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

Wanda Mimra† Alexander Rasch‡ Christian Waibel§

September 2013

Abstract

In credence goods markets, experts have better information about the appropriate quality of treatment than their customers. As experts provide both diagnosis and treatment, this leaves scope for fraud. We experimentally investigate how 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. 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.

*We would like to thank Bernd Irlenbusch, Rudolf Kerschbamer, Axel Ockenfels, Bettina Rockenbach, Matthias Sutter, and Achim Wambach for very helpful comments and discussions. We also thank Matthias Sutter for sharing the z-Tree code and the instructions. The authors would like to thank the ETH Zurich, the Cologne Graduate School in Management, Economics and Social Sciences of the University of Cologne, the Deutsche Forschungsgemeinschaft (DFG), and the European Centre for Liberal Professions (Cologne) for financial support. Part of this research was conducted while the Christian Waibel was visiting the University of Innsbruck. He would like to thank the Faculty of Economics and Statistics for its great hospitality throughout his stay.

†ETH Zurich, Zuerichbergstrasse 18, 8092 Zurich, Switzerland. Email: `wmimra@ethz.ch`. Phone: +41 (0)44 632-9826.

‡University of Cologne, Albertus-Magnus-Platz, 50923 Cologne, Germany. Email: `rasch@wiso.uni-koeln.de`. Phone: +49 (0)221 470-6067. Fax: +49 (0)221 470-5024. Phone: +41 (0)44 632-9826.

§Corresponding author. Address: ETH Zurich, Zuerichbergstrasse 18, 8092 Zurich, Switzerland. Email: `cwaibel@ethz.ch`. Phone +41 (0)44 632-03 98.

1 Introduction

In the United States, up to 10% of the 2.3 trillion USD of yearly health care expenditures are estimated to be due to fraud (Federal Bureau of Investigation, 2007). Fraud comprises upcoding of services, providing and charging unnecessary services, and the willingness to risk patient harm by supplying an insufficient treatment. In car repair, Europe's largest automobile club, the German Automobile Association ADAC *(Allgemeiner Deutscher Automobil-Club e. V.)*, reports that about 5% of the car repair shops tested charge for more repairs than actually provided.

Scope for fraud in these markets exists due to asymmetric information between provider and 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, performs both the diagnosis and the treatment. The customer, however, does not know what level of quality she needs or might not be able to verify all relevant aspects of trade (Dulleck and Kerschbamer, 2006). Goods with these properties are termed *credence good* as the customer has to rely on the expert's advice.[1] Whether the expert can and will exploit his informational advantage thereby crucially depends on the market environment and financial incentives. Providing an insufficient treatment but charging a high price for his services might be profitable for the expert if he cannot be made (fully) liable and does not risk losing future business. Besides the health care and car repair markets, many service markets exhibit credence goods properties, in particular, many of the so-called professional services (or liberal professions).[2]

Typically, customers can identify the expert they interact with and possess some information about expert behavior, either from their own past interaction with the expert or public information such as friends' recommendation or public rating/feedback devices. A prime example of a public feedback platform is *GoogleMaps*. Customers of car repair shops can rate the (perceived) quality of the provided service. This allows other customers to search for a *good* car repair shop.[3]

[1] The seminal paper on expert markets is by Dulleck and Kerschbamer (2006).

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

[3] *GoogleMaps* is displayed in *Figure 5* in the appendix. Another prime example for a public feedback platform is the *Arztnavigator* ("physician navigator"). The *Arztnavigator* polls patients with a standardized questionnaire about their last physician visit and then publishes the results. This allows patients to compare different physicians with respect to the quality perceived by other patients. The *Arztnavigator* is displayed in *Figure 4* in the appendix.

Experts compete primarily in two dimensions: prices on the one hand and quality of the provided credence good on the other. With fierce competition in prices posted, experts' incentive to provide sufficient quality and to build up reputation on quality might be impeded. Thus, a possible rationale behind restricting price competition in credence goods markets could be that price competition is harmful to consumers and induces fraudulent expert behavior.

For this paper, we conduct a lab experiment to investigate experts' incentives to defraud their customers when they can build up reputation and compete in prices or operate under fixed prices. In our set-up, experts can both undertreat, i.e., provide an insufficient quality/treatment, and overcharge, i.e., charge the price for a treatment that was not provided.[4] While 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*). Under private histories, customers are able to identify the experts they trade with and know 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 regarding undertreatment and prices charged.

Table 1: Conditions.

		Reputation mechanism	
		Private histories	Public histories
Price system	Fixed	PH Fixed	PUH Fixed
	Competitive	PH Comp	PUH Comp

We find that the level of undertreatment is significantly higher under price competition than when prices are fixed. Under fixed prices, customers return significantly less often to undertreating experts than under price competition in the first periods where reputational concerns play a role. Furthermore, under price competition, we observe a price pressure that undermines reputation building in the first periods: experts who undertreated in previous periods offer lower prices in the following periods.

[4]In our market, verifiability does not hold such that it is not profitable for the expert to overtreat instead of simply overcharge. Note that although we focus on experts' incentive to overcharge in this paper, expert behavior may also be interpreted as a form of overtreatment. In both cases, experts behave fraudulently in order to achieve a higher mark-up. Furthermore, customers are not able to detect either type of expert fraud.

Taken together, our results suggest that a reputation equilibrium in which experts build up reputation on treatment quality prevails under fixed prices whereas under price competition, the market coordinates on an equilibrium without reputation on treatment quality and fierce price competition.

With respect to customer information, we find that public histories go along with lower levels of undertreatment compared to private histories when prices are fixed whereas the opposite is true under price competition although differences are not significant. These results indicate that public information may help strengthen reputation building on treatment quality when prices are fixed whereas it intensifies price competition with negative feedback on treatment quality when prices are not fixed. These results under price competition thus provide first evidence for the concept of *bad reputation* introduced by Ely and Välimäki (2003) and Ely et al. (2008). Ely et al. provide a credence goods model in which reputation building may reduce market efficiency. Although our results match to those of Ely et al., note that the mechanisms at work differ. In Ely et al., experts are heterogeneous and try to signal their type by aiming at a treatment history that reflects the ex-ante probabilities. This may induce undertreatment by good types. Contrary to that, experts are homogeneous in our set-up. Our results are driven by the intensity of price competition and not separation of expert types.

Results on the second dimension of fraud (overcharging) mirror the results on undertreatment: the level of overcharging is significantly higher under competitive than under fixed prices. Furthermore, under price competition, the level of overcharging is significantly higher under public than private histories. Our results suggest that when customers are price-sensitive, price competition in credence good 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 customer information about experts' past behavior does not necessarily lead to an improvement in treatment quality.

Related literature

The seminal experimental paper on credence goods is Dulleck et al. (2011). The authors analyze experts' fraudulent behavior in markets with price competition and different institutional features. They show that while liability reduces the fraud level, verifiability and reputation with private histories hardly improve the market outcome. We complement and extend the analysis in two important directions: firstly, we analyze fixed prices in a market where reputational concerns play a role.

As pointed out before, this is motivated by the fact that the largest credence goods market in most economies—the health care market—is characterized by price regulation and identified experts. Secondly, we implement public histories where customers do not only observe their own but all customers' histories. This reputation mechanism mirrors the frequently observed online feedback platforms.

Dulleck et al. (2012) implement a credence goods experiment with fixed prices but without reputational concerns. The authors investigate whether *good* experts who always treat sufficiently post high prices or whether it is the high prices which induce a sufficient treatment. They show that *good* experts signal their type using the price but 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 at least identify the expert they are trading with, i.e., experts can build up reputation by not undertreating or by charging the price for the minor treatment, fixed prices lead to a more efficient market outcome than under price competition. The reason is that price competition reduces experts' mark-ups which in turn makes it less attractive to provide sufficient quality.

Another experimental paper investigating the impact of reputation on expert fraud is by Grosskopf and Sarin (2010). 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 the customer, the *bad* expert does not. In contrast to customers, experts know which type they are and which type of project maximizes 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 that reputation might be harmful to the expert's payoff. While in Grosskopf and Sarin (2010) 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 based on experts' reputations. Interestingly, we find indicative evidence that under price competition, more customer information does not lead to less but to more fraud because lower prices reduce the experts' incentive to act honestly.

The first field experiment conducted on reputation in the credence goods market is by Schneider (2012). He analyzes whether reputational concerns reduce a mechanic's incentive to defraud his customer. The author manipulates a car with defects and submits the car to garages for repair. He leaves a home address close to the garage and states that he was looking for an ongoing relationship in order to signal repeated interaction. In the other instance, he announces he will be moving away in order to signal a one-time interaction. While Schneider (2012) finds both widespread over- and undertreatment, he finds no evidence that reputation might alleviate these problems.

A second strand of 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 papers, Huck et al. (2012) and Huck et al. (2008) are closest to our work. The authors interpret the trust game as a market where customers choose between buying a search good if they do not trust the seller and an experience good in case customers trust the seller. In contrast, we implement a market for credence goods where problems from asymmetric information are more severe and reputation building is more complex.[5] Huck et al. (2012) vary competition between monopolistic and oligopolistic sellers/trustees and information available to customers about trustees' previous quality choices. The authors show that competition increases the traded quantity (trust rate) and quality of the experience good (rate at which trust is honored). Once competition is in place, additional information about sellers' previous honor rates only slightly increases the quality provided. In contrast to the credence goods market that we implement, parts of the increased quality in trust games may however be attributed to sellers'/trustees' reciprocity rather than to reputational concerns[6]: Sellers always receive a significant payoff once a customer has chosen to trust them.[7] In a follow-up study, Huck et al. (2008) extend the analysis by two treatments with flexible prices. The authors show that quality and efficiency decrease significantly when introducing price competition although the size of the

[5]Credence goods differ importantly in several respects: firstly, customers' valuation increases with the provided quality in case of an experience good while it is constant for credence goods as long as the quality is sufficient. Secondly, for any given price customers know which quality of the good they prefer in case of experience goods while customers do not know in case of credence goods. Thirdly, quality is always observable for experience goods ex post while customers in a credence goods markets only observe the sufficiency of the provided quality (see footnote 4 in Dulleck et al., 2011).

[6]Theoretically, in our market reputation building can occur in equilibrium with purely selfish (homogeneous) types, whereas in the trust game for reputation building to occur some market participants have to believe that there are trustworthy types.

[7]In the treatment in Huck et al. (2012) which is closest to our set-up (*fi-c-safe*) where sellers are given the base payoff independently of directed customer choice, sellers provide low quality more often if they face many customers than if they face few customers, whereas in the standard trust game treatments experts with more customers provide low quality less often than experts with few customers. This observation indicates that reciprocal concerns may drive the results obtained by Huck et al. (2012) rather than reputation per se.

effect is small. Our results on reputation in credence good markets can thus be seen as a complement to the analysis of competition and reputation in trust games in Huck et al. (2012) and Huck et al. (2008): Qualitative results go in the same direction in terms of provision of quality, however the mechanisms at work as well as the size of the effects differ substantially. We find differences in the fraud and efficiency level between competitive and fixed price markets about twice as large as that found in Huck et al. (2008).

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 parameterization. In section 4, we identify market equilibria for the given parameterization and derive predictions. In section 5, we describe the econometric methods used before turning to the results in section 6. The last section concludes.

2 Market

We model a credence goods market with scope 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 either suffers from 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 $1-h$. These ex-ante probabilities are common knowledge. An expert is able to identify the problem by performing a costless diagnosis.[8] 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, i.e., they may treat a customer suffering from a major problem with a minor treatment. The customer cannot observe the treatment but she can verify the treatment's outcome, i.e., the customer notices whether the expert undertreated her.[9] Observing undertreatment is feasible because the customer notices whether her problem has been fixed or not (Dulleck and Kerschbamer, 2006, p. 11). The prices for the treatments

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

[9]Remember that undertreatment refers to a situation where the customer has a major problem but obtains a minor treatment.

are denoted by p_L and p_H, respectively. 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, we outline the stage game for a market with price competition and a market with fixed prices. In both cases, we discriminate between private and public histories by denoting these situations 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 faces. With probability h a customer suffers from a major problem, with probability $1 - h$ she suffers from a minor problem.

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 and her private history[10] as specified below.

3." Each customer observes each expert's price menu posted in the current period and 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 3. Each expert either performs a minor treatment t_L or a major treatment t_H for (each of) his customer(s).

6. Each expert with an interaction charges (each of) his customer(s) the price p_L or the price 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 prices are common knowledge among the players before the first stage game starts.

[10]Note that a rational customer builds up her private history in the course of the game and is always aware of her history. Participants in the experiment, however, might forget parts of their history. Therefore, we display the private history in step three of the stage game as a reminder.

The expert's per-period payoff π_e is determined by the price p_i charged less the costs c_j for the treatment t_j applied $(i, j \in \{L, H\})$ where i and j do not have to coincide:

$$\pi_e = p_i - c_j \qquad\qquad i, j \in \{L, H\} \tag{1}$$

If no customer decides to interact with the expert, the expert's payoff amounts to σ. If the customer 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 has to pay the price for the treatment charged by the expert. The customer's per-period payoff π_c therefore amounts to

$$\pi_c = \begin{cases} v - p_i & \text{if not undertreated}, i \in \{L, H\} \\ -p_i & \text{if undertreated}, i \in \{L, H\} \end{cases} \tag{2}$$

if the customer decides to interact. 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:[11]

Private histories

Under private histories, each customer observes for each of the previous periods the expert she interacted with, 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 profit.

