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ABSTRACT

Money Illusion and Coordination Failure*

Economists long considered money illusion to be largely irrelevant. Here we show, however, that money illusion has powerful effects on equilibrium selection. If we represent payoffs in nominal terms, choices converge to the Pareto inefficient equilibrium; however, if we lift the veil of money by representing payoffs in real terms, the Pareto efficient equilibrium is selected. We also show that strategic uncertainty about the other players' behavior is key for the equilibrium selection effects of money illusion: even though money illusion vanishes over time if subjects are given learning opportunities in the context of an individual optimization problem, powerful and persistent effects of money illusion are found when strategic uncertainty prevails.

JEL Classification: C9, E32, E52

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1. Introduction

The rational expectations revolution in the 1970's eradicated the study of money illusion, and its implications, from economists' research agenda for a long time. The rational expectations approach assumes that people are rational; and since rational individuals do not exhibit illusions there is nothing to study. Money illusion was a concept to be mentioned in courses about the history of economic thought but not in actual research endeavors (Howitt 1989). In fact, a good recipe to get theory papers rejected by leading journals was to assume that money illusion affected individuals' behavior (Tobin 1972).[1] More recently, however, some economists seem to be willing to reconsider the relevance of money illusion in economics, partly because of evidence that nominal wages and prices seem to be rigid (Akerlof 2002; Bewley 1999; Blinder et al. 1998; Campbell and Kamlani 1997; Fehr and Tyran 2001; Howitt 2002; Kahn 1997; Kahneman, Knetsch and Thaler 1986; Shafir, Diamond and Tversky 1997).

A powerful intuitive argument supports the view that money illusion is largely irrelevant for economics, however: the illusion has detrimental effects on peoples' economic well-being and they thus have a strong incentive to make illusion free decisions. Therefore, people will ultimately make illusion free decisions, implying that money illusion has little or no impact on aggregate outcomes – at least in the long run. It is the purpose of this paper to show that this argument can be seriously misleading because it neglects the strategic repercussions of money illusion. We show experimentally that even if learning in the context of an individual optimization problem does remove individuals' money illusion, there can be large permanent effects of money illusion in a strategic environment. These effects arise because money illusion induces individuals to coordinate on inferior equilibria. Once individuals are locked in a bad equilibrium there is no escape, meaning that they experience permanent economic losses relative to the efficient equilibrium. Thus, even if individual-level money illusion is only a temporary phenomenon in an individual optimization task, it can cause permanent real effects in a strategic setting by coordinating people on inefficient equilibria.

[1] James Tobin (1972, p. 3) nicely described this situation: "An economic theorist can, of course, commit no greater crime than to assume money illusion". Tobin himself believed that money illusion is relevant.

Our results are based on a series of experiments that implemented a strategic pricing game with 3 Pareto-ranked equilibria. The experimental design is based on the characterization of money illusion as a framing effect (Shafir, Diamond and Tversky 1997, Fehr and Tyran 2001). Money illusion occurs when objectively identical situations cause different behavioral patterns depending on whether the situation is framed in nominal or in real terms. Accordingly, we capture the impact of money illusion by comparing behavior in a condition in which payoff information is provided in real terms to behavior in a condition in which payoff information is provided in nominal terms. In the Pareto-dominant equilibrium, each subject earns the highest *real* payoff but the *nominal* payoff is highest for each subject in a different equilibrium. Thus, if we give subjects payoff information in nominal terms they may exhibit money illusion by taking nominal payoffs as a proxy for real payoffs and coordinate on the equilibrium with highest nominal payoffs. In contrast, if we give subjects payoff information in real terms, the situation is transparent and it is clear that they earn the most in the Pareto-dominant equilibrium. This means that money illusion is ruled out under the real payoff representation while money illusion can play a role under the nominal payoff representation by coordinating subjects on a Pareto-inferior equilibrium. Therefore, if money illusion has no or little relevance, subjects should play the Pareto-dominant equilibrium both under the nominal and the real representation of payoffs.

The actual behavior of experimental subjects contrasts sharply with this prediction. Most subjects under the real payoff representation start to play at or close to the Pareto-dominant equilibrium and nearly all subjects quickly converge to this equilibrium. Not a single subject under the nominal payoff representation, however, plays this equilibrium. In this condition, the vast majority of subjects start to play far away from the Pareto-dominant equilibrium and they then converge to the inefficient equilibrium with high nominal payoffs. As a consequence, subjects' real earnings under the nominal payoff representation are on average almost 50 percent lower than under the real payoff representation. These results illustrate that money illusion may be a powerful source of coordination failure, causing permanent real effects.

In a next step, we examined the extent to which individual-level money illusion causes the failure to coordinate on the efficient equilibrium. This question is interesting because coordination failure in a strategic setting may also arise from the belief that the other players have money illusion. If everyone believes that the other players have money illusion and that, therefore, the others coordinate on a Pareto-inferior equilibrium with high nominal payoffs, it is in everyone's interest to play this equilibrium as well. To examine individual-level money illusion, we implemented a treatment in which each subject plays against pre-programmed computers who play a best reply. In addition, subjects are informed about the computers' response to each of their feasible choices. This means that the equilibrium selection problem is transformed into an individual optimization problem. In a sense, subjects are no longer in a truly strategic situation because no strategic uncertainty exists with regard to the other players' choices. Subjects can maximize their payoffs by unilaterally choosing the Pareto-dominant equilibrium, taking the computers' responses into account. If subjects can solve this optimization problem better under the real payoff representation than under the nominal payoff representation, we have evidence for individual-level money illusion.

The data indicates that a considerable number of subjects indeed suffer from individual-level money illusion during the first half of the experiment. Towards the end of the experiment, most subjects learn to make the optimal decision by choosing the efficient equilibrium. This observation shows that money illusion indeed vanishes at the individual level if subjects can repeatedly make the same decision in the context of an individual optimization task. However, repeatedly making the same decision in a strategic setting, where subjects face other human players whose actions have to be predicted, does not prevent the vast majority of subjects from coordinating on an inferior equilibrium. Apparently, it is one thing to pierce the veil of money in an individual optimization problem and another thing to escape the impact of money illusion in a strategic setting.

A few other papers have examined the role of money illusion in recent years. Shafir, Tversky and Diamond (1997) provided interesting questionnaire evidence indicating that money illusion affects both people's preferences as well as their perceptions of the constraints they face. More recently, Fehr and Tyran (2001) have shown that money illusion causes asymmetric responses to anticipated negative and positive monetary shocks. Money illusion strongly retards the adjustment of nominal prices to a unique equilibrium after a negative monetary shock, while prices quickly adjust to the new unique equilibrium after a positive shock. However, none of the previous papers has considered the effects of money illusion on coordination failure, i.e., they did not examine whether money illusion has permanent effects on subjects' behavior. In addition, we go beyond previous work by showing that, although there is a substantial initial prevailing level of money illusion, this illusion indeed vanishes if the decision about equilibrium selection is reduced to a repeated individual optimization problem. However, as our results on coordination failure show, this fact is fully compatible with powerful and persistent effects of money illusion in a strategic setting.

