Compromise and Coordination: An Experimental Study*

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Abstract

This paper experimentally studies the role of a compromise option in a repeated battle-of-the-sexes game. We find that in a random-matching environment, compromise serves as an effective focal point and facilitates coordination, but fails to improve efficiency. However, in a fixed-partnership environment, compromise deters subjects from learning to play alternation, a more efficient but also arguably more complex strategy. As a result, compromise hurts efficiency by allowing subjects to coordinate on the less efficient outcome. In a follow-up experiment, we find that many compromisers switch to alternate after they play the repeated game for multiple times. The evidence suggests that the subjects teach and learn from each other to use the alternation strategy.

Keywords: Compromise, Battle-of-the-Sexes, Repeated games, Behavioral game theory, Experimental economics.

JEL codes: C72, C92.

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1 Introduction

Coordination problems are prevalent in economics and coordination is especially hard to achieve when there exist conflicts of interests. When such conflicts are difficult to resolve given the available options, some people may seek for compromise options, while others may try to come up with some more effective ways of conflict resolutions. For example, a new couple who have different tastes for food may go to a restaurant that is not necessarily any of their favorites but definitely acceptable for their first date. However, when their relationship becomes stable, taking turn to dine at their respectively favorite restaurants seems to be a better idea. Another analogue example involves firms biding for government contract. If the government contract is offered only once, settling on a low bid that grants each firm an equal chance to win may be acceptable. However, when the government has a long term demand from these firms, they can instead coordinate some price conspiracy by taking turn to bid lower that the others.[1]

A compromise option naturally serves as a focal point (Schelling (1960)) for coordination.[2] First, it alleviates conflicts of interests. By coordinating on a compromise option, people can effectively avoid coordination failures and no one runs the risk of living with their least favorite options. Second, it features more equal payoffs across different parties. Hence, it is potentially favored by fair-minded players. The focality of a compromise option is found to be very effective in short-term interactions. Recently, Jackson and Xing (2014) experimentally study a variant of a battle-of-the-sexes game featuring two equilibria with highly asymmetric payoffs and another equilibrium with symmetric payoffs but a slightly lower total payoff. They find that the majority of the subjects choose to play the one with symmetric and inefficient outcome in one-shot interaction, even though there are variations across cultures. In a more recent laboratory experiment, Bett et al. (2016) find that subjects tend to choose a symmetric but strictly dominated option to avoid coordination failure in a one-shot battle-of-the-sexes game with a third option.

While a compromise option may serve as an effective coordination device in the short run, it is unknown how the presence of it may affect people's decisions in the long run. Coordination games in repeated interactions distinguish themselves from the ones in

[1] See Armentano (1994) for a discussion on the infamous "phase of the moon" conspiracy used by General Electric, Westinghouse, Allis-Chalmers, and I-T-E in the 1960s. We thank Glen Waddell and the 2018 PhD class at the University of Oregon for suggesting this example.

[2] See Crawford and Haller (1990), Mehta et al. (1994) and Crawford et al. (2008) for studies on focal points in coordination games.

one-shot interactions, as people can rely on past interactions as their coordination device.[3] Therefore, the effect of the compromise options in such settings become naturally more complicated. Would a compromise option retain its focality in repeated interactions? Would it help people to coordinate better or worse? Would people achieve a higher or lower long-run payoff? To our limited knowledge, few papers have investigated these questions in the literature. The current paper serves as an attempt.

We employ a two by two experimental design: 1) Subjects repeatedly play 30 rounds of either a standard 2×2 battle-of-the-sexes game or a 3×3 variant of the game with an additional compromise option, which is similar to the one studied in Jackson and Xing (2014). There are two highly asymmetric pure strategy Nash equilibria and one symmetric but less efficient pure strategy Nash equilibrium. 2) At the beginning of the experiment, subjects are permanently assigned to either a group of six, in which the members are randomly matched in pairs in each round (random matching), or to a group of two (fixed matching) in which the same persons are matched in each round. The comparison between the two games allows us to investigate how the compromise option would affect the subjects' behavior; the comparison between the two matching settings enables us to understand the role of compromise in a stranger environment and in a fixed-partnership environment, respectively.

We first find that under the random matching setting, most groups fail to coordinate better than chance in the 2×2 game. On the contrary, most groups choose to coordinate on the compromise option in the 3×3 game. This result demonstrates that the compromise option serves as a focal point in repeated interactions if people cannot form stable partnerships. However, we do not find significant improvement in terms of average payoff when the compromise option is available because those who fail to compromise earn a relatively low payoff that offsets the payoff advantage gained by the compromisers.

Second, we find that under the fixed matching setting, a majority of the groups learn to coordinate on a pattern of alternation between the two asymmetric pure Nash equilibria in the 2×2 game. This result confirms both the theoretical and experimental literature on alternating behavior in repeated games (see Bhaskar 2000, Lau and Mui 2008, Lau and Mui 2012, Kuzmics et al. 2014, Cason et al. 2013, Duffy et al. 2017, Romero and Zhang 2017,

[3]See Crawford and Haller (1990), Blume and Gneezy (2000), Lau and Mui (2008), among others, for studies on how past behaviors affect future actions.

Arifovic and Ledyard 2018, Sibly and Tisdell 2018, among many others).[4, 5] On the other hand, a mix of alternation and coordinating on the compromise option is observed in the 3×3 game. There is no significant difference between the coordination rates across the two games. However, the payoff earned by the subjects in the 3×3 game is significantly lower than that in the 2×2 game because coordinating on the compromise option is less efficient than alternation. To summarize, when people are in stable partnerships, a compromise option may disturb their learning process towards adopting the more efficient strategy of alternation. The compromisers seem to be short-sighted, compromise too early and give up long-term gains.

To further understand the rationale behind the main findings in the fixed matching settings, we run another experiment to investigate the behavior pattern when subjects have a chance to learn in a longer time span. In this follow-up experiment, subjects play the 30-round 3x3 game (refereed as a 'supergame') for four times with four different partners. We find that across supergames, the alternation strategy becomes more prevalent, crowding out the use of the compromise strategy. As a result, the average payoff increases over supergames. Moreover, we find that when a subject has past experiences with alternation, she always results in alternation in the subsequent supergames, even if she meets someone who only has experiences in compromising. We further look at those who only have experiences in compromising in early supergames, but manage to alternate in later supergames. We find that some learn alternation from their opponents, as they always choose the compromise option, but start to alternate only after they observe that their opponents alternate in a new supergame. The remaining subjects figure out the alternation strategy by themselves (they initiate to alternate for a few rounds), but eventually compromise in a supergame as it is a safer strategy; when they eventually meet someone who is willing to lead to alternate, they immediately follow. Therefore, the evidence suggests that both teaching and learning as well the reduction of strategic uncertainty over supergames explain why more subjects alternate when they gain experiences in playing the repeated game.