Public histories

Under public histories, each customer observes 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 profit was.

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

3 Experiment

3.1 Design

We apply a 2×2 factorial design. In all four conditions, the parameters are fixed and are the same as in the experiment by Dulleck et al. (2011): the ex-ante probability of a customer having a major problem is $h = 0.5$. The expert's costs for providing a minor treatment are $c_L = 2$ and $c_H = 6$ for a major treatment. The customer derives a utility of $v = 10$ if her problem is solved. Otherwise, the customer's utility amounts to $v = 0$. In case no interaction takes place, customers and experts 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 the role of a customer. The remaining four take 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. 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 four reasons: firstly, equal mark-ups ensure that experts' profits do not differ between the two treatments if experts treat and charge honestly. Secondly, equal mark-up prices are observed in several credence goods markets with price regulation.[12] The third reason to choose $\{p_L, p_H\} = \{4, 8\}$ is based on an observation made when first conducting the conditions under price competition: that the two equal mark-up vectors $\{4, 8\}$ and $\{3, 7\}$ are the most frequently posted price vectors under price competition. Thus, by choosing one of the two equal mark-up vectors, we approximate the expert pricing behavior observed under price competition. Among the two

[12]An example is the remuneration of short counseling interviews at general practitioners in Germany. Although the content of the counseling interviews and thus the service usually varies widely, the remuneration for the physician is always the same. Assuming that the general practitioner has similar costs for a short counseling independent of the content, he faces equal mark-ups for different services.

most often posted price vectors, we fourthly choose to implement the vector $\{4, 8\}$ as this is one of the vectors used in the related study by Dulleck et al. (2012) that we will compare our results to.

Note that under price competition, theory predicts that experts post a price p_H that is below marginal costs for the major treatment. Thus, experts make losses if they do not undertreat a customer with a major problem. Inducing expert losses exogenously by setting a price that is below costs for the major treatment may increase experts' undertreatment compared to a situation where the price choice is endogenous. Thus, we fix the price above costs for a major treatment along the above given criteria.

In periods 10–16, the price for the major treatment $p_H = 3$ is derived from the predicted expert pricing behavior.[13] The level of p_H ensures that customers still interact although 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. As 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. Under price competition, the price vectors observed most often 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 was 7.39 in the first period. We again follow 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 case of a sufficient treatment from 2 to 1. We employ four markets in the *PH Fixed* condition and four markets in the *PUH Fixed* condition for the robustness checks.

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

3.2 Procedure

The experimental sessions were conducted in the Cologne Laboratory for Economic Research between March and November 2012. 320 participants took part in the experiment. 256 out of the 320 participants were equally allocated to the four conditions with our main parametrization so that in each condition there were 64 participants. 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, 2004) to recruit participants. 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. After the experiment, players' social preferences were determined by the choice of payoff pairs for oneself and a randomly assigned other person. Additionally, we used a questionnaire to control for gender and age. The average time each session lasted was two hours. Participants earned on average 20.07 Euro.

4 Market: Theoretical analysis and predictions

In this section, we first provide a theoretical analysis of the above outlined market before deriving predictions for the experimental outcomes.

4.1 Theoretical analysis

In our theoretical analysis, we look for perfect Bayesian equilibria of the game described in section 2.[14] Two types of equilibria might emerge: *no-reputation equilibria* and *reputation equilibria* (see Dulleck et al., 2011). In the no-reputation equilibria the one-shot Bayesian equilibria are played repeatedly over all 16 periods while reputation equilibria are based on the players' repeated interaction. In what follows, we will characterize both types of equilibria for the conditions under price competition and fixed prices.

[14]Note that the outlined equilibria are not exhaustive. There exist, for example, also 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.

4.1.1 Price competition

The equilibria under price competition are adapted from Dulleck et al. (2011). In the following Lemmata we outline the outcomes in terms of fraud level and prices posted. For the no-reputation equilibria we do not need to distinguish between private and public histories.

Lemma 1 (No-reputation equilibria)**.** *In a market with price competition, there exist equilibria for private and public histories with the following characteristics: all experts post a price menu* $\{n.d., 3\}$[15] *with probability* $x = 0.84398$ *and an unattractive price menu* $\{n.d., p_H\}$ *where* $p_H > 3$ *with probability* $1 - x$*. If an expert posts* $\{n.d., 3\}$*, the expert undertreats customers with a major problem and always overcharges his customers. If no expert posts* $\{n.d., 3\}$*, there is no interaction.*

Proof. See Dulleck et al. (2011). □

In a market with price competition, there exist the above described no-reputation equilibria in which experts strongly compete in the price dimension. The competitive price $p_H = 3$ for the major treatment is so low that experts would even make losses in expectation if they always overcharged but did not undertreat customers with a major problem. Thus, it does not pay for experts to build up reputation. Hence, experts always undertreat customers with a major problem and always overcharge.

Experts are indifferent between posting a competitive price vector $\{n.d., 3\}$ with probability $x = 0.84398$ and posting an unattractive price vector where $p_H > 3$ with probability $1-x$. The reason experts play mixed strategies is that in case an expert only serves one customer, his profit amounts to 1 while the outside option yields a payoff of 1.6. Thus, it only pays for the expert to offer the competitive price if he can expect more than one customer on average.

We next turn to the reputation equilibria for which we distinguish between public and private histories:

Lemma 2 (Reputation equilibrium under public histories)**.** *In a market with price competition and public histories, there exists an equilibrium with the following characteristics: each expert posts a price menu* $\{n.d., 5\}$ *in the first nine periods and a price menu* $\{n.d., 3\}$ *afterwards. Experts always overcharge customers with a minor problem. Experts do not undertreat customers with a major problem in the first nine*

[15]'n.d.' denotes 'not determined'.

periods with sufficiently high probability. Experts undertreat customers with a major problem in periods 10–16 *and overcharge all customers.*

Proof. See *Appendix 8.1.* □

The logic of a reputation equilibrium is as follows: if an expert serves sufficiently many customers, he does not undertreat in the first periods as this implies future profits from returning and new customers. In contrast to the no-reputation equilibrium, in the reputation equilibrium experts post higher prices in the first periods allowing them to build up reputation by not undertreating. A customer observes all customers' histories under public histories regarding undertreatment and prices charged and whether an expert served a large enough number of customers. Hence, the customer observes whether experts have the incentive to treat sufficiently in future periods. A customer expects an expert to serve sufficiently when the said expert has never undertreated any customer provided that he served sufficiently many customers. The customer plays the following strategy: (i) choose an expert who is expected to treat sufficiently and (ii) never return to an expert who has undertreated when expected to treat sufficiently. If an expert did not undertreat in the first periods, the customer stays with this expert even in the later periods where experts will undertreat (periods 10–16). Customers still interact in periods 10–16 because the price for the major treatment is sufficiently low. Thus, the expected payoff from interacting exceeds the outside option.

The reasoning behind why experts only build up reputation in the treatment but not the charging dimension under price competition is as follows: customers cannot observe whether an expert overcharged. Thus, customers' strategy can only condition on whether the price for the minor or the major treatment was charged. Were an expert to try to build up reputation of not overcharging by always charging the price for the minor treatment (with $p_L < p_H = 5$) in the first periods, his payoff would be lower than the outside option. In later periods, the expert who built up reputation by charging the price for the minor treatment would have to return to charging the price for the major treatment in order to make positive profits. Due to price competition, the competitors would slightly undercut the higher price in later periods though and still offer a sufficient treatment. Hence, the competitors would attract all customers. Thus, charging p_L in the first periods is not profitable under price competition.

Lemma 3 (Reputation equilibrium under private histories)**.** *In a market with price competition and private histories, there exists an equilibrium with the following characteristics: each expert posts a price menu* $\{n.d., 5\}$ *in the first nine periods and a price menu* $\{n.d., 3\}$ *afterwards. Experts always overcharge customers with a minor problem. Experts do not undertreat customers with a major problem in the first nine periods. Experts undertreat customers with a major problem in periods* 10–16 *and overcharge all customers.*

Proof. See *Appendix 8.2.* □

Under private histories, customers only observe their own history of undertreatments and prices charged. Here, the logic under public histories of choosing or switching to an expert that is expected to treat sufficiently (since he had served sufficiently many customers previously and did not undertreat) does not work as the relevant information is lacking. A reputation equilibrium still exists, customers ex ante coordinate on experts and punish them by not returning if they undertreat such that experts have incentives to not undertreat.

4.1.2 Fixed prices

In contrast to a market with price competition, the experts' action set reduces to the treatment and charging choice if prices are fixed. In the following, we present equilibria that have a similar structure as the equilibria in a market with price competition. Under fixed prices, there exist no-reputation equilibria with the following properties:

Lemma 4 (No-reputation equilibria)**.** *In a market with fixed prices, there exist equilibria for private and public histories in which there is no interaction in periods 1–9. In periods 10–16, experts always overcharge customers and undertreat those customers with a major problem.*

Proof. See *Appendix 8.3.* □

In contrast to the no-reputation equilibria under price competition, prices are not low enough for customers to interact in periods 1–9. Their outside option of 1.6 is larger than the expected payoff from interacting which amounts to -3 given that experts always overcharge and undertreat customers with a major problem. Thus, customers do not interact in the first nine periods. In the last periods, prices in the fixed price set-up are low enough so that although experts always overcharge and always undertreat customers with a major problem, customers interact.

With prices given by $\{p_L, p_H\} = \{4, 8\}$ in periods 1–9 and by $\{p_L, p_H\} = \{0, 3\}$ in periods 10–16, customers would not interact in the first nine periods if they randomized between experts. If interaction is still observed, customers must hence coordinate on an expert as in the price competition case under private histories. Analogous to the case with price competition, the reputation equilibria outlined below are characterized by experts building up reputation by not undertreating in periods 1–9.

Lemma 5 (Reputation equilibria under private and public histories)**.** *In a market with fixed prices, there exist equilibria for private and public histories in which experts do not undertreat customers with a major problem in periods 1–9 but always overcharge customers with a minor problem. In periods 10–16, experts always overcharge and undertreat customers with a major problem.*

Proof. See *Appendix 8.4.* □

Under public histories, there exists an additional reputation equilibrium in which experts build up reputation in the first periods by not undertreating and always charging p_L in periods 1–7. The expert serving the customers makes zero profits in the first periods. In periods 8 and 9, the expert makes positive profits by charging the customers the major treatment and not undertreating. In periods 10–16, experts always overcharge customers and undertreat those customers with a major problem.[16] The equilibrium is characterized as follows:

Lemma 6 (Reputation equilibrium under public histories without overcharging)**.** *In a market with fixed prices and public histories, there exists an equilibrium in which experts do not undertreat in periods 1–9. In periods 10–16, experts always undertreat customers with a major problem. In periods 1–7, experts charge p_L; in periods 8–16, experts always overcharge customers with a minor problem.*

Proof. See *Appendix 8.5.* □

[16] As outlined before, a reputation equilibrium without overcharging does not exist under price competition. This is because competitors would slightly undercut the price of the expert not overcharging in periods 8 and 9.

If the expert serving customers deviated in periods 1–7 by undertreating a customer, by charging a customer p_H, or both, all customers would observe the deviation. Consequently, all customers would visit a different expert. This in turn disciplines the experts not to deviate. Note that the punishment mechanism for charging p_H only works under public but not under private histories. If a customer under private histories observed that she was charged p_H, visiting a different expert would not be a credible threat because being the only customer with the other expert would mean that she would be undertreated and overcharged, yielding a payoff of -3.[17] If the customer did not interact after the deviation instead of switching to a different expert, her payoff would amount to 1.6 while staying with the expert charging p_H yields a payoff of 2. Thus, customers charged p_H would still visit the same expert after being charged p_H. Thus, the deviation is profitable for experts under private histories.

4.2 Predictions

In the following, we derive predictions for the differences in the level of undertreatment and the level of overcharging between the four conditions. We also shortly describe experts' price posting behavior.

4.2.1 Level of undertreatment

The first hypothesis relates to the difference between the conditions with price competition and those with fixed prices. There is no trade in the first nine periods under fixed prices if the no-reputation equilibrium is played. Thus, if we observe interaction, theory predicts that experts and customers behave according to the reputation equilibrium. Then, none of the customers is undertreated in periods 1–9. Under price competition and observed trade, however, players might either coordinate on the reputation equilibrium or the no-reputation equilibrium. Hence, undertreatment is possible in periods 1–9. Independent of which equilibrium players coordinate on under price competition, the equilibrium price for the major treatment in the price-competition condition is lower than the exogenously set price in the fixed-price conditions. Thus, we can state the following hypothesis:

[17]Remember that under private histories customers do not observe how many customers an expert served in the previous period.

Hypothesis 1 (Price competition vs. fixed prices: undertreatment)**.** *If interaction between experts and customers is observed in periods 1–9, the level of undertreatment in periods 1–9 is equal or lower under fixed prices than under price competition. The price* p_H *experts post under price competition is lower than the exogenously set price* p_H *in the fixed-price conditions.*

Next, we turn to the difference in the level of undertreatment between private and public histories under price competition. If a reputation equilibrium is played, there might be some undertreatment under public histories whereas we should observe no undertreatment under private histories. However, whether the level of undertreatment is lower or higher under private than under public histories crucially depends on whether a no-reputation equilibrium or reputation equilibria are played. Thus, theory does not provide a direct prediction.