An important implication of the presence of money illusion is that nominal frames can have important real effects by coordinating the behavior of economic agents. Our experiment demonstrates this by examining behavior under a real and a nominal frame. The introduction of the Euro, for example, provided a natural experiment in which the nominal frame was changed. In the absence of money illusion, this change should not have affected people's behavior. Recent evidence seems to indicate, however, that the Euro changeover led to significant price changes in specific markets. For example, in January 2002, "the month-on-month increase in prices charged by restaurants and cafés in the euro area ... was more than three times higher than the average increase in the same month during the period 1996-2001... Similar price movements were noted for hairdressing … and other service items. For most of these items, price increases in the euro area were also rather high compared with those in non-euro area EU countries." (ECB 2003: 40). Adriani et al. (2003) suggest that the Euro changeover acted as a coordination device by shifting the industry to a high-price equilibrium. Empirical evidence based on data from 746 restaurants in the Michelin Red Guide 2002 and 2003 for six countries (Denmark, Sweden, UK, France, Germany, Italy) supports this conclusion. The increase was considerably higher in those countries which adopted the euro (France, Germany, Italy) than in the Non-Euro countries (Denmark, Sweden, UK).[2] This evidence is consistent with the view that purely nominal changes may have real effects because they lead to coordinated price changes.[3]

We believe that our paper also contributes to the debate about equilibrium selection principles in games with multiple equilibria. This debate has a strong focus on the principles of payoff dominance and risk dominance (Harsanyi and Selten 1988; van Huyck, Battalio and Beil 1991; Cooper et al. 1990, Cooper 1999, Camerer 2003). The principle of payoff dominance is typically interpreted as implying that equilibria, which dominate in terms of *real* payoffs, may have a particular attraction power. To our knowledge, no contributor in this debate has yet explicitly differentiated between nominal payoff dominance and real payoff dominance. The evidence presented in this paper shows, however, that this distinction is

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[2] In the three Euro countries, the most expensive restaurant items increased by 4.8%, the least expensive by 4.5%; the numbers were 0% and 0.5%, respectively in the three Non-Euro countries.

[3] The Euro changeover is, of course, a very complex natural experiment that led to many other changes as well. For example, the Euro facilitates price comparisons across national borders, probably enhancing competition and constraining price increases. However, this effect is likely to be negligible for locally traded services.

crucial. High nominal payoffs, even though associated with low real payoffs, seem to attract a considerable number of subjects. This suggests that the principle of *nominal* payoff dominance should also be taken into account in future discussions about equilibrium selection. Equilibria with high nominal payoffs may be focal points with a strong attraction power.

In the next section we describe the experimental design in more detail. Section 3 reports the results of our experiments. Section 4 summarizes our results and concludes the paper.

2. Experimental Design

To study the effects of money illusion on equilibrium selection, we designed a symmetric n-player pricing game with three Pareto-ranked equilibria. In this game, each subject simultaneously chose a price $P_i \in \{1, 2, \ldots, 30\}$. We implemented a symmetric game because we thought that this would simplify the attainment of an equilibrium. In addition, we also chose a simple payoff structure where each subjects' real payoff depended only on the subject's own price and on the average price $\bar{P}_{-i}$ of the *other* n-1 players. This was advantageous as it allowed us to represent each subject's payoff in a payoff matrix (see Appendix A). The payoff matrix showed the subject's payoff for any combination of the own price P_i and the others' average price $\bar{P}_{-i}$. Since the game was symmetric, each of the n players in the group had the same payoff table, which was common knowledge among the players.

The three equilibria of the game are described in Table 1 below. Equilibrium A arises when each subject chooses $P_A = 4$, leading to a real payoff of $\pi_A = 28$ for each player. In equilibrium B, the price is $P_B = 10$ causing a real payoff of 5. Equilibrium C arises when each subject chooses $P_C = 27$, leading to a real payoff $\pi_C = 21$. The players' best reply functions had a non-negative slope: if $\bar{P}_{-i}$ increased it was, in general, also in the interest of player i to increase his price. For every given level of $\bar{P}_{-i}$ player i had a unique best reply. Since the game is symmetric, the equilibria in this game in (P_i, $\bar{P}_{-i}$) space are located at the intersection of the best reply function with the 45-degree line. If subjects have adaptive expectations and play a best reply to their expectation, equilibrium A and C are stable, and equilibrium B is unstable.

Table 1: The equilibria in the price-setting game

Equilibrium	Equilibrium price level	Real equilibrium payoff	Nominal equilibrium payoff
A	$P_A = 4$	$\pi_A = 28$	$P_A\pi_A = 112$
B	$P_B = 10$	$\pi_B = 5$	$P_B\pi_B = 50$
C	$P_C = 27$	$\pi_C = 21$	$P_C\pi_C = 567$

Our price-setting game was implemented in four different treatment conditions (see Table 2). The treatments differed only with regard to the presentation of the payoffs and whether subjects played against other subjects or against n-1 pre-programmed computers. Individuals' real payoff functions were identical across treatments, i.e. the subjects earned the same real payoff for any combination of P_i and $\overline{P}_{-i}$, regardless of the treatment condition. Subjects' payoff matrix under the real payoff representation showed their payoff in real terms, while their payoff matrix showed their nominal payoff under the nominal payoff representation.[4] To compute the real payoff under the nominal representation, subjects had to deflate their nominal payoff by the prevailing level of $\overline{P}_{-i}$.[5] This was explained to the subjects in detail in the experimental instructions (see appendix A).

The behavioral differences across treatments with a nominal and a real payoff representation capture the effects of money illusion. Historically, economists have defined money illusion as a violation of the homogeneity postulate. According to this definition, money illusion prevails if demand and supply functions are not homogeneous of degree zero in all nominal prices (Leontief 1936). If all nominal prices change by the same percentage, people's opportunity set remains constant, so that rational individuals will make the same

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[4] Appendix A presents the payoff matrix for the real and the nominal case.

[5] We chose the average price of the other n -1 players as the deflator to make the subjects' task easier compared to the case where the overall average price of the group is the deflator. To be able to play a best reply, subjects have to predict $\overline{P}_{-i}$. Therefore, they have to deflate their nominal payoff with the predicted value of $\overline{P}_{-i}$ to compute their expected real payoff.

decisions as before the price change. Therefore, the historical definition is based on the intuition that rational individuals will make identical choices in objectively identical situations (when the objective consumption opportunities remain constant), regardless of the fact that nominal prices have changed: The nominal representation of a situation does not affect the behavior of rational individuals; if it does, individuals suffer from money illusion. In terms of our treatment conditions, this means that money illusion is absent if there are no behavioral differences across the nominal and the real payoff representation.