The paper is organized as follows. Section 2 introduces the experimental design, procedures and hypotheses. Section 3 provides the results. Section 4 presents the design

[4]While most of these papers study repeated coordination games, Cason et al. (2013) and Sibly and Tisdell (2018) use repeated games where the efficient outcomes are not stage game Nash equilibria.

[5]Note that Arifovic and Ledyard (2018) adopts an interesting perspective by using simulations to show that individual evolutionary learning (IEL) can well explain human behavior in repeated 2×2 battle-of-the-sexes games.

and results for a follow-up experiment. Section 5 explores the theoretical foundations and some alternative explanations for the hypotheses and the findings. Section 6 concludes.

2 Experimental Design, Procedures and Hypotheses

2.1 Treatment design

In the experiment, we implement the payoff matrices of Figure 1. Payoffs are presented in experimental currency. Figure 1A presents the payoffs of the specific 2×2 Battle-of-the-Sexes game and Figure 1B presents the 3×3 Battle-of-the-Sexes game with a compromise option. In both games, we keep the payoffs under actions X and Y constant. Both players always receive zero payoffs if they choose differently. The row player prefers coordinating on (X, X) and the column player prefers coordinating on (Y, Y). For the 3×3 game, an additional action Z is added to the 2×2 game, and both players receive an equal payoff of 100 if both choose Z. Note that (Z, Z) is the only outcome that yields the same payoff for both players, yet the total payoffs of (Z, Z) is lower than that of (X, X) or (Y, Y). Thus we call this option a "compromise", as it yields a fair outcome with an efficiency loss.

Figure 1: Payoff structures

	X	Y
X	250,50	0,0
Y	0,0	50,250

A: 2×2 **game**

	X	Y	Z
X	250,50	0,0	0,0
Y	0,0	50,250	0,0
Z	0,0	0,0	100,100

B: 3×3 **game**

To investigate the effect of the compromise option, we first vary the game subjects play in the experiment. Subjects are either presented with the game in Figure 1A, or with the game in Figure 1B. Before two players are matched to play one of the two games, they are informed about their preferences. Exactly one of them has the preference of the row player, and the other has the preference of the column player. The preference of each subject is kept fixed during the entire experiment.

To see how partnership interacts with the effect of the compromise option, we also vary the matching protocols. In a repeated play of 30 rounds, subjects are either in a random matching or a fixed matching condition. In the random matching condition, subjects are assigned in a fixed group of six. Half of the group are given the preference of the row player and the other half are given the preference of the column one. In each round, the row players and column players from the same matching group are randomly matched into pairs to play one of the games. Thus, subjects cannot form a long-term partnership with any of the players in their matching group, as they would not be able to identify each other. In the fixed matching condition, subjects are in a group of two. Similarly, one either has the preference of the row player or the column one. In contrast to the random matching condition, subjects in this condition naturally form a long-term partnership and can rely on past interactions to build future strategies. At the end of each round, each subject receives feedback about the action of her opponent and her own payoff. In order to minimize group effect, subjects are not provided with the decisions of the entire group in the random matching condition.

Each subject participates in only one of the treatments: one plays the 2×2 or the 3×3 game, either under random matching or fixed matching. This gives us a 2×2 between-subject design. Table 1 summarizes the treatments.

Table 1: Treatments overview

	Random matching	Fixed matching
2×2 game	R-2	F-2
3×3 game	R-3	F-3

Notes: Each cell displays the abbreviation of each treatment.

At the end of the experiment, we elicit subjects' risk attitudes using a simple task as Eckel and Grossman (2008) and add one option to capture risk-seeking behavior. In this method, a subject makes a choice among six coin-flip gambles that vary in the degree of risk and expected value. Gamble 1 will be chosen by risk-seeking subjects, gamble 2 by risk-neutral subjects, and gambles 3-6 by risk averse subjects with enhancing levels of risk aversion. Overall, a higher number in the gamble choice task indicates a higher level of risk aversion. The details of the risk-elicitation task are provided in Appendix A.

2.2 Procedures

The experiment was conducted at the Shanghai University of Finance and Economics. Chinese subjects were recruited from the subjects pool of the Economic Lab. We ran 9 sessions in total, treatments were randomized at the session level. In each session, we ran two different treatments. For each treatment, we ran 4 or 5 sessions. We had 10 or 11 independent matching groups under random matching, and 20 or 21 matching groups under fixed matching. In total 208 subjects were recruited, most of whom were undergraduate students from various fields of studies. Table 2 presents the number of subjects, the number of independent matching groups and the number of sessions in each treatment.

Table 2: Summary of subjects

Treatments	No. of subjects	No. of groups	No. of sessions
R-2	60	10	4
R-3	66	11	5
F-2	42	21	4
F-3	40	20	5
Total	208	62	9

The experiment was computerized using z-Tree and was conducted in Chinese.[6] Upon arrival, subjects were randomly assigned a card indicating their table number and were seated in the corresponding cubicle. Before the experiment started, subjects read and signed a consent letter to agree to participate in the experiment. All instructions were displayed on their computer screens. Control questions were conducted to check their understanding of the instructions. The same experimenters were always presented during all the experimental sessions.

After finishing the experiment, subjects received their earnings in cash privately. Average earnings were ¥45 (equivalent to around 7 US dollars). Each session lasted between 40 to 60 minutes.

2.3 Hypotheses

We are interested in testing three hypotheses in the experiment. First of all, we expect that under random matching, the compromise option serves as an effective focal point for coordination as found in the one-shot experiments in the literature such as Jackson and Xing (2014) and Bett et al. (2016). In addition, reducing coordination failures should also help to improve efficiency, as only coordination yields positive payoffs.

[6]The English translations are provided in Appendix A.

Hypothesis 1. Under random matching, the compromise option improves coordination and efficiency.

Second, we expect that under fixed matching, subjects are able to learn an efficient strategy in the 2×2 game, which leads to alternation between the two pure Nash equilibria.[7] We also expect that whenever the compromise option is available, it may deter subjects from learning the more sophisticated strategy of alternation given that the compromise option is simpler and that it results in instant coordination success. We will provide a theoretical foundation for the above two conjectures in Section 5.1 by drawing insights from the literature of optimal learning initiated by Crawford and Haller (1990).