We conjecture that reputation equilibria are more likely to be played under public than under private histories as public histories might serve as a coordination device between equilibria. The idea is as follows: Under private histories we only observe a reputation equilibrium when customers coordinate ex ante on an expert as customers cannot adequately punish experts and switch experts during the game due to lack of information. Conversely, under public histories customers can make use of the additional information to coordinate on experts during the game. We conjecture that this also facilitates coordination on playing a reputation equilibrium, and that this effect of public histories predominates. Thus, we can state the following hypothesis:

Hypothesis 2 (Private vs. public histories under price competition: undertreatment)**.** *In a market with price competition, we expect the level of undertreatment in periods 1–9 to be equal or lower for public than for private histories. The price* p_H *posted by experts does not differ between the conditions.*

The above-outlined reasoning for why we expect less fraud under public than under private histories also applies to a market with fixed prices.

Hypothesis 3 (Private vs. public histories under fixed prices: undertreatment)**.** *In a market with fixed prices, we expect the level of undertreatment in periods 1–9 to be equal or lower for public than for private histories.*

4.2.2 Level of overcharging

Next, we turn to the hypotheses concerning overcharging. Under price competition, customers are always overcharged. If experts charged p_L instead of p_H in the first periods, experts would have lower payoffs in expectation compared to a situation with no interaction. Thus, charging p_L might only be rational if higher prices in later periods compensated the forgone profit in the first periods. However, due to price competition, the competitors would undercut the higher price in later periods and still offer a sufficient treatment. Thus, charging p_L in the first periods is not profitable under price competition. Under fixed prices and public histories, however, there exists a reputation equilibrium in which customers are not overcharged in the first seven periods. Therefore, we state the following hypothesis with respect to the expected difference in overcharging in the two price regimes:

Hypothesis 4 (Price competition vs. fixed prices: overcharging)**.** *If interaction between experts and customers is observed in periods 1–9, the level of overcharging in periods 1–9 is equal or lower in a market with fixed prices than in a market with price competition.*

Under price competition, experts cannot build up reputation by treating sufficiently and charging p_L. This insight holds independent of the information structure in the market. The reason is that experts' possibility to undercut competitors' prices is sufficient for the non-existence of no-overcharging equilibria in the markets we consider. Thus, we expect no difference in the level of overcharging between public and private histories:

Hypothesis 5 (Private vs. public histories under price competition: overcharging)**.** *If interaction between experts and customers is observed in periods 1–9, the level of overcharging in periods 1–9 does not differ between public and private histories in a market with price competition.*

In a market with fixed prices and public histories, experts can build up reputation with respect to the sufficiency of a treatment and the charging decision. The equilibrium outlined in *Lemma 6* shows that experts charge customers p_L in periods 1–7. Customers can credibly threaten to switch to a different expert if an expert undertreats or charges p_H. This is because all customers observe an expert's deviation. Losing all customers induces a sufficiently high reduction in expert profits such that experts will not charge p_H in the first periods. Under private histories, however, customers cannot credibly threaten to switch to a different expert because other customers would not observe the deviation and thus would not punish the expert.[18] Visiting an expert who only serves one customer is not rational for the customer as she would be undertreated. Thus, visiting a different expert is not a credible threat. Hence, we can state the following prediction with respect to the difference between private and public histories under fixed prices:

Hypothesis 6 (Private vs. public histories under fixed prices: overcharging)**.** *If interaction between experts and customers is observed in periods 1–9, the level of overcharging in periods 1–9 is equal or lower under public than under private histories in a market with fixed prices.*

5 Methodology

This section provides an overview and a discussion of the methods used. In light of the theoretical considerations above, we restrict our analysis to the first nine periods where reputational concerns may play a role.

All non-parametric test results reported in the following are based on two-tailed Mann-Whitney U tests. Test results are reported to be (weakly) significant if the two-tailed test's p-value is smaller 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.

In order to separate out the mechanisms at work and to account for individual heterogeneity, we complement the non-parametric test results by parametric tests in form of regressions. The data structure, however, is challenging for regression analysis for the following reasons: firstly, the stage game is repeated which imposes a serial correlation between the observations per individual over time. Secondly, eight individuals interact within a market which potentially leads to correlated observations within the market. And thirdly, our dependent variables—whether a customer was undertreated and/or overcharged in a period—are binary.

We follow Dulleck et al. (2011) and make use of the random-effects panel probit regression with standard errors clustered at the individual level. The panel probit

[18]Note that under private histories, customers cannot observe how many other customers visit an expert.

model accounts for the fact that the stage game is repeated for 16 periods and that the dependent variable is binary. In contrast to the fixed-effects estimator, the random-effects estimator allows us to estimate the treatment effect although the condition does not vary within an individual. Note that current implementations of binary panel regressions do not allow clustering at a different level than the individuals' level nor is it possible to use robust standard errors. Thus, we may not be capturing the correlation within markets. Introducing market dummies to control for the different markets is not an option for two reaons: firstly, the dummies introduce high collinearity. Secondly, results would be relative to the reference market.

Therefore, we also present the results of a random-effects panel OLS regression with robust standard errors clustered at the market level (for the methodology of robust clustered standard errors, see Huber, 1967; White, 1980; Rogers, 1993). This alternative approach has been previously used by Dulleck et al. (2012) in the same set-up as ours. In contrast to the implementation of the panel probit regression, the implementation of the panel OLS regression does explicitly allow to cluster standard errors at the market level. There are two more advantages of the panel OLS results: firstly, the panel OLS regression eases the interpretation of coefficients. Secondly, the interaction term cannot be misleading (for a methodological discussion on the interpretation of interaction terms in non-linear response models, see Ai and Norton, 2003). The drawback of the panel OLS regression is that it does not account for the binarity of the dependent variable and hence suffers from out-of-bound predictions and built-in heterogeneity (Wooldridge, 2009).

Our main results hold independent of the choice of method. Whenever the panel OLS estimates deviate from the panel probit estimates, we indicate the deviation in a footnote.

6 Results

In this section, we present the experimental results with respect to the level of undertreatment and overcharging. For each result, we first describe the findings based on our main parametrization. We then complement and discuss the result in light of the robustness check.

Table 2: Percentage of undertreatment in periods 1–9.

		Reputation mechanism			
		This paper		Dulleck et al. (2011)	
		Private histories	Public histories	None	Private histories
Price system	Fixed	31.43%	24.41%	–	–
	Competitive	58.47%	63.46%	61.18%	59.22%

6.1 Level of undertreatment

The descriptive experimental results for the level of undertreatment are presented in *Table 2*. As our design is the same as in Dulleck et al. (2011), their corresponding results are also shown. The additional data allows us to compare the level of undertreatment under private and public histories with a situation in which the customer cannot even identify the expert she is interacting with (condition *None*), i. e., a market without reputational concerns.

In our 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

$$\begin{aligned} undertreatment_{it} = \beta_0 + \beta_1 period_{it} + \beta_2 private\_histories_{it} + \beta_3 fixed\_prices_{it} \\ + \beta_4 private\_histories_{it} \cdot fixed\_prices_{it} + c_i + u_{it} \end{aligned} \tag{3}$$

where c_i denotes the random intercept of individual i and u_{it} denotes the idiosyncratic error term for individual i in period t. *Table 3* displays our regression results. We report the random-effects panel OLS estimation with robust standard errors clustered at the market level in the last two columns.

Note that our hypotheses 1, 4, 5 and 6 condition on customers and experts actually trading. In all four treatments we observe interaction rates above 70% and in three out of four treatments even above 85% Hence, all above predictions do apply.

Result 1 (Price competition vs. fixed prices: undertreatment)**.** *The level of undertreatment is significantly higher under price competition than under fixed prices.*

Table 3: Random-effects panel regressions on undertreatment in periods 1–9.

	Panel probit				Panel OLS	
Undertreatment	(1)	(2)	(3)	(4)	(5)	(6)
Period	0.046*	0.047*	0.044*	0.044*	0.015	0.015
	(0.027)	(0.027)	(0.026)	(0.026)	(0.013)	(0.013)
Private histories		0.134	0.068	−0.133	−0.020	−0.043
		(0.187)	(0.155)	(0.216)	(0.071)	(0.100)
Fixed prices			−0.955***	−1.161***	−0.333***	−0.393***
			(0.160)	(0.227)	(0.072)	(0.114)
Private histories · fixed prices				0.415		0.125
				(0.312)		(0.141)
Intercept	−0.375**	−0.446**	0.064	0.171	0.531***	0.564***
	(0.161)	(0.190)	(0.187)	(0.204)	(0.093)	(0.098)
$R^2_{M\&Z}$	0.029	0.033	0.184	0.190		
R^2					0.117	0.120
Observations	454	454	454	454	454	454

Standard errors are clustered on the individual level for panel probit regressions (Note: clustering for panel probit regressions on a different level than the individuals' level has not yet been implemented). Standard errors are robust and clustered on the market level for panel OLS regression. Standard errors are reported in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. p-values are based on two-tailed tests.

Prices posted by experts under price competition are significantly lower than the exogenously given prices in the fixed-price condition.

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 (see models (3) and (5) in *Table 3*; Mann-Whitney U test: $p < 0.001$). According to the OLS estimates, this difference in the level of undertreatment amounts to 33.3 percentage points. Prices posted by experts under price competition are significantly lower than the exogenously given prices in the fixed-price condition (Mann-Whitney U test: $p < 0.001$ for both treatment prices).[19]

[19]Note that this difference in the level of undertreatment holds for both types of reputation mechanisms: private (Mann-Whitney U test: $p = 0.009$) and public histories (Mann-Whitney U test: $p = 0.006$).

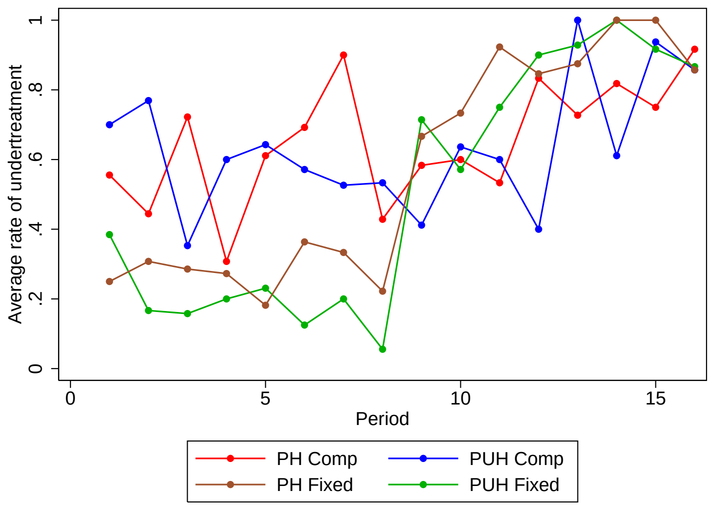


Figure 1: Average rate of undertreatment for each condition.

Players coordinate on the reputation equilibrium under fixed prices.[20] Experts build up reputation by treating customers sufficiently in the first periods. The average rate of undertreatment under fixed prices amounts to 27.59% in the first nine periods (and even only to 22.97% in the first eight periods). In later periods, experts take advantage of their reputation by undertreating. In line with our theoretical predictions, the average rate of undertreatment rises to 86.70% in periods 10–16 under fixed prices. *Figure 1* illustrates the average rate of undertreatment for each of the four conditions over time. The graph clearly shows that experts' switching behavior in their defrauding strategy matches almost one to one to our predictions. *Hypothesis 5* predicts that experts do not undertreat until period 9 and switch to undertreating in period 10. In the data, we observe that experts switch after period 8. As an indication that under fixed prices, the reputation equilibrium is actually played, we observe that customers punish experts who undertreat more often under fixed prices than under price competition: customers return significantly less often to the undertreating expert under fixed prices than under price competition in the first periods (Mann-Whitney U test: $p < 0.001$).

Under price competition, players tend to coordinate on the competitive rather than the reputation equilibrium. The average rate of undertreatment amounts to 60.81% in the first nine periods and rises to 77.78% in periods 10–16. We observe a price pressure that undermines reputation building in the first nine periods: experts do not

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

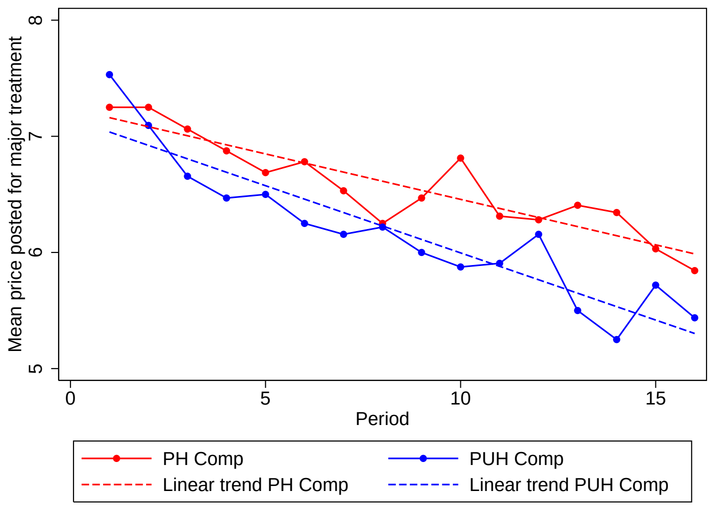


Figure 2: Average price posted for major treatment in conditions with price competition.

only compete in quality (treatment) under price competition but also in the prices posted. *Figure 2* shows the decline in the price posted for the major treatment over time in the two conditions with price competition. Experts who undertreated in previous periods try to balance 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 7.30 while the price significantly declines to 6.04 on average after an expert's first undertreatment (Mann-Whitney U test: $p < 0.001$). Concerning the customer behavior under price competition, our results show that customers return significantly more often to an expert who has undertreated the customer in one of the previous periods under the flexible- compared to the fixed-price conditions (Mann-Whitney U test: $p < 0.001$). Thus, the decline in the price posted for the major treatment by an expert who undertreated seems to be large enough to attract customers in future periods. Hence, price competition undermines reputation on quality and thereby leads to a higher level of undertreatment if price competition is in place.