One main purpose of our pricing game was to create a conflict between two potentially important equilibrium selection principles – the principle of real payoff dominance and the principle of nominal payoff dominance. This conflict between nominal and real payoff dominance is illustrated in Table 1, where the real payoff is highest for every player in equilibrium A but the nominal payoff is highest in equilibrium C. In fact, the payoff vector in equilibrium A is the only Pareto efficient point in the payoff space which renders equilibrium A particularly attractive. The principle of real payoff dominance predicts that equilibrium A is selected regardless of whether payoffs are represented in nominal or in real terms because the principle assumes that subjects can pierce the veil of money under the nominal representation. In contrast, the principle of nominal payoff dominance predicts that equilibrium A is selected when payoffs are represented in real terms while equilibrium C is selected under the nominal payoff representation. If we indeed observe that players permanently coordinate on equilibrium A under the real representation and on equilibrium C under the nominal representation, we not only have evidence for the principle of nominal payoff dominance but also for the striking claim that money illusion may have permanent real effects.

When the subjects faced pre-programmed computers, we told them the computers' aggregate reply, i.e., the level of $\overline{P}_{-i}$ the computers choose for each of their feasible price choices. Thus, each subject was a "Stackelberg-leader" vis à vis the *n*-1 computers. Each computer was programmed to play a best reply to the subject's choice and to the other computers' choices. Note that since subjects' knew the computers' response to each of their feasible price choices they faced no strategic uncertainty. To maximize their payoff, they had to solve an individual optimization problem taking the computers' aggregate response into account. The treatments with computerized opponents therefore measure the extent to which subjects can solve this individual optimization problem by choosing the efficient equilibrium A.

Table 2: Experimental Design

	Payoff representation in real terms	**Payoff representation in nominal terms**
Human opponents	Real treatment with human opponents (**RH**): 13 groups with *n* human players	Nominal treatment with human opponents (**NH**): 26 groups with *n* human players
Pre-programmed computerized opponents	Real treatment with computerized opponents (**RC**): 23 groups with 1 human and *n*-1 computerized players in each group	Nominal treatment with computerized opponents (**NC**): 22 groups with 1 human and *n*-1 computerized players in each group

Table 1 demonstrates clearly that equilibrium A dominates the other two equilibria in real terms. However, subjects may not be able to play the best equilibrium immediately. They may have to discover the best equilibrium when facing human opponents, or their optimal strategy when facing computerized opponents. For this reason, we repeated the same game for 30 periods in each treatment condition. When subjects faced human opponents, the group composition remained constant throughout the 30 periods. In all conditions, subjects were informed about the actual average price of the other players, $\bar{P}_{-i}$, at the end of each period and about their own real payoff. Then they entered the next period where they again chose their prices simultaneously.

The overall purpose of our treatment conditions was to isolate the role of money illusion as an equilibrium selection device from other boundedly rational forms of equilibrium selection. The two major conditions in our design are the Real treatment with human opponents (RH) and the Nominal treatment with human opponents (NH). The difference between these two conditions demonstrates the overall effect of money illusion on equilibrium selection. Money illusion can play no role in the RH because by representing payoffs in real terms the veil of money is already lifted. Money illusion could cause behavioral effects in the NH if, for example, subjects take nominal payoffs as a proxy for real payoffs. Thus, if significantly more subjects play the efficient equilibrium in RH compared to NH, we have evidence that money illusion affects equilibrium selection.

The next task then is to examine the mechanism that leads to the selection effects of money illusion. In principle, money illusion can effect equilibrium selection in two ways. First, there may be direct effects of money illusion on equilibrium selection: subjects may play the inefficient equilibrium C because they exhibit individual-level money illusion. Second, there may be indirect effects arising from subjects' expectations about other players' money illusion. Even if no player exhibits individual-level money illusion, most subjects may nevertheless have an incentive to play the inefficient equilibrium C if they believe that a sufficient number of other players exhibit money illusion and will, therefore, play equilibrium C. Our treatments with computerized opponents enable us to isolate the extent to which individual level money illusion directly affects equilibrium selection.

In the RC, the real treatment with computerized opponents, we measure the extent to which individual-level irrationality other than money illusion affects equilibrium selection. In the RC, any deviation from the efficient equilibrium A denotes a non-optimal individual choice.[6] In the NC, subjects face an individual optimization problem under the nominal payoff representation. The difference in subjects' price choices between the RC and the NC treatment informs us to what extent individual-level money illusion contributes to mis-coordination. If fewer subjects are able to coordinate on the efficient equilibrium in the NC than in the RC, we have evidence that individual-level money illusion is a source of mis-coordination.

Finally, our design allows for two other important comparisons: first, the comparison between the RC and the RH and, second, the comparison between the NC and the NH. The difference between RC and RH measures whether individual irrationality isolated from

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[6] When we designed the pricing game it was important to ensure that the same price choices constituted an equilibrium in the treatments with computerized opponents, where subjects were "Stackelberg-leaders" vis à vis the computers, as in the treatments with human opponents, where all players simultaneously chose their prices. Since the same price choices constitute equilibria across all four treatments, we can isolate the impact of individual irrationality from the other determinants of equilibrium selection.

money illusion is magnified or mitigated by strategic interaction with human players. If, for example, subjects play the efficient equilibrium more often in the RH than in the RC, we can conclude that strategic interaction with human players weakens the impact of individual irrationality other than money illusion on equilibrium selection.

A particularly interesting result would be obtained if individual irrationalities other than money illusion played no or almost no role in RH. In this case, the total amount of mis-coordination in the NH could be attributed to the direct and indirect effects of money illusion. Moreover, the difference between NC and NH in this case can be attributed to the indirect effects of money illusion arising solely through strategic interaction with human players.[7]

The experiments were conducted with the software Z-tree (Fischbacher 1999). A total of 174 undergraduate students from the Universities of Zürich, St. Gallen, and Innsbruck participated in our sessions. On average, an experimental session lasted 45 minutes and subjects earned CHF 31.20 (≈ US $ 25). Subjects were randomly allocated to groups of $n = 5$ or $n = 6$ players. They received written instructions explaining the procedures of the experiment, and nominal or real payoff matrices depending on the treatment condition (see Appendix A). The calculation of real payoffs based on the nominal payoffs shown on the payoff matrix was carefully explained in the NC and the NH. Subjects were allowed to ask questions before the experiment started. In each period they had to choose a price $P_i \in \{1, 2, \ldots, 30\}$. In addition, they had to indicate their expectation of $\bar{P}_{-i}$ in the treatments with human opponents in each period.