Note that alternation between the two pure Nash equilibria in the 2×2 game yields an average payoff of 150, while the compromise option in the 3×3 game gives each subject 100 in each round. Therefore, although introducing the compromise option may not change the rate of coordination (some subjects may switch from coordinating on alternation to coordinating on compromise), it can lower subjects' payoffs.

Hypothesis 2. Under fixed matching, the compromise option does not reduce the rate of coordination, but hurts efficiency.

Third, we wish to understand the difference between the two matching protocols. Contrasting to fixed matching, random matching effectively resembles a stranger environment in which subjects cannot form long-run partnerships and consequently are unable to learn more sophisticated strategies like alternation as in the case of fixed matching. Therefore, we expect that subjects can coordinate more successfully on better equilibria and earn a higher payoff under fixed matching than under random matching.

Hypothesis 3. In both games, fixed matching weakly improves efficiency.

[7]See Bhaskar (2000) and Kuzmics et al. (2014) for a theoretical foundation for efficient strategy in symmetric coordination games with conflicts of interests. Also, turn taking strategy can be supported in subgame perfect equilibria as shown in Lau and Mui (2008) and Lau and Mui (2012).

3 Results

3.1 Behavior in the 2×2 Battle-of-the-Sexes game

In the 2×2 Battle-of-the-Sexes game with random matching treatment (R-2), each subject meets one of the subjects in the matching group in every new round to play the game. In the stage game, there are two asymmetric pure strategy Nash equilibria with reversed payoffs for the two players, (X, X) and (Y, Y). Most of the ten matching groups fail to converge to any of the two asymmetric Nash equilibria or any other coordination pattern.[8]

This result is not surprising as subjects have no obvious ways to coordinate on one of the two asymmetric equilibria. In a one-shot Battle-of-the-Sexes, standard theory predicts that subjects will use a mixed strategy. In the mixed strategy equilibrium, subjects choose the action corresponding to their favorite outcomes with a frequency of 0.83 and the other action with a rate of 0.17.[9] However, in our experiment, subjects choose the former action with a rate of 0.65, which is well below the prediction (sign-rank test, $p < 0.01$). Moreover, this rate is also well above half (sign-rank test, $p < 0.01$), suggesting that the subjects are not using a naive randomizing strategy either.

This result serves as a benchmark of our experiment. It shows that without the possibility of forming long-run partnership or having the compromise option, subjects cannot coordinate better than chance in a Battle-of-the-Sexes game.

Result 1. *In R-2, subjects use a mixed strategy as there is no other effective ways of achieving coordination success.*

In the Battle-of-the-Sexes game with fixed matching treatment (F-2), there exhibits a very different behavior pattern compared with that in R-2. Most of the pairs (16 out of 21) use some alternation strategies to maximize both coordination rate and total payoffs.[10] In an alternation strategy, two opponents with different preferences alternate between each of their favorite outcomes. Two examples of such alternation strategies are shown in

[8] The coordination rate over time in each matching group is shown in Figure 9 in Appendix B. As can be seen, only group 2 exhibits a pattern to coordinate better over time, this might be caused by a relatively the small group size (6 subjects in each group) so that subjects are able to converge to one of the two asymmetric equilibria.

[9] $0.83 = \frac{250}{250+50}$, $0.17 = \frac{50}{250+50}$.

[10] Among the other five pairs, three fail to coordinate, two converge to one of the two asymmetric equilibria. Group level data can be found in Figure 11 in Appendix B.

Figure 2. As can be seen in the left panel of Figure 2, after about 10 rounds, two players alternate between their favorite outcomes every round. By contrast, in the right panel of Figure 2, after about 5 rounds, two player alternate between their favorite outcomes by every multiple rounds. These examples suggest that subjects are not only able to use an alternation strategy, but can use it in a more complex manner. These results confirm the experimental findings of the alternation strategies in repeated Battle-of-the-Sexes game (e.g. Cason et al. 2013, Duffy et al. 2017).

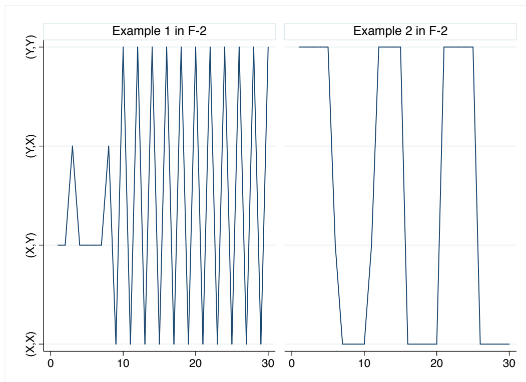

Figure 2: Examples of behavior patterns in F-2. The x-axis is the round number. The y-axis is the outcome distribution, in the order of (X,X), (X,Y), (Y,X) and (Y,Y), from bottom to top.

The advantage of the alternation strategy is twofold: First, it yields the highest total payoff that can be achieved in such a repeated-game setting; second, it gives each player an equal payoff once the alternating pattern is established. This treatment therefore shows how long-run partnership solves the coordination problem.

Result 2. *In F-2, subjects use an alternation strategy to achieve coordination success.*

3.2 Behavior in the 3×3 game with the compromise option

In the treatment of 3×3 Battle-of-the-Sexes game with the compromise option and under random matching (R-3), in the stage game there are two asymmetric pure strategy equilibria (X,X) and (Y,Y) and one symmetric pure strategy Nash equilibrium (Z,Z). Among the eleven matching groups, nine groups converge to playing the symmetric equilibrium while the other two groups fail to do so.[11]

This result suggests that subjects rely on the compromise option to solve the coordination problem otherwise presented in the 2×2 Battle-of-the-Sexes game. They quickly learn to use the compromise option exclusively and abandon using the other two actions. This provides clear evidence that among the three equilibria the symmetric one stands out as the focal point. This finding confirms and further strengthens the experimental findings of Jackson and Xing (2014) and Bett et al. (2016), as they only find in a one-shot setup that the symmetric but less efficient equilibrium is most often selected.