A 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 drives the results. However, we find no evidence for this concern in our robustness checks. The level of undertreatment remains similar to the set-up with prices $\{p_L, p_H\} = \{4, 8\}$ (see *Table 4*). The level of undertreatment under fixed prices $\{p_L, p_H\} = \{3, 7\}$ is again significantly lower than under price competition (Mann-Whitney U test: $p = 0.011$). Hence, our *Result 1* is robust to changes in the exogenously given prices. In fact, we do not even find a significant increase in the level of undertreatment when changing prices from $\{p_L, p_H\} = \{4, 8\}$ to $\{p_L, p_H\} = \{3, 7\}$ (Mann-Whitney U test: $p = 0.186$).

Table 4: 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%

The lower level of undertreatment under fixed prices leads to a significantly higher rate of efficiency (Mann-Whitney U test: $p = 0.008$). Undertreatment decreases market efficiency because the expert's treatment induces costs while no customer benefit is generated. As the rate of undertreatment does not increase when lowering the fixed prices to $\{p_L, p_H\} = \{3, 7\}$, efficiency remains on a significantly higher level under fixed than under competitive prices. Thus, price competition may not only be detrimental to the quality provided but also to market efficiency in expert markets.

Table 5: 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 normed to the interval $[0, 1]$ on the market level. 0 corresponds to the (minimum surplus per market - outside option) while 1 corresponds to the (maximum surplus per market - outside option).

Result 2 (Private vs. public histories under price competition: undertreatment)**.** *Under price competition, the level of undertreatment is non-significantly higher under public than under private histories.*

In contrast to *Hypothesis 2*, we find that more customer information does not lead to a decrease in the expert's incentive to undertreat his customer under price competition. The descriptives even suggest that more customer information might lead

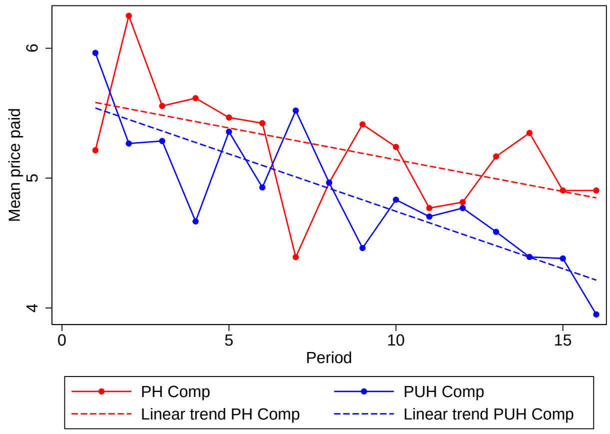


Figure 3: Average price paid in conditions with price competition.

to a higher level of undertreatment in periods 1–9. However, this difference is not statistically significant (see models (4) and (6) in *Table 3*; Mann-Whitney U test: $p = 0.916$). The higher undertreatment rate under public histories comes along with a lower average price paid by the customer in the public-history condition (5.15) compared to the private-history condition (5.38). *Figure 3* illustrates the average price paid by customers over time and shows that for all except for two periods, the average price paid is lower under public than under private histories.

Price competition under public histories is more intense than under private histories as customers observe all customers' histories. Comparing prices posted by experts in period 1 and 10 shows that the decline in the prices is larger under public than under private histories (Mann-Whitney U test: $p = 0.145$ for the minor treatment and $p = 0.045$ for the major treatment). Also, the decline in the average price posted before and after the first undertreatment is larger under public than under private histories (1.54 vs. 1.23). Hence, we conclude that the additional customer information provided under public histories intensifies price competition and thus makes it less profitable for the expert to treat sufficiently.

Result 3 (Private vs. public histories under fixed prices: undertreatment)**.** *Under fixed prices, the level of undertreatment is non-significantly lower under public than under private histories.*

In contrast to the price-competition treatments, the level of undertreatment is lower under public than under private histories if prices are fixed but differences are not significant (Mann-Whitney U test: $p = 0.103$). The additional customer information under public histories seems to serve as a coordination device. Customers observe

Table 6: 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%

not only their own treatment history but all customers' treatment histories. Thus, public histories ease customers' coordination on the reputation equilibrium even if this is not played from the very beginning as theory would predict.

The additional customer information as to whether other customers receive a sufficient treatment increases the rate of interaction significantly (Mann-Whitney U test: $p = 0.042$). Whereas under private histories, customers interact in 73.26% of the cases, the rate of interaction amounts to 96.18% in the public-history condition.

Thus, we can conclude that the additional customer information provided by public histories tends to increase the provision of a sufficient treatment when experts do not compete in prices. However, if there is price competition, the additional information from public histories tends to intensify price competition which in turn makes it less profitable for experts to treat sufficiently.

6.2 Level of overcharging

In what follows, we present the results relating to the level of overcharging. *Table 6* provides an overview of the level of overcharging across conditions.

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

$$\begin{aligned} overcharging_{it} = \beta_0 + \beta_1 period_{it} + \beta_2 private\_histories_{it} + \beta_3 fixed\_prices_{it} \\ + \beta_4 private\_histories_{it} \cdot fixed\_prices_{it} + c_i + u_{it}. \end{aligned} \tag{4}$$

Table 7 displays our regression results.

Result 4 (Price competition vs. fixed prices: overcharging)**.** *Under price competition, the level of overcharging is significantly higher than under fixed prices.*

Table 7: Random-effects panel regressions on overcharging in periods 1–9.

	Panel probit				Panel OLS	
Overcharging	(1)	(2)	(3)	(4)	(5)	(6)
Period	0.043*	0.042*	0.041*	0.046**	0.011	0.012
	(0.022)	(0.022)	(0.022)	(0.022)	(0.008)	(0.008)
Private histories		0.301	0.240	−0.425**	0.094	−0.086
		(0.191)	(0.162)	(0.213)	(0.073)	(0.060)
Fixed prices			−0.882***	−1.492***	−0.259***	−0.440***
			(0.163)	(0.213)	(0.078)	(0.116)
Private histories · fixed prices				1.324***		0.388***
				(0.305)		(0.137)
Intercept	0.486***	0.340**	0.759***	1.045***	0.728***	0.808***
	(0.146)	(0.170)	(0.176)	(0.186)	(0.068)	(0.063)
$R^2_{M\&Z}$	0.022	0.035	0.151	0.211		
R^2					0.104	0.149
Observations	705	705	705	705	705	705

Standard errors are clustered on the individual level for panel probit regressions (Note: clustering for panel probit regressions on a different level than the individuals' level has not yet been implemented). Standard errors are robust and clustered on the market level for panel OLS regression. Standard errors are reported in parentheses. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. p-values are based on two-tailed tests.

In line with *Hypothesis 4*, overcharging is significantly lower under fixed prices than under price competition (see models (3) and (5) in *Table 7*; Mann-Whitney U test: $p = 0.019$).[21] Following the OLS estimates, this difference in the probability of being overcharged amounts to 25.9 percentage points. As can be seen in *Figure 2*, the average price posted for the major treatment declines over time under price competition. The average price posted for the minor treatment declines from 3.95 in period 1 to 2.90 in period 9.

One possible explanation as to why experts overcharge more often under price competition may be that experts try to compensate lower profits due to lower prices by overcharging. Furthermore, our hypothesis is confirmed that under price competition, there is no reputation building on the charging dimension.

[21]Note that the difference in the level of overcharging between price competition and fixed prices is driven by the difference between the public-history conditions (Mann-Whitney U test: $p = 0.006$). The difference between the private-history conditions is not statistically significant (Mann-Whitney U test: $p = 0.834$).

Note that *Result 4* is robust against reducing the fixed prices to $\{p_L, p_H\} = \{3, 7\}$ (Mann-Whitney U test: $p = 0.050$; see also *Table 8*). However, the reduction in fixed prices leads to a considerable increase in the level of overcharging under public histories.

Table 8: 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 5 (Private vs. public histories under price competition: overcharging)**.** *Under price competition, the level of overcharging is significantly higher under public than under private histories.*

We find evidence that the level of overcharging is higher under public than under private histories if experts compete in prices (Mann-Whitney U test: $p = 0.093$).[22] Under public histories, a customer observes the price each customer was charged in the previous periods and not only the price she was charged herself, resulting in stronger price competition (compare *Figure 2*). The lower prices are compensated by higher frequencies of overcharging thus leading to an increased level of overcharging under public histories.

Result 6 (Private vs. public histories under fixed prices: overcharging)**.** *Under fixed prices $\{p_L, p_H\} = \{4, 8\}$, the level of overcharging is weakly significantly lower under public than under private histories. The difference diminishes if prices are fixed at $\{p_L, p_H\} = \{3, 7\}$.*

This result on overcharging again follows the pattern we find for the level of undertreatment: in a fixed-price regime, there is less overcharging under public than under private histories. According to the Mann-Whitney U test, the level of undertreatment is different on a significance level of $p = 0.066$.[23]

[22] Note that the panel probit regression supports this result on a 5% significance level whereas the panel OLS regression does not find a statistically significant difference.

[23] 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 show a high level of overcharging.

The difference in the level of overcharging between public and private histories is due to the fact that customers can observe whether other experts charged the price for the minor or the major treatment in previous periods under public histories. If the experts' mark-up is sufficiently high as under prices $\{p_L, p_H\} = \{4, 8\}$, experts charge honestly in the first periods. However, if the experts' mark-up is low, such as under prices $\{p_L, p_H\} = \{3, 7\}$, the experts' incentive to charge honestly vanishes even under public histories.

Note that we find virtually no undercharging under public histories, this being in contrast to the predicted expert behavior in the reputation equilibrium without overcharging (see *Lemma 6*).

7 Conclusion

We analyze the level of fraud in a credence goods market with repeated interaction and reputation building when experts can either compete in prices or face fixed prices on that market. We find that the level of fraud—both undertreatment and overcharging—is significantly higher under competitive compared to fixed prices. Under price competition, customers return significantly more often to undertreating experts than under fixed prices in the first periods. Furthermore we observe price pressure that undermines reputation building in the first periods: experts who undertreated in previous periods offer lower prices in the following periods under price competition. Taken together, 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 find that public histories go along with lower levels of undertreatment compared to private histories when prices are fixed whereas the opposite is true under price competition although differences are not significant. Under price competition, the observed price decline over time under public histories is greater than under private histories. These results indicate that public information might help strengthen reputation building regarding treatment quality when prices are fixed whereas it might intensify price competition with negative feedback on treatment quality when prices are not fixed. Results on the second dimension of fraud (overcharging) mirror the results on undertreatment: under price competition, the level of overcharging is significantly higher under public than under private histories. Declining prices under public histories seem to be compensated by higher overcharging rates compared to private histories.

While Grosskopf and Sarin (2010) show that in an expert market without competition, more customer information about expert behavior always improves market outcomes, we find that in a market with price competition, more customer information may be detrimental to market efficiency. Our results thus provide some evidence for the notion of *bad reputation*.

Our results also provide a possible rationale for why prices tend to be regulated in several 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 needs to be adopted. In markets where the potential welfare loss from undertreatment is substantial, 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 due to information asymmetry.

In terms of available information, feedback platforms seem to be an adequate instrument to reduce the level of fraud when prices are not competitive. In markets with price competition, however, more customer information might focus attention too strongly on price with adverse effects on treatment quality.

Reputation building is one possibility to constrain experts' fraudulent behavior in credence goods markets. Obviously, one can think of several other instruments such as enhancing customers' opportunities to search for second opinions. Market design to improve outcomes in credence goods markets remains an important topic for future research.

8 Appendix A: Proofs

In the following proofs, we assume that if customers are indifferent between visiting and not visiting an expert, the customer opts for the visit. Experts who are indifferent between undertreating and not undertreating do not undertreat.

For each type of equilibria (no-reputation and reputation equilibria) we consider equilibria in which customers either randomize with equal probability among experts or coordinate on an expert in the first period.

8.1 Proof of Lemma 2

8.1.1 Reputation Equilibria in which Customers Randomize

The strategies and beliefs as well as the corresponding proof for the reputation equilibrium under public histories in which customers randomize follows Dulleck et al. (2011). Assume that customers who are indifferent between different experts randomize with equal probability among them.

Customers' beliefs:
In period 1, the customer believes to be treated sufficiently with probability 37/64 if experts post a price vector $\{n.d., 5\}$. If experts post a price vector $\{n.d., 3\}$, the customer believes to receive the minor treatment.