3. Results

In the following we compare the results of our treatment conditions. Our main interest is focused on the comparison between the NH and the RH. We summarize this comparison in

[7] More generally, the indirect effects of money illusion can be measured by comparing the price difference between RH and RC with the price difference between NH and NC. The difference between NH and NC measures the indirect effects of all individual irrationalities because both money illusion and other individual irrationality can play a role in the nominal treatments. The difference between RH and RC measures only the indirect effects of individual irrationality that have nothing to do with money illusion. Thus, by subtracting the price difference between RH and RC, $P^{RH} - P^{RC}$, from the price difference between NH and NC, $P^{NH} - P^{NC}$, we isolate the indirect effects of money illusion on prices. Note, that if $P^{RH} - P^{RC} \leq 0$, the indirect effects of money illusion are given by $(P^{NH} - P^{NC}) - (P^{RH} - P^{RC})$ which is greater than or equal to $P^{NH} - P^{NC}$. Therefore, the whole difference between P^{NH} and P^{NC} can be attributed to the indirect effects of money illusion.

Result 1: In the Nominal treatment with human opponents (NH), the vast majority of the subjects converge to the inefficient equilibrium C, whereas almost all subjects quickly converge to the efficient equilibrium A in the Real treatment with human opponents (RH).

Figure 1 and Tables 3 and 4 provide support for Result 1. Figure 1 and Table 3 show the evolution of average prices across NH and RH. The figure illustrates that a large gap in average prices across treatments already arises in period 1 – the average price in the NH is 20.1 in the first period whereas it is 8.4 in the RH. This difference is highly significant ($p < .0001$) according to a Mann-Whitney test. Moreover, the average price quickly converges towards the efficient equilibrium $P_A = 4$ in the RH whereas a steady convergence to the inefficient equilibrium $P_C = 27$ occurs in the NH.[8] From period 4 onwards, the average price in the RH is always extremely close to $P_A = 4$ and the hypothesis that subjects play the efficient equilibrium can only be rejected (at the 10 percent significance level) in periods 1 and 2.[9]

Table 4 presents the percentage of subjects who play the efficient equilibrium. From this table it becomes transparent how radically different individuals' price choices in the NH and the RH are. Throughout the 30 periods, there is not a single case in which a subject chose the efficient equilibrium in the NH, while 64 percent of the subjects already opted for $P_A = 4$ in period 1 in the RH. From period 7 onwards more than 90 percent of the subjects chose the efficient equilibrium in the RH. In contrast, a relatively slow convergence to the inefficient equilibrium $P_C = 27$ occurs in the NH. Initially, only 18 percent of the subjects chose $P_C = 27$ but 38 percent already played this equilibrium in period 10, and reaching 68 percent in period 20 and 84 percent in period 30.

Naturally, this divergence between the NH and the RH is reflected in the real payoffs the subjects earned. Columns 5 and 6 of Table 3 show that subjects earn considerably less in

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[8] Period-wise Mann-Whitney tests with group average prices as the units of observation indicate significant differences ($p < .001$) between RH and NH in every period.

[9] This is indicated by period-wise t-tests with group average prices as the units of observation. From period 3 onwards the p-values for the null hypothesis of equilibrium play exceed the 10 percent level.

the NH than in the RH in all periods. Recall from Table 1 that the real equilibrium payoff in the efficient equilibrium is 28, while if subjects play the inefficient equilibrium C they only earn 21. There is rarely a period in which subjects do not earn at least 10 units more on average in the RH. This indicates that the mis-coordination in the NH goes beyond the fact that subjects coordinated on an inefficient equilibrium. The large payoff difference is partly caused by the larger incidence of disequilibrium play in the NH.[10]

The striking price divergence across the NH and the RH suggests that money illusion has powerful effects on equilibrium selection. The mere fact that payoffs are represented in nominal terms induces subjects to predominantly choose the equilibrium with the higher nominal but the lower real payoff. How can this fact be explained? The movement of price expectations across treatments provides a first hint (see the broken graphs in Figure 1). The average price path in both the RH and the NH closely parallels subjects' average expectations of $\overline{P}_{-i}$. Since subjects almost always played a best reply to their expectation about $\overline{P}_{-i}$ this expectation is a decisive determinant of subjects' price choices.[11] Therefore, the strong divergence of the subjects' price expectations, which was already apparent in period 1, is of great interest – they expected on average a value of 20.0 for $\overline{P}_{-i}$ in the NH, whereas they expected a value of 8.2 in the RH. Not a single subject (out of 77) expected $\overline{P}_{-i} = 4$ in period 1 in the NH and only 1 subject expected $\overline{P}_{-i} = 5$. In contrast, 48.1 percent (25 out of 52) held equilibrium expectations of $\overline{P}_{-i} = 4$ in the RH and an additional 11.5 percent (6 out of 52) expected $\overline{P}_{-i} = 5$ in period 1. These differences in expectations are highly significant (Mann-Whitney test, $p < .0001$).

So far our analysis suggests that the nominal representation of payoffs causes significantly higher price expectations, which in turn induce subjects to choose significantly higher prices in the NH. This raises the question whether there were indeed subjects who failed to see through the veil of money or whether the higher expectations in the NH were

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[10] Subjects occasionally caused disequilibrium play by choosing low prices in a deliberate attempt to push the group towards the efficient equilibrium.

[11] If a subject is uncertain about the true value of $\overline{P}_{-i}$ the calculation of the best reply requires, of course, taking the subjective distribution of $\overline{P}_{-i}$ and not only the expectation of $\overline{P}_{-i}$ into account. However, for simplicity, in the following we will use the term "best reply" in the sense of a best reply to the expectation of $\overline{P}_{-i}$.

solely rooted in subjects' beliefs about other players' money illusion. To examine the existence of individual-level illusion we turn to

Result 2: Only a minority of subjects initially plays the efficient equilibrium in the Nominal treatment with computerized opponents (NC), whereas a large majority of subjects plays the efficient equilibrium from the beginning in the Real treatment with computerized opponents (RC). However, the differences between the NC and the RC become small and insignificant over time.

We provide support for Result 2 by means of Figure 2 and Tables 3 to 5. In Figure 2, we depict the evolution of average prices in the RC and the NC. To facilitate comparison with the previously discussed treatments, we also included the average prices of the RH and the NH. Figure 2 and Table 3 show that the average price in the NC in the first 15 periods lies between 4 and 12 units higher than in the RC. Yet, the price difference diminishes to only 2-3 units from period 16 onwards. A similar picture emerges if we look at the frequency with which the efficient equilibrium is played (see Table 4). Almost two thirds of all subjects already play the efficient equilibrium in period 1 of the RC and the frequency of equilibrium play from period 10 onwards is rarely below 80 percent. In the NC, only 22.7 percent of the subjects play the efficient equilibrium in period 1 and it takes 16 periods until roughly two-thirds of the subjects play $P_A = 4$. Finally, we also conducted period-wise Mann Whitney test of the null hypothesis that subjects' price choices are identical across the RC and the NC. Table 5 indicates that the null hypothesis can be rejected for the majority of the first 15 periods. From period 16 onwards, the null hypothesis can no longer be rejected.