Result 3. *In R-3, subjects use the compromise option to achieve coordination success.*

In the treatment of 3×3 game with the compromise option and under fixed matching (F-3), there exists a distinct behavior pattern compared with that in R-3. While many of the pairs (9 out of 20) use a similar alternation strategy as in F-2, a significant number of pairs (7 out of 20) converge to the symmetric equilibrium.[12]

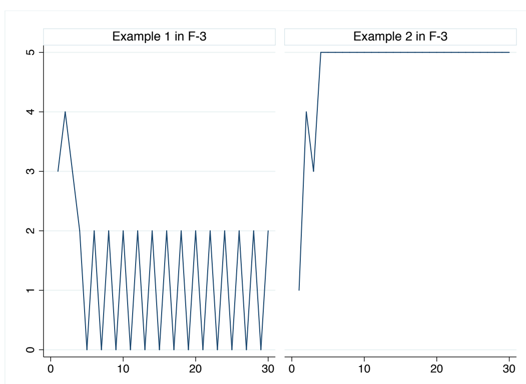

Figure 3: Examples of behavior patterns in F-3. The x-axis is the round number. The y-axis is the outcome distribution, and number 0-5 indicates (X,X), (X,Y) or (Y,X), (Y,Y), (X,Z) or (Z,X), (Y,Z) or (Z,Y), and (Z,Z), respectively.

[11] The compromise rate over time in each matching group is shown in Figure 10 in Appendix B. As can be seen, only group 7 and group 16 fail to exhibit a pattern of converging to compromise over time. Sign-rank tests reports that the compromise rates in the last 15 rounds of these nine groups are not statistically different from 0.95 at a 10 percent level.

[12] Among the other four pairs, three fail to converge to any pattern, and one group converges to a non-equilibrium outcome (X,Y).

This result is intriguing. Subjects fall into two distinct behavior patterns: As shown in the left panel of Figure 3, in the alternating pattern subjects play the game as if the compromise option is not presented; as displayed in the right panel of Figure 3, in the compromise pattern subjects play the game in a similar manner as in R-3.

Compared with R-3, the focality of the compromise option is diminished in F-3. Yet, compared with F-2, its focality still persists and partially crowds out the use of the alternation strategy.

Given that subjects fall into two categories according to the strategies they use, it is natural to ask which strategy actually gives a higher payoff. Subjects earn 130 or 92 respectively, when using the alternation or the compromise strategy (Mann-Whitney test, $p < 0.001$, using group level data as per observation).[13] That is, alternation yields a higher return than compromise.

Result 4. *In F-3, subjects either use the alternation strategy or the compromise strategy to achieve coordination success.*

3.3 The effect of the compromise option on coordination

In this section we move to analysis at the treatment level. First, we investigate the effect of the compromise option on coordination. Figure 4 shows the average coordination rate in each treatment. It can be seen that while the overall coordination rate is 0.53 in treatment R-2, it is much higher in the other three treatments (0.75 in R-3, 0.80 in F-2 and 0.80 in F-3). Mann-Whitney tests show that the coordination rate in R-2 is significantly lower than the other three treatments ($p < 0.05$), while the other three are not statistically different.

How often do subjects use the compromise option? As is shown in Table 3, under random matching, subjects use the compromise option 83% of the time overall, and this rate is increased to 88% in the last 15 rounds. This observation suggests that subjects learn to use the compromise option most of the time to avoid coordination failure. Under fixed matching, subjects use the compromise option 43% of the time overall, and 39% of the time in the last 15 rounds. Although this option is not as frequently used as in random matching, it remains the most attractive option among the three. In treatments with the 2×2 game, subjects prevalently alternate between actions X and Y, resulting in a balanced choice distribution.

[13]The average payoffs are higher for both types in the last 20 rounds, which are 146 and 98 respectively.

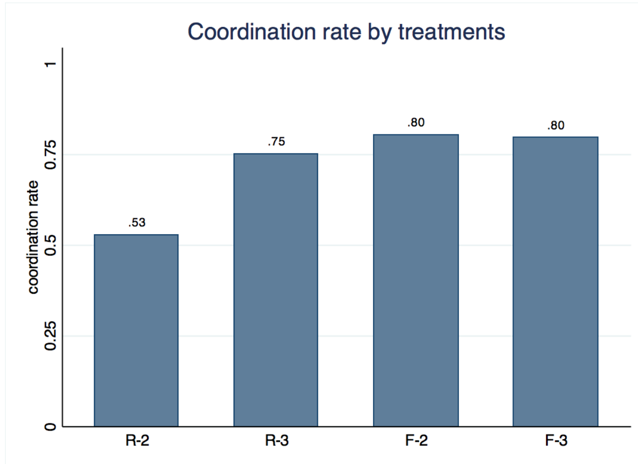

Figure 4: All-rounds average coordination rate by treatment.

Does it take longer to establish an alternating pattern in F-3 than in F-2? By looking at the pairs who eventually use the alternation strategy, we find that on average it takes 4.25 rounds for an alternating pattern to be established in F-2, while it takes 6.44 rounds in F-3 ($p = 0.127$, two sided Mann-Whitney test). Therefore, the presence of the compromise option weakly increases the number of rounds it takes for the subjects to converge to alternation, though the difference is insignificant.

Table 3: Choice distribution in each treatment

Treatment	Rounds 1-30			Rounds 16-30		
	Favorite	Preferred	Compromise	Favorite	Preferred	Compromise
R-2	0.65	0.35	–	0.63	0.37	–
R-3	0.12	0.04	0.83	0.09	0.03	0.88
F-2	0.56	0.44	–	0.54	0.45	–
F-3	0.32	0.25	0.43	0.34	0.27	0.39

Notes: Here, "favorite" is the action of one's favorite equilibrium, "preferred" is the action of one's least attractive equilibrium, and "compromise" is the action of the symmetric equilibrium. Each cell displays the rate of each action.

Result 5. *Under random matching, the compromise option serves as a focal point and facilitates coordination. Under fixed matching, the compromise option partially crowds out the use of the alternation strategy and induces the use of compromise as a coordination strategy.*

Overall, the effect of the compromise option depends on the matching protocol. Under random matching, it is evident that the compromise option largely improves coordination. The mechanism is that the compromise option stands out among other actions and becomes the focal point. By choosing to compromise, the coordination problem is largely resolved. This supports Hypothesis 1 in terms of coordination. By contrast, under fixed matching, the compromise option partially crowds out the use of the alternation strategy. Yet, coordination failure still exists in some groups. As a result, the overall coordination remains intact. This supports Hypothesis 2 in terms of coordination.