In periods 2–9, the customer believes to be treated sufficiently with probability 1 by an expert if and only if (i) she is treated under a price menu $\{n.d., 5\}$, (ii) the expert had the strict majority of customers in the previous period, (iii) the expert has never undertreated any customer except for a situation where all experts served exactly one customer or two experts served two customers each. If all experts served exactly one customer in the previous period or two served two each, the customer believes to be treated sufficiently at least with probability 7/16 by any expert posting a price vector $\{n.d., 5\}$. Otherwise, the customer believes to receive the minor treatment.

For periods 10–16, the customer believes to always receive the minor treatment.

For all periods, each customer believes that experts always charge p_H.

Customers' strategy:
In the first period, customers randomize with equal probability among experts who have posted $\{n.d., 5\}$. If no expert has posted $\{n.d., 5\}$, customers randomize among experts who have posted $\{n.d., 3\}$. If no expert has posted $\{n.d., 5\}$ or $\{n.d., 3\}$, customers do not interact.

In periods 2–9, customers visit the expert who is expected to treat sufficiently with probability 1. If no expert is expected to treat sufficiently with probability 1, customers randomize among all experts posting $\{n.d., 5\}$ that have never undertreated when they were serving the strict majority of customers. If no expert is expected to treat sufficiently with probability 1 and among experts posting $\{n.d., 5\}$ there is no expert that has never undertreated when serving the strict majority of customers, customers randomize among experts that have posted $\{n.d., 3\}$, or, if none of the experts has posted $\{n.d., 3\}$, customers abstain from trade.

In periods 10–16, among experts posting $\{n.d., 3\}$, customers choose the expert who served the strict majority of customers in period 9 if the expert has not undertreated in periods 1–9 except for a situation where all experts served exactly one customer or two experts served two customers each. If there is no expert who had the strict majority of customers in period 9, the customer randomizes between the experts posting $\{n.d., 3\}$ that have never undertreated when they were serving the strict majority of customers. If there is no expert offering the price menu $\{n.d., 3\}$, customers refrain from interacting.

Experts' strategy:
In period 1–9, all experts post $\{n.d., 5\}$. They serve customers sufficiently if they have three or four customers. If experts serve two customers they treat sufficiently if they did not serve exactly two customers in the previous period. Experts always provide the minor treatment otherwise. Experts always charge p_H.

In period 10, experts post the price menu $\{n.d., 3\}$ and always provide the minor treatment if they served three or four customers in period 9 or if they served two customers in period 9 and did not serve two customers in period 8. In period 11-16, experts post the price menu $\{n.d., 3\}$ and always provide the minor treatment if they served three or four customers in period 10. Otherwise, experts play the strategy described *Lemma 1* in periods 10–16. Experts always charge p_H.

Verification:
For customers, it is rational to interact in periods 1–9 because their minimum ex-

pected payoff of interacting (Period 1: $(0.5+0.5(1-0.75^3))5-0.5\cdot 0.75^3\cdot 5 = 2.8906$; Period 2–9: $(0.5 + 0.5 \cdot 7/16 \cdot 5 - 0.5 \cdot 9/16 \cdot 5 = 2.1875)$ is larger than the outside option of 1.6. Customers' behavior in periods 10–16 is rational because it either yields an expected payoff of 2 if there exists an expert posting $\{n.d., 3\}$ or they are not served at all.

In the following, we check experts' behavior.

In period 16, experts always undertreat and overcharge. By backward induction, in periods $10 - 16$, it is any experts dominant strategy to undertreat and overcharge: Assume the price for the major treatment is 5 in round 10 (and 3 subsequently) and an expert serves 4 customers. His maximum additional future payoff of treating customers sufficiently amounts to $6 \cdot 2.4 = 14.4$ whereas the maximum additional current payoff from undertreating is $4((5-2)-(5-6)) = 16$, i.e. the expert will undertreat even with a price of 5. Then, experts always undertreat and overcharge for a lower price (and later period).
It is rational for experts to post $\{n.d., 3\}$ in periods 11-16 if they served four customers in the previous round or to mix as predicted in *Lemma 1* if they did not serve four customers. In period 10, it is rational for experts to post $\{n.d., 3\}$ if they (a) served three or four customers in period 9 as they serve 4 customers or (b) served two customers in period 9 but did not serve two customers in period 8 as the expert serves four customers with probability 0.8594, which leads to a higher profit than the outside option or playing a mixed strategy. Otherwise, it is optimal to mix as predicted in *Lemma 1*.

In period 9 four cases have to be considered:
(a) There is an expert with either three or four customers. His maximum additional future payoff of treating customers sufficiently amounts to $7 \cdot 2.4 = 16.8$ whereas the maximum additional current payoff from deviating is $4((5-2)-(5-6)) = 16$.
(b) There is an expert with two customers who did not have exactly two customers in period 8. Then there are two possible distributions of customers to experts. With probability $3(1/3)^2$, the two remaining customers are at the same expert; with probability $(3 \cdot 1/3 \cdot 2/3)$, they are at different experts. Thus, the expert with two customers has the strict majority of customers with probability $(3 \cdot 1/3 \cdot 2/3)/(3(1/3)^2 + (3 \cdot 1/3 \cdot 2/3)) = 2/3$. His maximum additional future payoff from treating sufficiently amounts to $16.8 \cdot 2/3 = 11.2$ which is more than the maximum additional current payoff from deviating amounting to 8.
(c) There is an expert with two customers who served exactly two customers in

period 8. Then, the expert can infer that another expert has also two customers such that neither of them has the strict majority of customers. Then there is no additional expected future payoff from treating sufficiently. Consequently, the expert will cheat.
(d) The expert has only one customer. Then there is no additional expected future payoff from treating sufficiently. Consequently, the expert will cheat.
For periods 1–8, the additional expected future payoff from treating sufficiently is higher than in period 9. Therefore, the experts' incentives to deviate are lower.

8.1.2 Reputation Equilibrium in which Customers Coordinate

In the following, we assume that customers coordinate on one of the experts in the first period. We refer to the four experts as expert $A1$, $A2$, $A3$, and $A4$. The strategies and beliefs in the reputation equilibrium with customers coordinating under public histories are as follows.

Customers' beliefs: Each customer believes that experts always charge p_H. Each customer believes to be treated sufficiently if and only if (i) she is treated under a price menu $\{n.d., 5\}$ and the expert has at least two customers, (ii) the expert has only undertreated a customer in situation where all experts served exactly one customer, and (iii) the game is in periods 1–9. Otherwise, each customer believes to get the minor treatment.

Customers' strategy: Each customer visits among the experts posting a price menu $\{n.d., 5\}$ the same expert as all other customers (in the following expert $A1$) in the first period. In periods 2–9, if expert $A1$ did not undertreat any of the customers in the previous period and expert $A1$ posts a price menu a $\{n.d., 5\}$ in the current period, customers return to expert $A1$. If expert $A1$ undertreated any of the customers in the previous period or posts a price menu different from $\{n.d., 5\}$ in the current period, all customers coordinate to another expert (in the following expert $A2$) among the experts posting a price menu $\{n.d., 5\}$. If there is no expert posting $\{n.d., 5\}$, customers randomize between those experts posting $\{n.d., 3\}$. If there is no expert posting $\{n.d., 3\}$, customers do not interact. Customers' strategy when visiting experts $A2$, $A3$ and $A4$ is according to the above strategy at expert $A1$. If there is no expert who never undertreated, customers do not interact. In periods 10–16, customers choose expert $A1$ if he never undertreated in periods 1–9. If expert $A1$ undertreated in any period 1–9, customers visit expert $A2$ if he never undertreated in any period 1–9; and so forth. If there is no expert who never undertreated, customers randomize between experts with equal probability in periods 10–16.

Expert Strategy: In the first nine periods, all experts post $\{n.d., 5\}$. Each expert serves his customers sufficiently if he has two or more customers and provides the minor treatment otherwise. In periods 10–16, all experts post the price menu $\{n.d., 3\}$ and always provide the minor treatment if one seller had strictly the most customers in period 9. Otherwise all experts play the strategy described *Lemma 1*.

Verification:
We now verify that the given strategies and beliefs form a perfect Bayesian equilibrium. We first show that customers' strategies are rational. In periods 10–16, if customers interact, they receive an expected payoff of $0.5(10-3)+0.5(0-3)=2$ which is larger than their outside option of 1.6. In periods 1–9, given expert behavior, it is optimal to interact as the expected payoff of $10-5=5$ is larger than the one from not interacting (1.6). If customers return to play the above described randomization equilibrium, customers' strategy off-equilibrium is optimal as shown in the public histories reputation equilibrium with randomization.

In the following, we show that experts' strategy is rational. In periods 10–16 it is optimal to always provide the minor treatment because the maximum additional future payoff of treating sufficiently $6 \cdot 2.4 = 14.4$ (in period 10) is lower than the maximum current payoff from deviating $4((5-2)-(5-6)) = 16$. In period 9, if the expert serves four customers, the expert's maximum additional future payoff of treating customers sufficiently amounts to $7 \cdot 2.4 = 16.8$ whereas the maximum additional current payoff from deviating is $4((5-2)-(5-6)) = 16$. If the expert serves three customers, his maximum additional future payoff of treating customers sufficiently also amounts to $7(4-1.6) = 16.8$ (because the single customer will visit this expert in periods 10–16) whereas the maximum additional current profit from deviating is $3((5-2)-(5-6)) = 12$. If an expert serves two customers in period 9, the maximum current payoff from deviating amounts to $2((5-2)-(5-6)) = 8$. Whether the expert will serve all four customers in periods 10–16 depends on whether the expert serves the strict majority of customers in period 9. Given customers' strategies, an expert should never serve only two customers. Hence, Bayes' rule cannot be applied to calculate the probability with which an expert expects to be the expert with the strict majority of customers. We assume that the expert believes to serve the strict majority of customers with probability 1. Given these beliefs, the expert's maximum additional future payoff of treating sufficiently amounts to 16.8 because all customers will choose this expert in periods 10–16. In periods 1–8, future payoff of treating customers sufficiently is larger so that deviation incentives are lower. Hence, the expert will treat customers sufficiently if he serves at least two customers under the above beliefs. In case the expert only serves one customer, the maximum additional future payoff from treating sufficiently amounts to $7(1 - 1.6) = -2.8$ while the maximum current payoff from deviating is 4. Thus, the expert always provides the minor treatment if he serves a single customer. Given that all other experts charge the price p_H for both treatments in all 16 periods, it is optimal for the individual expert to also charge p_H. Consequently, experts' strategies are rational.

8.2 Proof of Lemma 3

8.2.1 Reputation Equilibria in which Customers Randomize

Under private histories a reputation equilibrium where customers randomize between experts and interact in the first nine periods does not exist. This is because customers cannot switch to an expert who is expected to serve sufficiently because customers do not observe how many customers an expert serves and whether he undertreated other customers previously. Without customers observing which expert served the most customers and did not undertreat and the corresponding customer switching, it is optimal for experts to undertreat customers unless they face four customers: If experts post prices as outlined in *Lemma 3* and an expert serves three customers, his maximum additional future payoff from treating customers sufficiently amounts to $7(3-1.6) = 9.8$ in period 9 (which is the last period where reputational concerns may play a role), while the maximum additional current payoff from deviating amounts to $3((5-2)-(5-6)) = 12$. Thus, experts always provide the minor treatment if they serve three or less customers. Thus, customers belief only to be treated sufficiently if an expert has four customers. With randomization, the probability in period 1 that an expert serves four customers is $1/64$. Then, however, the expected payoff from interacting for customers is $(0.5+)5-0.5(1-1/64)\cdot 5 = 0.078125$ which is lower than the outside option of 1.6. Thus, customers would not interact.

8.2.2 Reputation Equilibrium in which Customers Coordinate

The strategies and beliefs in the reputation equilibrium with customers coordinating under private histories are as follows.

Customers' beliefs: Each customer expects 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 $\{n.d., 5\}$ and the expert has four customers, (ii) if the expert has never undertreated the customer before, and (iii) the game is in periods 1–9. Otherwise, each customer believes to get the minor treatment.

Customers' strategy: Each customer visits among the experts that post a price menu $\{n.d, 5\}$ the same expert as all other customers (in the following expert $A1$) in the first period. In periods 2–9, if expert $A1$ did not undertreat the customer in the previous period and posts $\{n.d, 5\}$, the customer returns to expert $A1$. If expert $A1$ undertreated the customer in the previous period or posts a price vector different from $\{n.d, 5\}$, the customer refrains from interacting. In periods 10–16, if expert $A1$ did not undertreat the customer in any period 2–9, the customer stays with expert $A1$. If expert $A1$ undertreated the customer in any period 2–9, the customer randomizes between the remaining three experts with equal probability in periods 10–16.

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 and provides the minor treatment otherwise. In periods 10–16, experts always provide the minor treatment. Experts always charge p_H.

Verification:
We now verify that the given strategies and beliefs form a perfect Bayesian equilibrium. We first show that customers' strategies are rational. In periods 10–16, if customers interact, they receive an expected payoff of $0.5(10 - 3) + 0.5(0 - 3) = 2$ which is larger than their outside option of 1.6. In periods 1–9, given expert behavior, i.e., always sufficient treatment, it is optimal to interact as the expected payoff of $10-5 = 5$ is larger than the one from not interacting (1.6). If expert $A1$ undertreats, it is optimal for the customer to refrain from interacting because the outside option of 1.6 is larger than the expected payoff from interacting $(0.5(10-5)+0.5(0-5) = 0)$.