Thus, taken together, the evidence suggests that the nominal representation causes significantly more problems for the subjects in solving the individual optimization problem. This provides direct evidence for individual-level money illusion. Yet, over time subjects increasingly learn to see better through the veil of money and solve the optimization problem in the NC roughly in the same way as in the RC. This result seems to provide a justification for economists' reluctance to take money illusion seriously because if subjects have inexpensive individual learning opportunities, individual-level money illusion largely disappears over time. We believe, however, that this conclusion is premature because even if individual-level money illusion only exists temporarily it may nevertheless contribute to the selection of inefficient equilibria or it may strongly retard adjustment towards a unique equilibrium as shown in Fehr and Tyran (2001). The reason why the conclusion mentioned above is premature is that strategic interaction with human players may magnify individual-level irrationality. For this reason we next examine how strategic interaction in the RH affects individual irrationality other than money illusion:

Result 3: Strategic interaction with human players in the treatments with a real payoff representation increases the frequency with which the *efficient* equilibrium is played and, eventually, removes almost all inefficiencies.

Figure 2 and Table 3 show that the average price in the RC and the RH in period 1 is almost identical. After period 1, the average price quickly converges to the efficient equilibrium in the RH while it fluctuates between 2 and 4 units above the efficient equilibrium in the RC. In Table 5, we have conducted period-wise Mann Whitney tests of the null hypothesis of equal average group prices across the RC and the RH. Occasionally, the difference is significant (e.g. in periods 2, 10, and 15) but the null hypothesis cannot be rejected in most periods. Nevertheless, the relative frequency with which the efficient equilibrium is played is higher in the RH than in the RC in most periods (see Table 4). In period 1, 65.2 percent of the individuals in the RC and 63.2 percent of subjects in the RH play the efficient equilibrium but from period 5 onwards the frequency of efficient equilibrium play is always higher in the RH, reaching 98 percent in the final 4 periods. Thus, although the difference between the RC and the RH is small, it persists over time. This indicates that there is a small amount of individual-level irrationality in the RC, which is largely removed in the RH. Interestingly, when payoffs are represented in real terms strategic interactions with human players do not magnify but remove the impact of individual-level bounded rationality on mis-coordination. A possible interpretation of this result is that the imitation of other human players enhances adjustment towards the equilibrium in the RH. Recall that in the RH, most players quickly play the Pareto efficient equilibrium. This information is transmitted to the subjects at the end of each period, so that the less than fully rational subjects can easily imitate the others' behavior. Such imitation is not possible in the RC where each subject has to calculate the response of the computerized players to his or her own choice. An alternative interpretation is that rational play is easier in the RH than in the RC if the vast majority of human opponents plays the Pareto efficient equilibrium. In this case, strategic uncertainty about the others' behavior is virtually absent and it is, therefore, easy for the less intelligent players to best reply to the "given" average price of the others. Since the average price of the other (computerized) players in the RC cannot be taken as given, no such easy solution exists for the less intelligent players. In view of the fact that strategic interaction in the RH facilitates full adjustment towards the efficient equilibrium relative to the RC, a comparison of people's behavior in the NC and the NH is of interest:

Result 4: Under the nominal payoff representation, strategic interaction with human players causes a large increase in the frequency with which the *inefficient* equilibrium C is played, and it completely eliminates play of the efficient equilibrium from the beginning.

We again refer to Figure 2 and Tables 3 to 5 to support this result. Figure 2 and Table 3 indicate that the average price in the NC and the NH are relatively close together in the first two to three periods. However, whereas the average price rises steadily in the NH, it falls in the NC, generating a sharply increasing price difference. This gradual divergence in average prices is reflected in period-wise Mann Whitney tests presented in Table 5. During the first 8 periods, the null hypothesis of equal average group prices across NC and NH cannot be rejected but afterwards prices are always significantly different. The reason for the diverging price movements is that subjects learn to choose the efficient equilibrium in the NC whereas groups increasingly coordinate on the inefficient equilibrium in the NH. In the NC, the frequency of playing the *efficient* equilibrium rises from 22.7 percent in period 1 to 81.8 percent in period 30, while the frequency of playing the *inefficient* equilibrium C in the NH rises from 18.2 percent in period 1 to 84.4 percent in period 30.

In our view, the comparison between the NC and the NH is exciting because it suggests that most subjects do learn to play the efficient equilibrium when they are provided with individual learning opportunities and when they are not entrapped in the attraction power of an inefficient equilibrium. Thus, individual learning largely removes the power of the veil of money over subjects' behavior in an environment where beliefs about the opponents' money illusion are rendered irrelevant. However, when subjects play the pricing game with other humans, the level of money illusion which existed initially throws subjects in the basin of attraction of the inefficient equilibrium from which no escape seems possible. The inefficient equilibrium slowly but relentlessly attracts the subjects' behavior. This development is also associated with a shift in the relative importance of the direct and the indirect effects of money illusion. Initially, during the first few periods, the difference in prices between the NC and the NH is small, suggesting that individual-level money illusion initially dominates subjects' behavior in both treatments. Over time, individual-level illusion declines in the NC but the overall effect of money illusion nevertheless increases as indicated by the rising frequency with which the inefficient equilibrium is played in the NH. This suggests that the indirect effects of money illusion, which are caused by the effects of money illusion on subjects' price expectations, become increasingly important over time.

4. Concluding remarks

In this paper, we show that seemingly innocuous differences in the payoff representation have powerful effects on equilibrium selection. When payoffs are represented in nominal terms, 84 percent of the subjects eventually converge to a Pareto inferior equilibrium while 98 percent of the subjects finally play the Pareto efficient equilibrium under the real payoff representation. This constitutes clear and powerful evidence for the behavioral relevance of money illusion. In addition, our results suggest that nominal payoff dominance is an equilibrium selection principle which drives individuals' behavior in strategic settings. We are also able to show that the persistent effects of money illusion occur, although most individuals are eventually able to pierce the veil of money when they are given individual learning opportunities. Thus, the argument that the impact of money illusion on aggregate outcomes will eventually vanish through learning, can be seriously misleading. In our context, it is misleading because learning in strategic environments with multiple equilibria may be difficult or impossible or, if it occurs, it may be too late to have much impact on the aggregate outcome.