3.4 The effect of the compromise option on efficiency

In this section, we investigate the effect of the compromise option on efficiency. In both games, the maximal efficiency is achieved at one of the asymmetric equilibria, and is a constant. Therefore, we can simply measure efficiency by the average payoffs of the subjects in all treatments.[14]

Figure 5 shows the all-rounds average individual payoffs in each treatment. Under random matching, subjects in R-2 earn 79.3 on average, while subjects in R-3 earn 76.0 on average (Mann-Whitney test, $p = 0.832$). Under fixed matching, subjects in F-2 receive a significantly higher payoffs than subjects in F-3 (120.7 versus 101.4, Mann-Whitney test, $p < 0.05$). These results suggest that the effect of compromise on efficiency are neutral at its best: Though imposing no effect under random matching, it hurts efficiency under fixed matching.

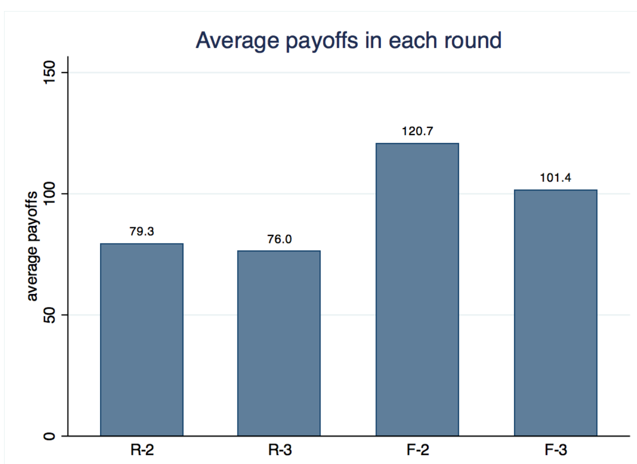

Figure 5: All-rounds average payoffs by treatment.

[14]We can also measure efficiency by the average payoffs divided by the maximal payoffs.

What are the underlying mechanism for such a neutral or even negative effect? Since subjects in each treatment adopt different strategies over time, we turn to look at the average payoffs for each type of the strategies. According to the group level analysis in section 3.1 and 3.2, we group strategies into three categories. First, the "alternation" strategy refers that a pair of subjects alternate between achieving each of their favorite outcomes. Second, the "compromise" strategy refers that a group or a pair of subjects choose the compromise option and achieve the symmetric outcome. Third, the "asymmetric" strategy refers that a group or a pair of subjects converge to one of the asymmetric equilibria. Finally, "none" refers that a group or a pair of subjects fail to converge to any of these successful strategies.[15]

Table 4: Payoffs by type of strategy in each treatment

Treatment	Rounds 16-30			
	Alternation	Compromise	Asymmetric	None
R-2	–	–	127 (n=1)	81 (n=9)
R-3	–	95 (n=9)	–	32 (n=2)
F-2	145 (n=16)	–	105 (n=2)	60 (n=3)
F-3	147 (n=9)	99 (n=7)	–	53 (n=4)

Notes: Each cell displays the average payoffs of the corresponding strategy, and in the parenthesis are the number of matching groups or pairs who use the strategy.

Table 4 provides the average payoffs by the type of the strategy in each treatment. Since we focus on the payoffs once the strategy is already used stably, we only use the data in rounds 16-30. As can be seen from Table 4, the earnings under each type of strategy tend to be similar across treatment. For example, subjects earn slightly lower than 150 if they use the "alternation" strategy, while they earn slightly lower than 100 if they use the "compromise" strategy. Payoffs are below 150 (the mean of 50 and 250) for subjects playing the "asymmetric" strategy as some of them sometimes deviate from the pattern. Finally, the earnings are much lower for subjects who fail to use any successful strategy to coordinate.

Under random matching, we can see from Table 4 that although the compromise option

[15]We call a strategy unsuccessful if in the last 10 rounds, a group or a pair of subjects fail to match their actions for more than 20 percent of the time.

allows groups of subjects to use the “compromise” strategy, the payoff gains are not large (from 81 under “none” in R-2 to 95 under “compromise” in R-3). Moreover, subjects who fail to use the “compromise”strategy in R-3 earn much less than subjects in R-2. As a result, there is no difference in the overall payoffs across the two treatments. Under fixed matching, comparing F-3 and F-2, the most critical change is that the compromise option moves about half of the groups who would have used the “alternation” strategy otherwise to the use of the “compromise” strategy. This also leads to a significant payoff drop (from 147 to 99).

Result 6. *Under random matching, the compromise option overall has no effect on subjects' average payoff. Under fixed matching, the compromise option lower subjects' average payoff.*

In sum, Result 6 does not provide supports for Hypothesis 1 which predicts a positive role of the compromise option in increasing the subjects' payoffs. However, it does support Hypothesis 2 in terms of efficiency.

Finally, we also find that when playing the same game, subjects always earn more under fixed matching than under random matching. In the 2×2 game, 79.3 under random matching is lower than 120.7 under fixed matching (Mann-Whitney test, $p < 0.01$). In the 3×3 game, 76.0 under random matching is also lower than 101.4 under fixed matching (Mann-Whitney test, $p < 0.05$). This result indicates that fixed partnership helps subjects learn more quickly on using the efficient strategy. We will talk about the pace of learning in greater details in the next section.

Result 7. *Subjects earn more under fixed matching than random matching.*

Result 7 thus supports Hypothesis 3.

3.5 Learning

Although both games are simple, subjects may have to learn how to use the best strategies given others' strategies and how their strategies are dependent on the past history. In this section, we briefly investigate whether there is learning effect.

Figure 6 shows the average payoffs over rounds in each treatment. This is the best measure for learning, as subjects are expected to earn more if they learn to use better strategies over time. As can be seen in this figure, subjects indeed earn more over time in all the treatments. Moreover, the increasing pattern is particularly strong in treatments F-2 and F-3, suggesting that subjects tend to learn more quickly under fixed matching than under random matching. This is intuitive as fixed matching allows subjects to learn the strategies of their partners in every single round. In the first few rounds, there is no obvious payoff difference across treatments. After that, F-2 yields a higher earning pattern than F-3, and both F-2 and F-3 yield a higher earning pattern than R-2 and R-3. This provides an explanation from a dynamic aspect for why fixed matching yields a higher payoffs in both games.