In the following, we show that experts' strategies are rational. In periods 10–16 it is optimal to always provide the minor treatment because the maximum additional future payoff of treating sufficiently $6 \cdot 2.4 = 14.4$ (in period 10) is lower than the maximum current payoff from deviating $4((5-2)-(5-6)) = 16$. In period 9, if the expert serves four customers, the expert's maximum additional future payoff of treating customers sufficiently amounts to $7 \cdot 2.4 = 16.8$ whereas the maximum additional current payoff from deviating is $4((5-2)-(5-6)) = 16$. In periods 1–8, future payoff of treating customers sufficiently is larger so that deviation incentives are lower. If the expert serves three or less customers, his maximum additional future payoff of treating customers sufficiently amounts to $7(3-1.6) = 9.8$ (in case he serves three customers) which is less than the maximum additional current profit from deviating $3((5-2)-(5-6)) = 12$.[24] Thus, it is optimal for the expert to provide the minor treatment. Given that all other experts charge the price p_H for both treatments in all 16 periods, it is optimal for the individual expert to also charge p_H. Hence, experts' strategy is rational.

8.3 Proof of Lemma 4

Both types of equilibria (with customer randomization and customer coordination) described in *Lemma 4* are characterized as follows:

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. Customers randomize between experts in each period respectively coordinate in any (arbitrary) way on the experts in periods 10–16.

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

[24]Note that the fourth customer in the market will be undertreated because she ends up as a single customer at an expert in period 9. As the fourth customer cannot observe whether the expert serving three customers undertreated his customers, her behavior in periods 10–16 is not changed by the treatment decision of the expert serving three customers in period 9. Hence, the fourth customer is irrelevant when determining whether the expert serving three customers deviates or sticks to the equilibrium strategy.

equilibrium. Customers' behavior is rational because their expected payoff from interaction in periods 1–9 amounts to $0.5(10-8)+0.5(0-8)=-3$ which is less than the outside option of 1.6. In periods 10–16, if customers interact, they receive an expected payoff of $0.5(10-3)+0.5(0-3)=2$ 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. Note that the expert cannot decide not to participate.

8.4 Proof of Lemma 5

The players' strategies and beliefs in the reputation equilibria without overcharging in a market with fixed prices are outlined below. The reputation equilibria require that customers coordinate on one expert in the first period. Given the strategies and beliefs of reputation equilibria under price competition in which customers randomize, customers would face a lower payoff than the outside option under fixed prices. Thus, if interaction is still observed, customers must coordinate on one of the experts. We refer to the four experts as expert $A1$, $A2$, $A3$, and $A4$.

Public Histories The strategies and beliefs in the reputation equilibrium with customer coordination under public histories are as follows.

Customers' beliefs: Each customer expects to be charged p_H in any of the periods. Each customer believes to be treated sufficiently if and only if (i) the expert serves at least two customers, (ii) the expert only undertreated a customer in situation where all experts served one customer, and (iii) the game is in periods 1–9. Otherwise, each customer believe to receive the minor treatment.

Customers' strategy: Each customer visits the same expert (in the following expert $A1$) as all other customers in the first period. In periods 2–9, if expert $A1$ did not undertreat any of the customers in the previous period, customers return to expert $A1$. If expert $A1$ undertreated in the previous period, all customers visit expert $A2$. If expert $A2$ did not undertreat any of the customers in the previous period, customers return to expert $A2$ whereas if he undertreated in the previous period, customers choose expert $A3$; and so forth. If there is no expert who never undertreated, customers do not interact. In periods 10–16, customers choose expert $A1$ if he never undertreated. If expert $A1$ undertreated in any period 1–9, customers visit expert $A2$ if he never undertreated; and so forth. If there is no expert who never undertreated, customers randomize between experts with equal probability in periods 10–16.

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

Verification:

We now verify that the above described strategies and beliefs form a perfect Bayesian equilibrium. We first show that customers' strategies are rational. In periods 10–16, if customers interact, they receive an expected payoff of $0.5(10-3)+0.5(0-3)=2$ which is larger than their outside option of 1.6. In periods 1–9, given expert behavior, i.e., always sufficient treatment, it is optimal to interact as the expected payoff of $10-8=2$ is larger than the one from not interacting (1.6).

In the following, we show that experts' strategy is rational. In periods 10–16 it is optimal to always provide the minor treatment because the maximum additional future payoff of treating sufficiently $6 \cdot 2.4 = 14.4$ (in period 10) is lower than the maximum current payoff from deviating $4((8-2)-(8-6)) = 16$. In period 9, if an expert serves four customers, the expert's maximum additional future payoff of treating customers sufficiently amounts to $7 \cdot 2.4 = 16.8$ whereas the maximum additional current payoff from deviating is $4((8-2)-(8-6)) = 16$. If the expert serves three customers, his maximum additional future payoff of treating customers sufficiently also amounts to $7(4-1.6) = 16.8$ (because the single customer will visit this expert in periods 10–16) whereas the maximum additional current profit from deviating is $3((8-2)-(8-6)) = 12$. If an expert serves two customers in period 9, the maximum current payoff from deviating amounts to $2((8-2)-(8-6)) = 8$. Whether the expert serving two customers in period 9 will serve all four customers in periods 10–16 depends on whether the expert serves the strict majority of customers in period 9. Given customers' strategies, an expert should never serve only two customers. Hence, Bayes' rule cannot be applied to calculate the probability with which an expert expects to be the expert with the strict majority of customers. We assume that the expert believes to serve the strict majority of customers with probability 1. Given these beliefs, the expert's maximum additional future payoff of treating sufficiently amounts to 16.8 because all customers will choose this expert in periods 10–16. In periods 1–8, future payoff of treating customers sufficiently is larger so that deviation incentives are lower. Hence, the expert will treat customers sufficiently if he serves at least two customers under the above beliefs. In case the expert only serves one customer, the maximum additional future payoff from treating sufficiently amounts to $7(1 - 1.6) = -2.8$ while the maximum current payoff from deviating is 4. Thus, the expert always provides the minor treatment if he serves a single customer. Given that all other experts charge the price p_H for both treatments in all 16 periods, it is optimal for the individual expert to also charge p_H. Consequently, experts' strategies are rational.

Private Histories The strategies and beliefs in the reputation equilibrium with customers coordinating under private histories are as follows.

Customers' beliefs: Each customer expects to be charged p_H in any of the periods. Each customer believes to be treated sufficiently if and only if (i) the expert has four customers, (ii) the expert has never undertreated the customer before, and if (iii) the game is in periods 1–9. Otherwise, each customer expects to receive a minor treatment.

Customers' strategy: Each customer visits the same expert as all other customers (in the following expert $A1$) in the first period. In periods 2–9, if expert $A1$ did not undertreat any of the customers in the previous period, customers return to expert $A1$. If expert $A1$ undertreated in the previous period, customers refrain from interacting. In periods 10–16, if expert $A1$ did not undertreat the customer in any period 2–9, customers stay with expert $A1$. If expert $A1$ undertreated the customer in any period 2–9, customers randomize between experts with equal probability in periods 10–16.

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

Verification:
We now verify that the above described strategies and beliefs form a perfect Bayesian equilibrium. We first show that customers' strategies are rational. In periods 10–16, if customers interact, they receive an expected payoff of $0.5(10-3)+0.5(0-3) = 2$ which is larger than their outside option of 1.6. In periods 1–9, given expert behavior, it is optimal to interact as the expected payoff of $10 - 8 = 2$ is larger than the one from not interacting (1.6).

In the following, we show that experts' strategy is rational. In periods 10–16 it is optimal to always provide the minor treatment because the maximum additional future payoff of treating sufficiently $6 \cdot 2.4 = 14.4$ (in period 10) is lower than the maximum current payoff from deviating $4((8-2)-(8-6)) = 16$. In period 9, if the expert serves four customers, the expert's maximum additional future payoff of treating customers sufficiently amounts to $7 \cdot 2.4 = 16.8$ whereas the maximum additional current payoff from deviating is $4((8-2)-(8-6)) = 16$. In periods 1–8, future payoff of treating customers sufficiently is larger so that deviation incentives are lower. If the experts serves three or less customers, his maximum additional future payoff of treating customers sufficiently amounts to 9.8 (in case he serves three customers) which is less than the maximum additional current profit from deviating $3((8-2)-(8-6)) = 12$.[25] Thus, it is optimal for the expert to provide the minor treatment. Given that all other experts charge the price p_H for both treatments in all 16 periods, it is optimal for the individual expert to also charge p_H. Hence, experts' strategy is rational.

8.5 Proof of Lemma 6

The strategies and beliefs of the players in the reputation equilibrium without overcharging in a market with fixed prices are outlined below. We refer to the four experts as expert $A1$, $A2$, $A3$, and $A4$.

Customers' beliefs:
In periods 1–7, each customer believes to be charged p_L if (i) the expert served at least two customers in the previous period and (ii) the expert has never charged p_H in any of the previous periods. Otherwise, each customer expects to be charged p_H.

In periods 1–9, each customer believes to be treated sufficiently if and only if (i) the expert served at least two customers in the previous period and (ii) the expert has never undertreated in any of the previous periods. Otherwise, each customer expects to receive the minor treatment.

Customers' strategy:
In the first period, each customer visits expert $A1$.

In periods 2–9 customers return to expert $A1$ if expert $A1$ did not undertreat any of the customers and did not charge p_H in the previous period. If expert $A1$ un-

[25]Note that the single customer is again irrelevant for the above analysis.

dertreated in the previous period or charged p_H, all customers visit expert $A2$. If expert $A2$ did not undertreat any of the customers and did not charge p_H in the previous period, customers return to expert $A2$; otherwise, all customers visit expert $A3$. If expert $A3$ did not undertreat any of the customers and did not charge p_H in the previous period, customers return to expert $A3$; otherwise, all customers visit expert $A4$. If expert $A4$ did not undertreat any of the customers and did not charge p_H in the previous period, customers return to expert $A4$; otherwise, all customers visit expert $A1$ if expert $A1$ has not undertreated in any of previous periods; otherwise, all customers visit expert $A2$; and so forth. If there is no expert who has not undertreated, customers do not interact.

In periods 10–16, customers choose expert $A1$ if he has not undertreated customers in periods 1–9 and has only charged p_L in periods 1–7. Otherwise, customers choose expert $A2$ if he has not undertreated customers in periods 1–9 and has only charged p_L in periods 1–7; and so forth. If there is no expert who never undertreated in periods 1–9 and charged p_L in periods 1–7, customers visit expert $A1$ if he never undertreated in periods 1–9. If expert $A1$ undertreated in any period 1–9, customers visit $A2$ if he has never undertreated in periods 1–9; and so forth. If there is no expert who never undertreated, customers randomize between experts with equal probability in periods 10–16.

Experts' strategy:
In periods 1–7, each expert charges each customer p_L if he serves at least two customers and charges p_H otherwise. In periods 8–16, experts always charge p_H.

In periods 1–9, each expert treats his customers sufficiently if he serves two or more customers and provides the minor treatment otherwise. In periods 10–16, experts always provide the minor treatment.

Verification:
We now verify that the above described strategies and beliefs form a perfect Bayesian equilibrium. We first show that customers' strategies are rational. Customers interact in periods 1–7 because their expected payoff from interacting amounts to $10 - 4 = 6$ which is more than the outside option of 1.6. Customers interact in periods 8 and 9 because $0.5(10 - 8) + 0.5(10 - 8) = 2 > 1.6$. Customers interact in periods 10–16 because $0.5(10 - 3) + 0.5(0 - 3) = 2 > 1.6$.

In the following, we show that experts' strategy is rational.

In periods 10–16 it is optimal to always provide the minor treatment because the maximum additional future payoff of treating sufficiently $6 \cdot 2.4 = 14.4$ (in period 10) is lower than the maximum current payoff from deviating $4((8-2)-(8-6)) = 16$. In period 9, if the expert serves four customers, the expert's maximum additional future payoff of treating customers sufficiently amounts to $7 \cdot 2.4 = 16.8$ whereas the maximum additional current payoff from deviating is $4((8-2)-(8-6)) = 16$. If the expert serves three customers, his maximum additional future payoff of treating customers sufficiently also amounts to $7(4-1.6) = 16.8$ (because the single customer will visit this expert in periods 10–16) whereas the maximum additional current profit from deviating is $3((8-2)-(8-6)) = 12$. If an expert serves two customers in period 9, the maximum current payoff from deviating amounts to $2((8-2)-(8-6)) = 8$. Whether the expert will serve all four customers in periods 10–16 depends on whether the expert serves the strict majority of customers in period 9. Given customers' strategies, an expert should never serve only two customers. Hence, Bayes' rule cannot be applied to calculate the probability with which an expert expects to be the expert with the strict majority of customers. We assume that the expert believes to serve the strict majority of customers with probability 1. Given these beliefs, the expert's maximum additional future payoff of treating sufficiently amounts to 16.8 because all customers will choose this expert in periods 10–16.

In periods 8 and 9, future payoff of treating customers sufficiently is larger so that deviation incentives are lower. Hence, the expert will treat customers sufficiently if he serves at least two customers under the above beliefs. In case the expert only serves one customer, the maximum additional future payoff from treating sufficiently amounts to $7(1-1.6) = -2.8$ while the maximum current payoff from deviating is 4.