Finally, we believe that our experimental design can be the basis for further investigations. For example, by conducting the NC condition after the NH condition it would be possible to study whether the NH condition prevents subjects from piercing the veil of money, i.e., from learning which is the best equilibrium in real payoff terms, or whether subjects are caught in a Pareto inferior equilibrium despite the fact that they know individually what the best equilibrium is. Suppose, for example that subjects, who first experienced the NH condition, exhibit the same pattern of behavior in the subsequent NC condition as subjects who play the NC condition from the beginning. This would constitute evidence that the NH condition prevents subjects from learning to play the Pareto dominant equilibrium. Alternatively, if most subjects immediately play the Pareto dominant equilibrium in the NC condition after they coordinated on the Pareto inferior equilibrium in the NH condition, we could conclude that they have been locked in the inferior equilibrium although they were individually able to pierce the veil of money in the NH. Thus, our design could also be a useful tool in further studies of the relevance and the nature of money illusion.

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Appendix A: Instructions

[The original instructions were in German. The instructions below refer to the nominal treatment with human players (NH). The subjects received the instruction below and the nominal payoff matrix.]

Welcome to the experiment. Please read these instructions carefully. You can earn money in this experiment. During the experiment, we calculate your income in points. All points you earn during the experiment will be converted into Swiss Francs according to the exchange rate: 10 points = 0.40 Francs.

Please **do not communicate** with other participants during the experiment. Please ask us if you have questions.

This experiment has 30 periods. All participants are members of a group. Your monitor indicates the number of people in your group. You do not know who is in your group but the composition of the group remains stable throughout the experiment. Only the decisions in your group are relevant for your earnings. Decisions by other groups are irrelevant for you.

All group members are in the role of firms. In each period, all firms must **simultaneously** set a price from 1 to 30 (1 and 30 included). How much a firm earns depends on the price it chooses and on the average price all **other** firms in the group choose.

The income table shows your **nominal point income**. All firms have the same tables. *Example*: Suppose you choose a price of 15 and the other firms choose prices of 16 on average. In this case your *nominal* point income is 48 points.

For the determination of your earnings at the end of the experiment, only the real point income is relevant. This holds for all firms. To calculate your real point income from your nominal point income, you have to divide the nominal point income by the average price of other firms. Therefore, the nominal and the real point income are related as follows:

Real point income = Nominal point income / Average price of other firms

In the example above, your nominal point income is 48 points, but you **real** point income is 3 points (= 48 points / 16).

Here is how the experiment proceeds: At the beginning of each period, you choose a selling price (a number from 1 to 30) and indicate which average price of other firms you expect. At the end of each period you are informed about the actual average price of the other firms and about your actual real point income.

Do you have any questions?

The decisions of other firms

[This decision sheet was only given to subjects in the NC and the RC] In this experiment, the decisions of other firms will not be taken by other participants but by *pre-programmed computers*. These **computers choose their prices depending on your choice**. The table below shows how the computers respond to your pricing decision.

Your price choice	Average price of other (computerized) firms
1	4
2	4
3	4
4	4
5	4
6	4
7	4
8	5
9	6
10	10
11	14
12	15
13	16
14	17
15	18
16	19
17	20
18	21
19	22
20	23
21	24
22	25
23	26
24	27
25	27
26	27
27	27
28	27
29	27
30	27

Table A1: Payoff table in the nominal treatments (NH and NC)

Average price of other firms

selling price	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
1	13	11	11	15	19	15	13	12	11	10	11	12	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2	24	25	19	25	32	22	16	14	12	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
3	13	48	44	58	73	37	23	16	13	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
4	6	25	84	112	140	84	39	22	15	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
5	3	11	44	58	73	162	88	37	19	12	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
6	2	7	19	25	32	84	168	80	29	12	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
7	2	5	11	15	19	37	88	152	59	14	13	14	15	16	17	18	19	19	20	21	22	23	24	25	26	27	28	29	30	31
8	2	4	8	10	13	22	39	80	108	18	14	15	15	16	17	18	19	20	21	22	23	24	25	25	26	27	28	30	31	32
9	1	3	6	8	10	15	23	37	59	30	17	16	17	17	18	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
10	1	3	5	7	9	12	16	22	29	50	22	19	18	18	19	19	20	21	21	22	23	24	25	26	27	28	29	30	31	32
11	1	3	5	6	8	10	13	16	19	30	39	26	22	21	20	20	21	21	22	23	24	24	25	26	27	28	29	30	31	32
12	1	3	4	6	7	9	11	14	15	18	66	48	31	25	23	22	22	22	23	23	24	25	26	27	27	28	29	30	31	32
13	1	2	4	5	7	8	10	12	13	14	39	84	59	36	29	25	24	24	24	24	25	25	26	27	28	29	30	31	32	33
14	1	2	4	5	6	8	9	11	12	12	22	48	104	70	42	32	28	26	26	26	26	26	27	28	28	29	30	31	32	33
15	1	2	4	5	6	8	9	10	11	12	17	26	59	126	83	48	36	31	29	28	27	27	28	28	29	30	31	32	33	34
16	1	2	4	5	6	7	9	10	11	11	14	19	31	70	150	96	54	40	34	31	30	29	29	29	30	30	31	33	33	34
17	1	2	3	5	6	7	8	9	10	11	13	16	22	36	83	176	111	61	44	36	33	32	31	31	31	31	32	34	34	35
18	1	2	3	5	6	7	8	9	10	11	12	15	18	25	42	96	204	126	68	48	40	36	34	33	32	32	34	35	35	36
19	1	2	3	4	6	7	8	9	10	10	12	14	17	21	29	48	111	234	143	76	53	43	38	36	35	34	35	37	37	37
20	1	2	3	4	6	7	8	9	10	10	12	13	15	18	23	32	54	126	266	160	84	57	46	41	38	36	38	39	39	38
21	1	2	3	4	5	7	8	9	10	10	12	13	15	17	20	25	36	61	143	300	179	92	62	49	43	40	42	43	42	41
22	1	2	3	4	5	7	8	9	10	10	12	13	14	16	19	22	28	40	68	160	336	198	101	67	53	46	48	50	46	44
23	1	2	3	4	5	6	8	9	9	10	11	13	14	16	18	20	24	31	44	76	179	374	219	110	73	57	59	61	54	49
24	1	2	3	4	5	6	7	8	9	10	11	13	14	15	17	19	22	26	34	48	84	198	414	240	120	78	81	84	67	57
25	1	2	3	4	5	6	7	8	9	10	11	12	14	15	17	18	21	24	29	36	53	92	219	456	263	130	135	140	93	71
26	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	18	20	22	26	31	40	57	101	240	500	286	297	308	157	99
27	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	18	19	21	24	28	33	43	62	110	263	546	567	588	348	168
28	1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	19	21	23	26	30	36	46	67	120	286	297	308	667	375
29	1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	19	20	22	24	27	32	38	49	73	130	135	140	348	720
30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	20	21	23	26	29	34	41	53	78	81	84	157	375