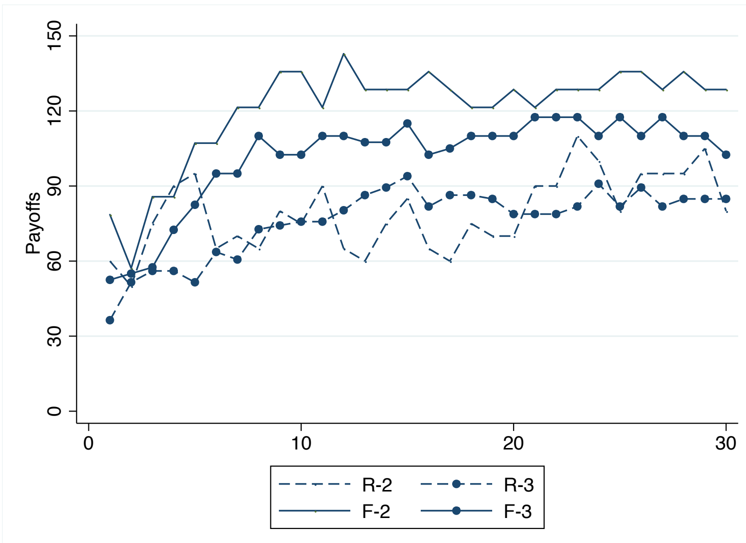

Figure 6: Average payoffs over rounds.

Result 8. *There is clear evidence of learning, and the pace of learning is faster under fixed matching than under random matching.*

Result 8 provides further supports for Hypothesis 3. The ability to learn under fixed matching helps subjects to achieve higher payoffs.

Next, we compare the pace of learning for subjects who use different strategies in treatment F-3.[16] By comparing the mean number of rounds when subjects converge to using either the alternation or the compromise strategy, we find that it takes longer for the

[16] In F-3, subjects use two types of strategies, while in the other treatments subjects use at most one type of strategy.

alternators to learn their strategy than the compromisers (6.44 rounds versus 3.86 rounds, $p < 0.1$, two-sided Mann-Whitney test), suggesting that alternation is more complex.

4 Follow-up experiment

The alternation strategy payoff-dominates the compromise option, yet a significant number of subjects coordinate on the compromise option instead of alternation when the compromise option is available under fixed matching. This is in contrast to the prevalent use of alternation when compromise is unavailable. In this section, we attempt to understand such an issue by implementing a follow-up experiment. In this experiment, we investigate the behavioral pattern when subjects play the 30-round 3x3 game repeatedly. We refer to the 30-round 3x3 game as a 'supergame'.

4.1 Experimental design and procedures

In the experiment, we implement the 3x3 game in Figure 1B. In each supergame, subjects play the 3x3 game repeatedly with the same partner for 30 rounds, which is the same as the F-3 treatment in the main experiment. After finishing one supergame, subjects are re-matched with a new partner to play the supergame again. In total, each subject plays the supergame for 4 times, and each time with a different partner. Within a supergame, after each round, subjects learn the strategy (of the partner) and the payoffs in that round. At the end of a supergame, each subject learns both hers and her partner's strategies and payoffs in the entire 30 rounds.

The follow-up experiment was also conducted at the Shanghai University of Finance and Economics. A total of 72 subjects participated in one of the three sessions. Subjects who had participated in the main experiment were excluded. In each session, we recruited 24 subjects. Each subject was randomly assigned into a matching group of 8 people. In total, we had 9 independent matching groups. Subjects earned on average ¥105 (equivalent to around 15 US dollars). Each session lasted between 70-90 minutes.

4.2 Behavioral patterns across supergames

First, we investigate whether subjects use different strategies after they play the supergame multiple times. Figure 7 shows the number of pairs that converge to "alternation" or "compromise" by supergame. As we can see, among the total 36 pairs, about half converge to “alternation” while the other half play “compromise” in the first supergame. Once they gain some experiences, more pairs converge to “alternation” over time, while the number of “compromise” plays diminishes.[17] This result clearly shows that subjects learn to play “alternation” over supergames.[18]

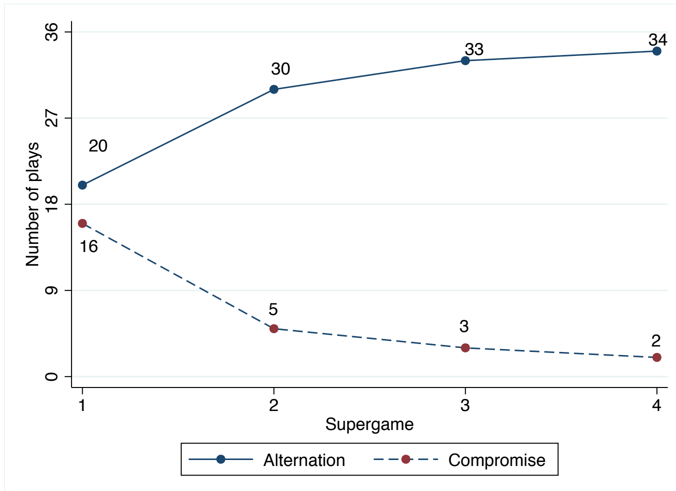

Figure 7: Number of each strategy in each supergame.

Next, we look at how average payoffs change as subjects gain experience over the supergames. Figure 8 shows the average payoffs in each supergame; they are significantly different across supergames (66.3 vs 116.3, $p = 0.01$, 116.3 vs 129.3, $p = 0.04$, 129.3 vs 137.5, $p = 0.06$. Two-sided Mann-Whitney tests at matching group level). This result shows that subjects earn more when they have more experience playing the supergames, which is consistent with the previous finding that more subjects alternate over time.

Result 9. *Subjects learn to alternate over supergames, and this yields them a higher average payoff over supergames.*

[17] In the second supergame, one pair of subjects fail to converge to any of the two equilibrium strategies, and therefore we exclude this pair in Figure 7.

[18] At the matching group level, we also find that the number of “alternation” play weakly increases when subjects have more experience, while the number of “compromise” play weakly decreases with experience. The details can be found in Figure 13 in Appendix B.