Next, we check experts' incentive to deviate from their strategy in periods 1–7. Note that experts' incentive to deviate is largest in period 1 and not in period 7. This is because experts make zero profits if they play according to equilibrium strategy in periods 1–7 while a deviation leads to a profits of 1.6 per period (outside option). In period 1, experts' behavior is rational because the maximum additional current payoff from deviating—if all four customers have a major problem, the expert charges p_H but provides the minor treatment—amounts to $4((8-2)-(4-6)) = 32$ while the maximum expected future payoff from charging p_L and treating sufficiently amounts to $2 \cdot 4(0.5(8-6)+0.5(8-2)) - 9 \cdot 1.6 + 7 \cdot 2.4 = 34.4$.[26] For the case of three and two customers, the same reasoning applies as for the deviation in period 9. Hence, experts charge p_L if they face at least two customers given the above outlined belief. In periods 2–7, the incentive to deviate is lower than in period 1. Thus, the experts' behavior is rational.

[26]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 $7(4-1.6)$.

9 Appendix B: Screenshots of Feedback Systems

9.1 Feedback System in a Fixed Price Market

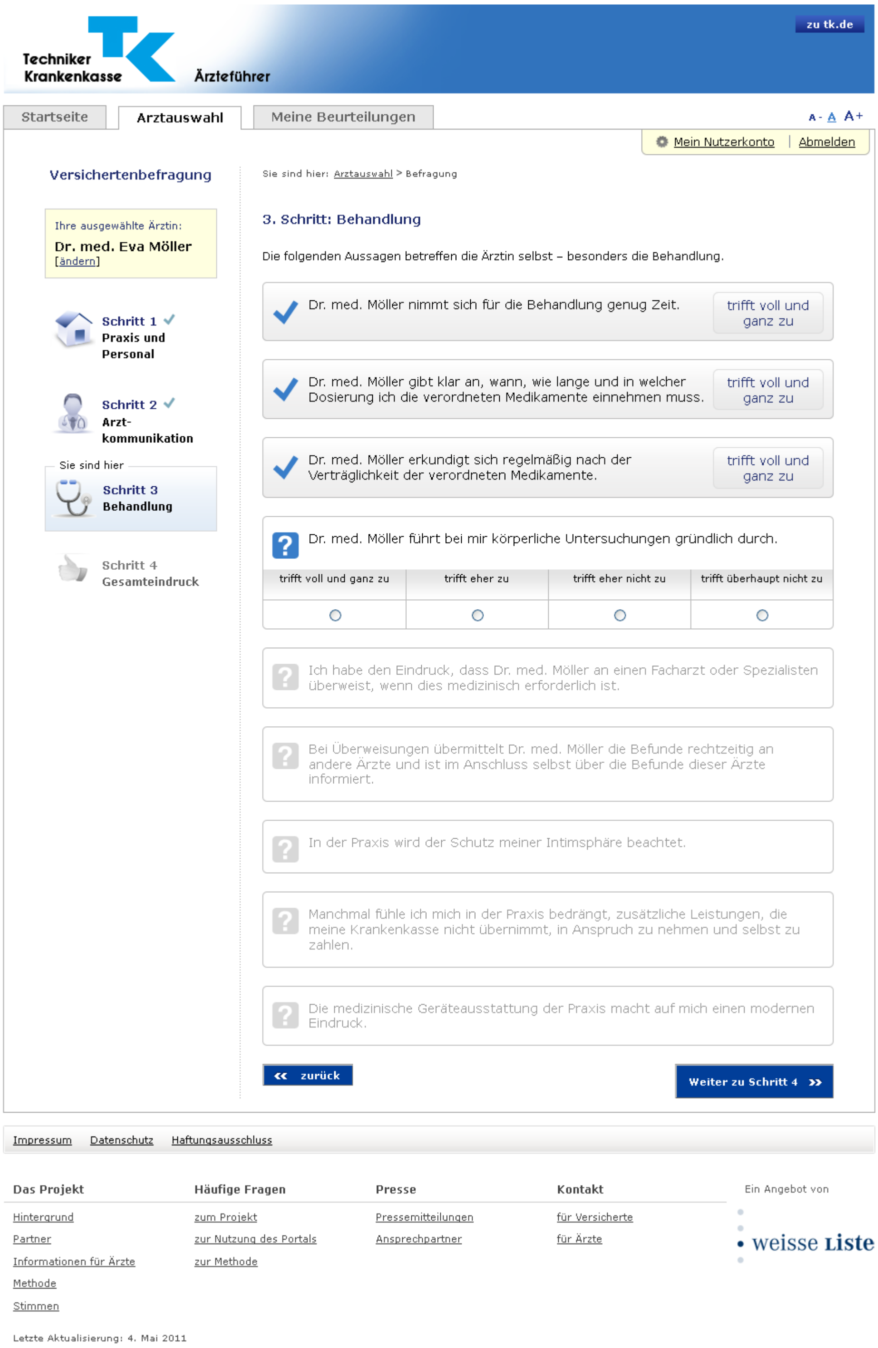


Figure 4: Patient feedback at the *Arztnavigator*. Source: `https://weisse-liste.arzt-versichertenbefragung.tk.de/`, accessed on July 18, 2012.

9.2 Feedback System in a Market with Price Competition

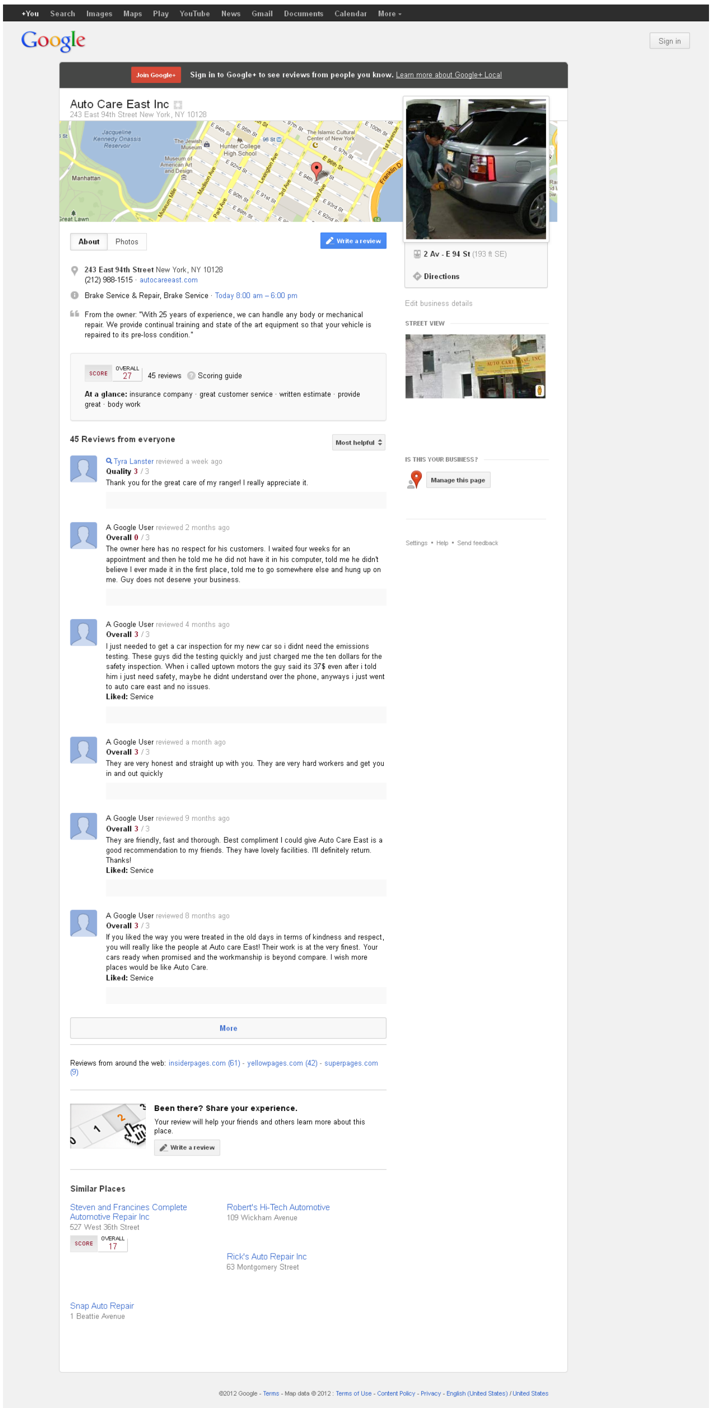


Figure 5: Car repair shop rating at *Google Maps*.
Source: `https://plus.google.com/109459300714062123468/about?gl=US&hl=en`, accessed on July 18, 2012.

10 Appendix 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.

10.1 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

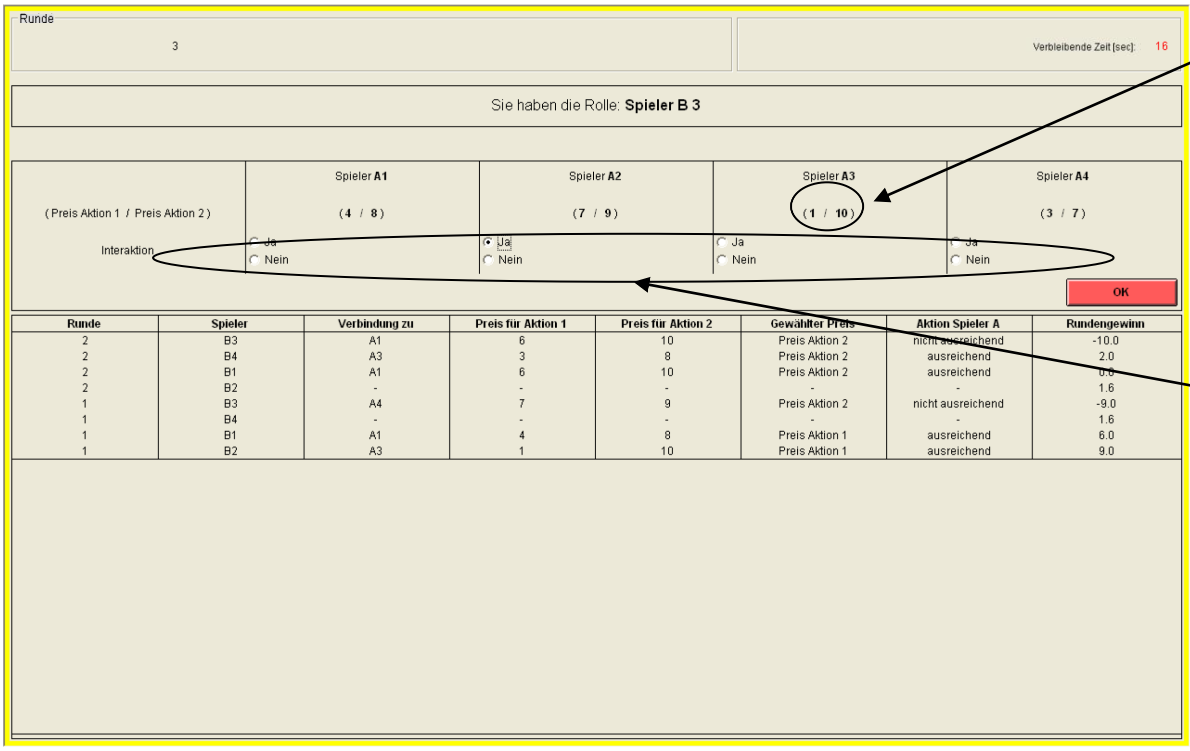
(strikt) positive Preise in vollen Punkten von 1 Punkt bis maximal 11 Punkte sind möglich. D.h. die zulässigen Preise sind 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 oder 11.
Beachten Sie, dass der Preis für die Aktion 1 den Preis für die Aktion 2 nicht übersteigen darf.

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)



Runde	Spieler	Verbindung zu	Preis für Aktion 1	Preis für Aktion 2	Gewählter Preis	Aktion Spieler A	Rundengewinn
2	B3	A1	6	10	Preis Aktion 2	nicht ausreichend	-10.0
2	B4	A3	3	8	Preis Aktion 2	ausreichend	2.0
2	B1	A1	6	10	Preis Aktion 2	ausreichend	0.0
2	B2	-	-	-	-	-	1.6
1	B3	A4	7	9	Preis Aktion 2	nicht ausreichend	-9.0
1	B4	-	-	-	-	-	1.6
1	B1	A1	4	8	Preis Aktion 1	ausreichend	6.0
1	B2	A3	1	10	Preis Aktion 1	ausreichend	9.0

Die erste Zahl steht immer für „Preis für Aktion 1" und die zweite für „Preis für Aktion 2".

Hier können Sie in höchstens einer Spalte „Ja" anklicken. Wenn Sie gar nichts anklicken und auf „OK" klicken, dann haben Sie in dieser Runde keine Interaktion.

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.