Table A2: Payoff table in the real treatments (RH and RC)

	Average price of other firms																													
selling price	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
1	13	6	4	4	4	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	24	13	6	6	6	4	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	13	24	15	15	15	6	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	6	13	28	28	28	14	6	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	3	6	15	15	15	27	13	5	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	2	4	6	6	6	14	24	10	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	2	3	4	4	4	6	13	19	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	2	2	3	3	3	4	6	10	12	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	1	2	2	2	2	3	3	5	7	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	2	2	2	2	2	2	3	3	5	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	1	2	2	2	2	2	2	2	2	3	4	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	2	1	2	1	2	2	2	2	2	6	4	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	2	1	1	4	7	5	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	2	4	8	5	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	2	2	5	9	6	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	2	2	5	10	6	3	2	2	2	1	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	2	3	6	11	7	3	2	2	2	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3	6	12	7	4	2	2	2	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	7	13	8	4	3	2	2	2	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	7	14	8	4	3	2	2	2	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	8	15	9	4	3	2	2	2	2	2	1	1
22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	4	8	16	9	4	3	2	2	2	2	2	1
23	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	4	9	17	10	5	3	2	2	2	2	2
24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	4	9	18	10	5	3	3	3	2	2
25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	4	10	19	11	5	5	5	3	2
26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	4	10	20	11	11	11	5	3
27	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	5	11	21	21	21	12	6
28	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	5	11	11	11	23	13
29	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	5	5	5	12	24
30	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	3	3	5	13

Appendix B - Functional Specification of Payoffs

The real payoff function for all players *i* is:

$$\pi_i = 1 + \frac{H}{1 + (P_i - P_i^*)^2}$$

The table below shows the best reply P_i^* for player *i* and the parameter H for every feasible average price of the other players $\overline{P}_{-i}$. Note that P_k, $k \in$ {A, B, C}, is the price in equilibrium A, B, or C, respectively. π_k, $k \in$ {A, B, C}, is the real profit in equilibrium A, B, or C, respectively. Recall from Table 1 that $P_A = 4$, $P_B = 10$, $P_C = 27$, $\pi_A = 28$, $\pi_B = 5$ and $\pi_C = 21$. For example, if $\overline{P}_{-i}$ is below $P_A - 1$, player *i*'s best reply is given by $\overline{P}_{-i} + 1$ and H = $\pi_A - 5$. The real payoff matrix is based on the payoff function above but all numbers in the matrix are rounded to integers.

Table B1: Real payoffs

If the average price of other firms is in the range	player *i*'s best reply P_i^* is given by	and the parameter *H* is given by
$\overline{P}_{-i} < P_A - 1$	$\overline{P}_{-i} + 1$	$\pi_A - 5$
$P_A - 1 \le \overline{P}_{-i} \le P_A + 1$	P_A	$\pi_A - 1$
$P_A + 1 < \overline{P}_{-i} < P_B$	$\overline{P}_{-i} - 1$	$2 + \alpha\overline{P}_{-i}$
$\overline{P}_{-i} = P_B$	P_B	$\pi_B - 1$
$P_B < \overline{P}_{-i} < P_C - 1$	$\overline{P}_{-i} + 1$	$4 - \alpha$
$P_C - 1 \le \overline{P}_{-i} \le P_C + 1$	P_C	$\pi_C - 1$
$\overline{P}_{-i} > P_C + 1$	$\overline{P}_{-i} - 1$	$3 - \alpha$
		where: $\alpha = 10 - \overline{P}_{-i}$

Table 3: Evolution of Prices and Real Payoffs over Time

	Average Price				Average real payoff			
	Human opponents		Computerized opponents		Human opponents		Computerized opponents	
period	Real (RH)	Nominal (NH)	Real (RC)	Nominal (NC)	Real (RH)	Nominal (NH)	Real (RC)	Nominal (NC)
1	8.4	20.1	8.3	17.3	8.9	2.9	21.3	13.1
2	6.6	20.9	7.4	19.0	13.9	5.3	22.3	15.5
3	5.2	21.9	7.3	18.3	19.5	6.3	21.7	15.3
4	4.6	22.2	7.7	17.3	22.5	6.0	25.4	18.1
5	4.1	22.7	8.9	15.5	24.0	6.7	25.5	21.8
6	4.0	23.1	9.0	14.4	25.1	8.0	23.8	21.4
7	3.9	23.4	6.0	15.3	26.6	10.6	26.8	22.6
8	4.1	23.9	6.0	14.4	25.4	10.9	25.5	23.9
9	4.3	23.9	7.0	11.6	24.7	11.4	27.1	22.1
10	4.4	24.0	9.7	12.5	24.0	12.3	23.8	23.1
11	4.0	24.1	6.8	12.4	26.5	11.5	25.4	24.1
12	4.0	24.0	6.0	12.3	27.1	11.9	26.8	23.1
13	4.4	24.1	7.2	12.8	24.4	13.6	25.1	23.6
14	4.9	24.2	7.0	12.5	21.6	13.5	25.7	24.5
15	3.9	24.1	5.1	13.4	26.9	14.1	26.6	25.1
16	3.9	24.5	6.8	10.5	26.3	15.4	25.7	24.6
17	3.9	25.1	6.0	8.6	26.9	15.1	26.4	24.5
18	4.2	24.9	8.0	9.2	25.4	13.8	26.3	26.4
19	3.9	25.3	7.3	9.2	26.7	15.2	25.0	25.2
20	3.9	26.0	6.0	9.3	27.3	16.9	26.8	26.0
21	4.0	25.1	6.0	9.7	27.1	13.6	26.0	24.7
22	3.9	26.1	7.0	9.6	27.0	16.0	27.0	23.6
23	4.0	26.4	6.0	7.9	27.1	16.9	26.7	24.5
24	4.0	26.6	7.0	8.7	26.8	15.3	27.0	25.4
25	3.9	27.1	6.0	8.2	27.1	17.2	26.7	24.1
26	4.0	27.2	6.0	8.0	27.3	19.1	27.4	26.7
27	3.9	27.1	6.0	8.1	27.5	19.4	27.4	25.9
28	3.9	26.7	8.0	8.2	27.5	18.0	27.0	26.3
29	3.9	26.8	6.0	8.3	27.5	18.4	26.8	26.7
30	3.9	26.4	7.0	8.2	27.5	17.8	27.4	25.9