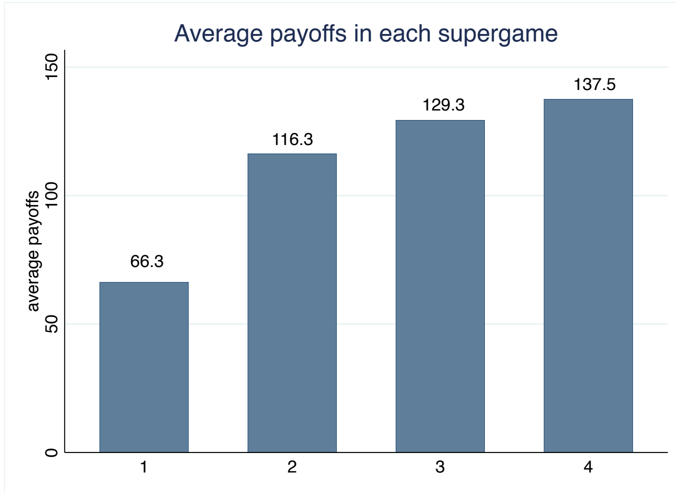

Figure 8: Average payoffs in each supergame.

4.3 Teaching and learning

Next, we investigate why subjects alternate more often across supergames. To do so, we first look at how the strategy profile of a new pair is influenced by each subject's past strategy in the last supergame. We use the data from supergames 2-4, as in these supergames, subjects have past experiences in playing the 3x3 game. We find that when at least one player alternates in the previous supergame, they always result in alternation in the subsequent supergame. When both subjects compromise in the previous supergame, they might result in "compromise" (10 out of 14), "alternation" (3 out of 14) or "coordination failure" (1 out of 14).

The above result suggests that the alternators may lead or teach the compromisers to alternate in a new supergame. In order to investigate if more alternation is indeed caused by teaching, we investigate whether the past compromisers already know how to alternate or learn to alternate from their opponents: If a compromiser tries to alternate by herself but eventually compromise in a supergame, we can infer that she understands the alternation strategy but chooses to compromise due to strategic uncertainty. By contrast, if a compromiser never tries to alternate (even for a few rounds) by herself, but starts to alternate when her opponent takes the lead to alternate, we can infer that this compromiser learns the alternation strategy from her opponent. Table 5 shows the behavior patterns of all the initial compromisers (subjects who compromise in the first supergame). Among the total 32 initial compromisers, 28 switch to alternation in one of the subsequent supergames; and among the 28 switchers, 24 purely learn to alternate from their opponents (a), while the remaining 4 already try to alternate by themselves but compromise in early supergames due to strategic uncertainty. They eventually meet someone who is willing to lead to alternate and they follow since then (b). Finally, 4 compromisers never establish an alternation pattern in any supergame (c and d), though 2 of them try to alternate for a few rounds but fail and never get a chance to meet someone who is willing to lead to alternate (c). Overall, these observation provide evidence that at least two channels can explain why many compromisers switch to alternation across supergames: (1) some learn to alternate from their new opponents, (2) some fail to alternate due to strategic uncertainty in earlier supergames, but then they meet someone who is willing to lead to alternate, which makes them believe that alternation is doable.[19]

Table 5: Behavior pattern of initial compromisers

Behavior	No. of subjects
a. Learn alternation from opponents and alternate	24
b. Know alternation but compromise once (and then alternate)	4
c. Learn alternation from opponents but compromise	2
d. Do not know the alternation strategy (and never alternate)	2
Total	32

Why are teaching and learning effective in boosting alternation? One plausible explanation is that alternation is more complex than compromise as it requires the two subjects to alternate between two different outcomes instead of choosing the same action every round. Hence, it arguably requires a higher cognitive load than compromise does. For example, Luhan et al. (2017) find that in bargaining games, many subjects tend to settle on equal and inefficient payoffs if it is more complex to achieve equal and efficient payoffs.

Result 10. *Teaching and learning as well as the reduction of strategic uncertainty can explain why many compromisers switch to alternation across supergames.*

[19]In our experimental survey, many subjects said that they learned the alternation strategy from their opponents, and some subjects reported that they figured out the alternation strategy by themselves but chose to compromise as it seemed to be a safer strategy. This also supports our finding.

5 Discussions

In this section, we first provide an optimal learning based theoretical foundation for hypothesis 2 in this paper. Then we briefly discuss if risk attitudes play a role.

5.1 Theoretical supports for hypothesis 2

Hypothesis 2 in this paper is based on the conjecture that subjects learn to alternate in F-2, while the compromise option disrupts the learning process towards alternation and leads to lower efficiency in F-3. We will show in this section that these conjectures lie on a solid theoretical ground provided by the literature of optimal learning. Optimal learning is first studied by Crawford and Haller (1990) in repeated symmetric pure coordination games without a common-knowledge description and Blume (2000) extends it to the context with partial language. Optimal learning provides a description of play in which players can achieve coordination as fast as they can by utilizing the asymmetries that arise after symmetry is broken by the history of play. Hence, if the players are sufficiently sophisticated and the optimal learning rule is unique, it should become focal. Perhaps the game experimentally investigated by Blume and Gneezy (2000) provides the best illustration of the idea: Consider 3 identical locations that are evenly arranged on a circle. Two players both get a payoff of 1 if they simultaneously and anonymously choose the same location. Otherwise, they get nothing. Suppose the two players play this game for two rounds. If they happen to coordinate in the first round, they should choose the same location in the second round because it is the optimal thing to do. If they miscoordinate in the first round, then the location that neither of them chooses becomes uniquely distinguishable and the players should learn to play it in the second round because it guarantees coordination. Blume and Gneezy (2010) further study how cognitive ability influences optimal learning. Bhaskar (2000) takes the idea to symmetric games with a conflict of interests such as the battle-of-the-sexes game and the hawk-dove game and show that the so called “egalitarian” convention is efficient, which provides the fastest way for players to break symmetry and achieve alternation. Kuzmics et al. (2014) further extend Bhaskar (2000) to allocation games.[20] They provide a formal theory arguing that conventions or meta-norms in such games should satisfy two criteria: Pareto optimality and simplicity. Note that these two criteria are satisfied by the “egalitarian” convention by Bhaskar (2000). In addition, Al’os-Ferrer and Kuzmics (2013) provide a framework

[20]When there are only 2 players, an allocation game is equivalent to a battle-of-the-sexes game.

for studying focal points in one-shot normal form games that is based on the symmetry structure of the games.

Although games we consider in this paper are not symmetric, we believe that the same idea of optimal learning can be applied. To see this, let us first look at the 2×2 battle-of the-sexes game. For the ease of exposition, we consider two players playing this game repeatedly for inifinite rounds, but the main intuition naturally carries to the finitely repeated version.