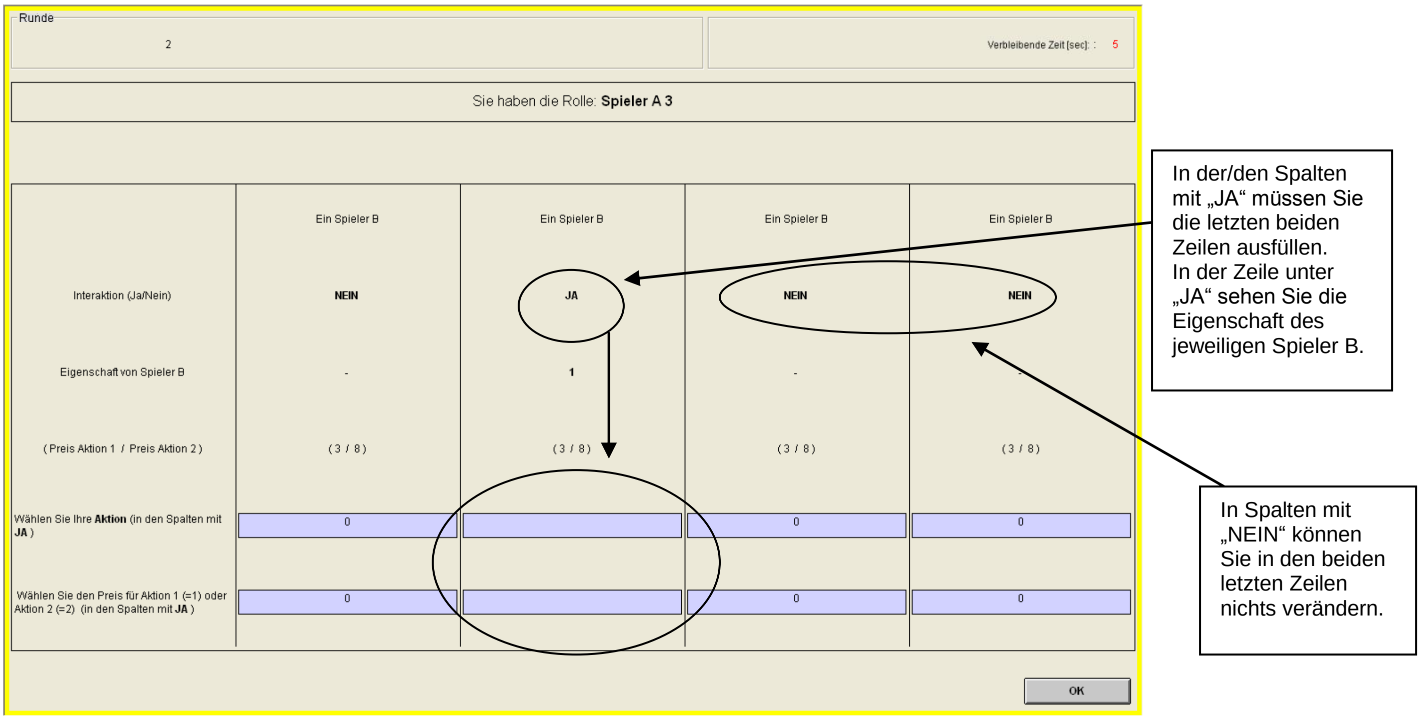
Spieler B erhält **10 Punkte**, wenn die von Spieler A gewählte **Aktion ausreichend** ist. **Spieler B** erhält **0 Punkte**, wenn die von Spieler A gewählte **Aktion nicht ausreichend** ist. In beiden Fällen ist noch der entsprechende Preis zu bezahlen (siehe unten bei „Auszahlungen").

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).

10.2 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.

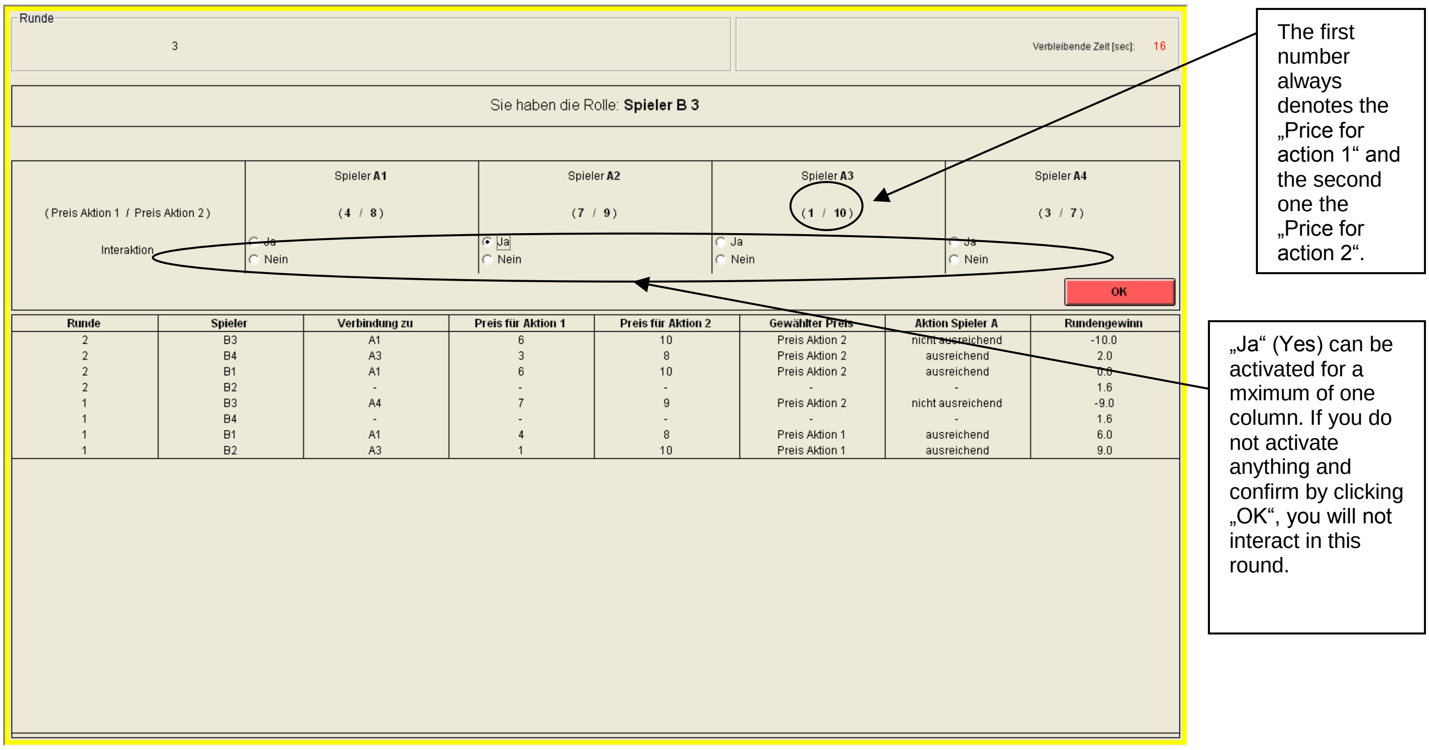
Decision 2
Player B observe the prices set by each of the 4 players A at decision 1. Then, player B decides whether he wants to interact with one of the players A and—if he wants to do so—with which one.
If he wants to interact, player A can choose an action at decision 3 and charge a price for that 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.

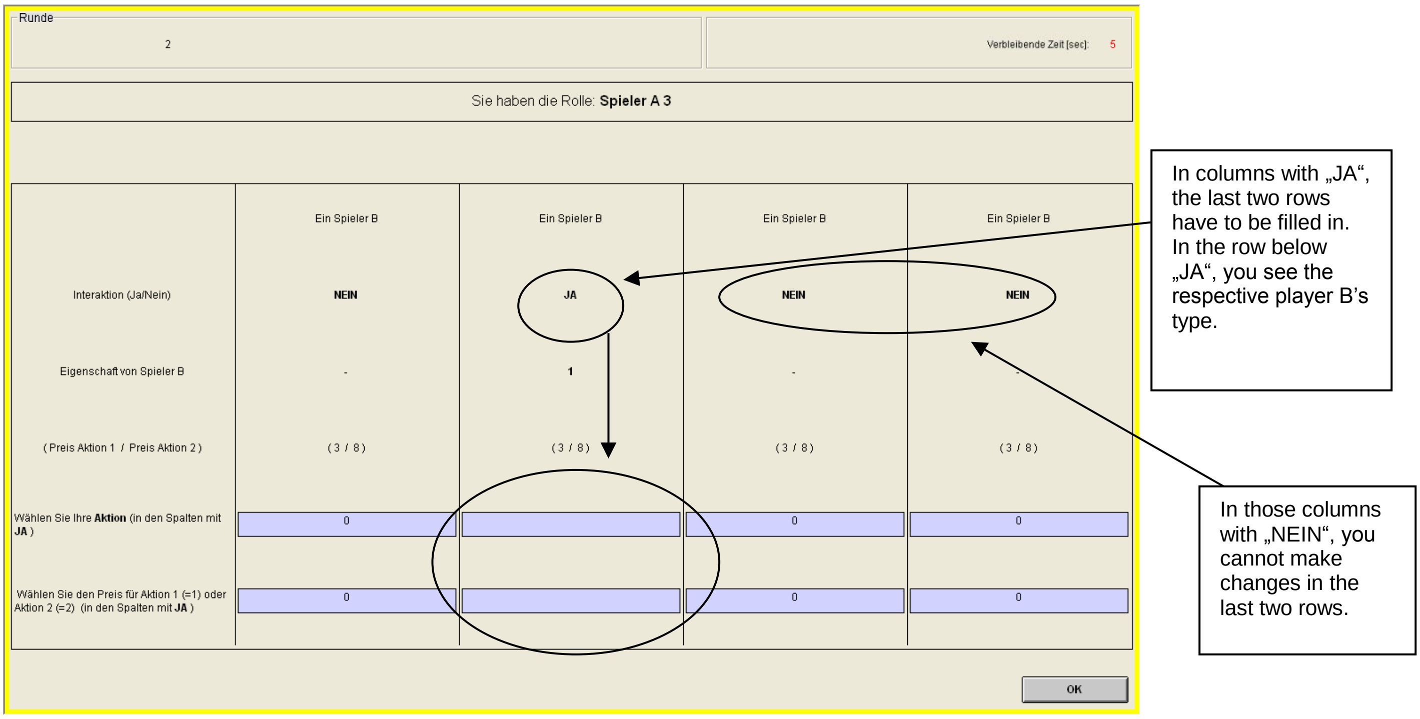
Decision 4
Each player B that interacts with player A is **charged** the **price** (which he determined at decision 1) for one of the two actions by player A. The price charged **does not have to** match the price of the action chosen at decision 3 but may be the price for the other action. In case more 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).

References

Ai, C., Norton, E. C., 2003. Interaction Terms in Logit and Probit Models. Economics Letters 80 (1), 123–129.

Anderhub, V., Engelmann, D., Güth, W., 2002. An experimental study of the repeated trust game with incomplete information. Journal of Economic Behavior & Organization 48 (2), 197–216.

Berg, J., Dickhaut, J., McCabe, K., 1995. Trust, Reciprocity, and Social History. Games and Economic Behavior 10 (1), 122–142.

Brown, M., Falk, A., Fehr, E., 2004. Relational contracts and the nature of market interactions. Econometrica 72 (3), 747–780.

Commission of the European Communities, 2004. Report on Competition in Professional Services.

Dulleck, U., Johnston, D., Kerschbamer, R., Sutter, M., 2012. The Good, the Bad and the Naive: Do Fair Prices Signal Good Types or Do They Induce Good Behaviour? Working Paper.

Dulleck, U., Kerschbamer, R., 2006. On Doctor, Mechanics, and Computer Specialists: The Economics of Credence Goods. Journal of Economic Literature 44 (1), 5–42.

Dulleck, U., Kerschbamer, R., Sutter, M., 2011. The Economics of Credence Goods: An Experiment on the Role of Liability, Verifiability, Reputation, and Competition. American Economic Review 101 (2), 526–555.

Ely, J., Fudenberg, D., Levine, D. K., 2008. When is Reputation Bad? Games and Economic Behavior 63 (2), 498–526.

Ely, J. C., Välimäki, J., 2003. Bad Reputation. Quarterly Journal of Economics 118 (3), 785–814.

Federal Bureau of Investigation, 2007. Financial Crimes Report to the Public: Fiscal Year 2007.

Fischbacher, U., 2007. z-Tree: Zurich Toolbox for Ready-Made Economic Experiments. Experimental Economics 10 (2), 171–178.

Greiner, B., 2004. The Online Recruitment System ORSEE 2.0—A Guide for the Organization of Experiments in Economics. Working Paper.

Grosskopf, B., Sarin, R., 2010. Is Reputation Good or Bad? An Experiment. American Economic Review 100 (5), 2187 – 2204.

Huber, P. J., 1967. The Behavior of Maximum Likelihood Estimates Under Nonstandard Conditions. In: Le Cam, L. M., Neyman, J. (Eds.), Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability. Vol. 1. University of California Press, pp. 221–233.

Huck, S., LÃ¼nser, G. K., Tyran, J.-R., 2012. Competition fosters trust. Games and Economic Behavior 76 (1), 195 – 209.

Huck, S., Lünser, G. K., Tyran, J.-R., 2008. Pricing and Trust: Working Paper.

Rogers, W. H., 1993. Regression of Standard Errors in Clustered Samples. Stata Technical Bulletin 3 (13), 19–23.

Schneider, H. S., 2012. Agency Problems and Reputation in Expert Services: Evidence From Auto Repair. Journal of Industrial Economics 60 (3), 406–433.

White, H., 1980. A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. Econometrica, 817–838.

Wooldridge, J. M., 2009. Introductory Econometrics: A Modern Approach. Cengage Learning Services, Mason.