		Private histories	Public histories
Price system	Fixed	17.17/13.86	16.58/17.94
	Competitive	17.83/13.43	18.04/14.84

Payoffs are denoted as expert payoff/customer payoff. Payoffs include show-up fee, payment for correctly answering the control questions, the flat payment and any profits from the experiment.

Across three out of four conditions, we observe on average lower payoffs for customers than for experts. This is mainly due to the fact that experts very rarely had negative profits per period while any undertreated customer incurred losses.

Note that the sum of expert and customer profit per condition does not mirror the above discussed efficiency in periods 1–9. There are two main reasons: first, we here report payoffs across all periods. As there is more undertreatment in the fixed price (especially under private histories) compared to the competitive price conditions in the last periods, average payoffs almost balance across time. Secondly, efficiency is assessed based on interactions, i.e., it does not matter whether all four customers visit the same expert and get a certain treatment or each customer visits a different expert. For payoffs this is relevant because if all customers visit the same expert, the remaining three get their outside option. If customers are e.g. evenly distributed across all experts, they do not.

The above payoffs were complemented by the compensation for the test on social preferences (see *Section 3.2*). Participants earned on average almost 4 Euro leading to a total average profit of 20.07.

E Regression analysis for the level of overcharging

Following the analysis for the level of undertreatment, we specify our regression function as follows:

$$
\begin{aligned}
overcharging_{it} = \beta_0 + \beta_1 period_{it} + \beta_2 private\_histories_{it} + \beta_3 fixed\_prices_{it} \\
+ \beta_4 private\_histories_{it} \cdot fixed\_prices_{it} + c_i + u_{it}.
\end{aligned}
$$

Table 11 displays our regression results.

Table 11: Random-effects panel regressions on overcharging in periods 1–9.

	Panel probit			
Overcharging	(1)	(2)	(3)	(4)
Period	0.043*	0.042*	0.041*	0.046**
	(0.022)	(0.022)	(0.022)	(0.022)
Private histories		0.301	0.240	−0.425**
		(0.191)	(0.162)	(0.213)
Fixed prices			−0.882***	−1.492***
			(0.163)	(0.213)
Private histories · fixed prices				1.324***
				(0.305)
Intercept	0.486***	0.340**	0.759***	1.045***
	(0.146)	(0.170)	(0.176)	(0.186)
$R^2_{M\&Z}$	0.022	0.035	0.151	0.211
Observations	705	705	705	705

Standard errors are clustered on the individual level and are reported in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. p-values are based on two-tailed tests. In order to evaluate the model fit, we report the McKelvey and Zavoina $R^2_{M\&Z}$ (McKelvey and Zavoina, 1975).

F Additional graphs

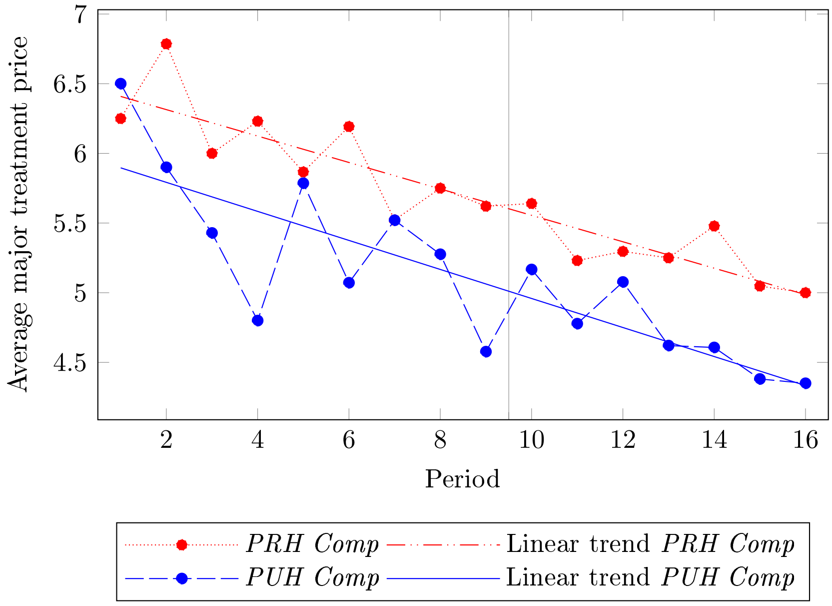


Figure 11: Average price posted for major treatment conditional on interaction in conditions with price competition.

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