Table 4: Percentage of subjects choosing the efficient equilibrium

period	Human opponents		Computerized opponents	
	Real (RH)	Nominal (NH)	Real (RC)	Nominal (NC)
1	63.5	0.0 (18.2)*	65.2	22.7
2	59.6	0.0 (9.1)	69.6	22.7
3	65.4	0.0 (10.4)	65.2	27.3
4	78.8	0.0 (14.3)	78.3	31.8
5	80.8	0.0 (14.3)	73.9	45.5
6	86.5	0.0 (15.6)	69.6	45.5
7	94.2	0.0 (26.0)	87.0	45.5
8	92.3	0.0 (28.6)	82.6	54.5
9	94.2	0.0 (33.8)	87.0	54.5
10	92.3	0.0 (37.7)	69.6	59.1
11	92.3	0.0 (42.9)	82.6	63.6
12	96.2	0.0 (48.1)	87.0	59.1
13	92.3	0.0 (46.8)	78.3	59.1
14	92.3	0.0 (50.6)	82.6	63.6
15	94.2	0.0 (48.1)	87.0	59.1
16	90.4	0.0 (49.4)	82.6	68.2
17	94.2	0.0 (57.1)	87.0	72.7
18	94.2	0.0 (58.4)	82.6	77.3
19	94.2	0.0 (59.7)	73.9	77.3
20	96.2	0.0 (67.5)	87.0	77.3
21	96.2	0.0 (61.0)	91.3	72.7
22	94.2	0.0 (66.2)	87.0	72.7
23	96.2	0.0 (70.1)	91.3	81.8
24	94.2	0.0 (68.8)	87.0	72.7
25	96.2	0.0 (71.4)	91.3	81.8
26	96.2	0.0 (85.7)	91.3	81.8
27	98.1	0.0 (89.6)	91.3	81.8
28	98.1	0.0 (85.7)	82.6	81.8
29	98.1	0.0 (83.1)	91.3	81.8
30	98.1	0.0 (84.4)	82.6	81.8

* Numbers in parentheses denote the percentage of subjects playing the inefficient equilibrium C.

Table 5: Statistical significance of treatment differences

period	RC vs. NC	RC vs. RH	NC vs. NH
1	0.013	0.077	0.609
2	0.001	0.018	0.401
3	0.005	0.491	0.951
4	0.009	0.123	0.950
5	0.061	0.154	0.531
6	0.104	0.248	0.192
7	0.003	0.145	0.603
8	0.018	0.641	0.295
9	0.110	0.771	0.005
10	0.363	0.038	0.019
11	0.031	0.978	0.033
12	0.014	0.754	0.006
13	0.161	0.095	0.015
14	0.114	0.348	0.006
15	0.019	0.028	0.015
16	0.221	0.042	0.002
17	0.101	0.117	0.000
18	0.601	0.244	0.000
19	0.629	0.285	0.000
20	0.339	0.084	0.000
21	0.125	0.490	0.001
22	0.313	0.028	0.000
23	0.420	0.490	0.000
24	0.290	0.346	0.000
25	0.355	0.032	0.000
26	0.376	0.490	0.000
27	0.408	0.107	0.000
28	0.945	0.063	0.000
29	0.336	0.107	0.000
30	0.838	0.064	0.000

Table 5 reports two-tailed p-values of Mann Whitney tests of the null hypothesis that average prices are equal across the corresponding treatments. Average group prices are the independent units of observation.

Figure 1: Average prices and expectations in the treatments with human opponents

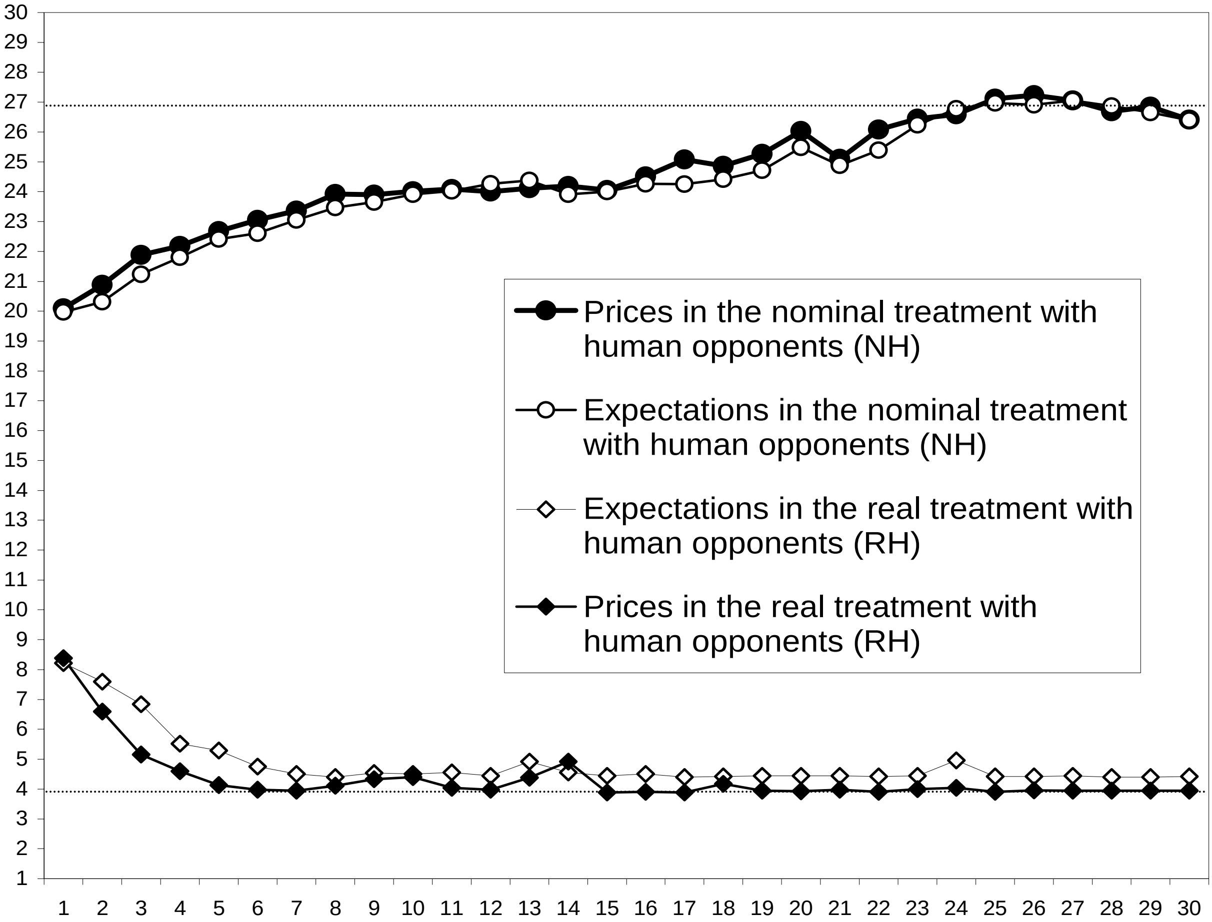

Figure 2: Average prices across all treatments