Assume that the two players have identical discount factor $a \in (0,1)$ and they adopt the following strategy: In the first round, player 1 plays X with probability s, Y with probability $1-s$; Player 2 plays X with probability $1-s$, Y with probability s, where $s \in [0,1]$. If both players choose X, then in the next round, both choose Y and alternate thenceforth; if both choose Y, then in the next round, both choose X and alternate thenceforth. Otherwise, they restart the same process in the next round. Such a strategy is very similar to the "egalitarian" convention considered in Bhaskar (2000), with the exception that the two players may put different weights on the two actions given that they have different preferences over them.

Let W denote both players' repeated-game payoffs (although the game is asymmetric, following the above described strategy yields the same expected payoffs for both players in the infinite repeated game) and player 1's payoffs in the repeated game can be reduced to a one-stage game with the following payoff matrix:

Table 6: Repeated game payoffs for the 2×2 game

	$1-s$	s
s	$\frac{250+50a}{1-a^2}$	aW
$1-s$	aW	$\frac{50+250a}{1-a^2}$

The optimal s is chosen to maximize:

$$\begin{aligned} W &= s(1-s)\left(\frac{250+50a}{1-a^2}+\frac{50+250a}{1-a^2}\right)+(s^2+(1-s)^2)aW \\ &= \frac{s(1-s)\frac{300}{1-a}}{1-a(s^2+(1-s)^2)}. \end{aligned}$$

The unique solution to the maximization problem is $s = 0.5$, independent of the value of a. Hence, although the two players have a conflict of interests, randomizing between X and Y with equal probability guarantees the highest expected payoffs for them because it is the fastest way for them to achieve alternation. The optimal strategy we find above provides us the first theoretical support for hypothesis 2 that subjects learn to alternate in the 2×2 game and the result of F-2 confirms the theory.

Next, let us look at the 3×3 battle-of-the-sexes game with the compromise option. We still consider the infinite repeated version of the game and assume that the two players have identical discount factor $a \in (0,1)$. We will discuss the additional nuances associated with the finitely repeated version at the end.

Consider the following strategy: In the first round, player 1 plays X with probability s_1, Y with probability s_2, Z with probability $1-s_1-s_2$; Player 2 plays X with probability s_2, Y with probability s_1, Z with probability $1-s_1-s_2$, where $s_1, s_2 \in [0,1]$ and $s_1+s_2 \leq 1$. If both players choose X, then in the next round, both choose Y and alternate thenceforth; if both choose Y, then in the next round, both choose X and alternate thenceforth. Otherwise, they restart the same process in the next round. Although the compromise option provides a chance for instant coordination, alternation is the efficient convention and players may wish to coordinate on it as soon as they can. If both players choose either X or Y in a round, then alternation becomes viable. However, if they choose otherwise, there is no obivous way to establish the alternating pattern. Even though they know they will be better off by starting alternation immediately from the next round, their conflict of interests prevents them from finding a way to start the pattern because player 1 would prefer alternation starting from (X, X) and player 2 would prefer alternation starting from (Y, Y). Therefore, restarting the procress is the best way leading to alternation.

Player 1's payoffs in the repeated game can be reduced to a one-stage game with the following payoff matrix:

Table 7: Repeated game payoffs for the 3×3 game

	s_2	s_1	$1-s_1-s_2$
s_1	$\frac{250+50a}{1-a^2}$	aW	aW
s_2	aW	$\frac{50+250a}{1-a^2}$	aW
$1-s_1-s_2$	aW	aW	$100+aW$

The optimal s_1 and s_2 are chosen to maximize:

$$\begin{aligned} W &= s_1 s_2 \left(\frac{250+50a}{1-a^2} + \frac{50+250a}{1-a^2}\right) + (1-s_1-s_2)^2 100 + (1-2s_1 s_2) aW \\ &= \frac{s_1 s_2 \frac{300}{1-a} + (1-s_1-s_2)^2 100}{1-a(1-2s_1 s_2)}. \end{aligned}$$

Simple calculation yields that there exists a threshold $\tilde{a} \in (0,1)$ such that when $a < \tilde{a}$,

$s_1^* = s_2^* = 0$; when $a > \tilde{a}$, $s_1^* = s_2^* = 0.5$. For impatient players, they will keep compromising because the compromise option yields instant coordination. For sufficiently patient players, they are willing to endure some initial failures of miscoordination so as to acheive alternation in the long run. Hence, alternation and compromise coexist if there exist subjects with a both above and below the threshold. This provides us the second theoretical support for hypothesis 2 and the results in F-3 confirm the coexistence of alternation and compromise.

The result shares some similarities with the 3 by 3 pure coordination game studied in Crawford and Haller (1990) (p.586). In their game, Coordination on X or Y yields both players a payoff of 1, and coordination on Z yields both players a payoff $b < 1$. Miscoordination results in a payoff of 0. They show that when players are impatient, they will settle on Z; when they are patient, they randomize between X and Y so as to acheive coordination as fast as possible.

The finite repeated version of the game involves heavier calculation compared with the infinite repeated game because the number of remaining rounds changes as the game proceeds. One potential difference between the finite and the infinite repeated game is that $\tilde{a}$ should increase in the number of rounds in the finite game. This is because when the number of remaining rounds decreases, even very patient players, who would have preferred to establish the alternation pattern in earlier rounds but fail to do so, would tend to settle on compromise.

5.2 Risk attitudes

Risk attitude could be another reason for why some pairs converge to compromise in F-3. If at least one of the subject in a pair is very risk averse, she might want to avoid alternating, as there is a risk of not receiving her own favorite outcome in the future periods.

To assess whether risk attitude plays a role in affecting subjects' decisions, we compare the choices made in the risk-elicitation part of the experiment by subjects who alternate and those who compromise in treatment F-3. We find that the compromisers are slightly more risk-averse than the alternators on average (4.36 versus 3.78, $p = 0.28$, two sided Mann-Whitney test). However, the difference is not significant. Hence, we do not find strong supports for risk attitudes playing a role in F-3.

6 Conclusion

In this paper, we investigated how a compromise option affects play in a Battle-of-the-sexes game under random matching (repeated one-shot game) and under fixed matching (repeated games), as well as when the fixed-matching repeated-game (supergame) is played repeatedly with different partners. Experimentally, we found that the effectiveness of the compromise option depended crucially on the matching protocol. Under random matching, the inclusion of the compromise option affected play drastically, as most subjects tended to use the compromise option to avoid coordination failure otherwise existed without such an option. In contrast, under fixed matching, the compromise option partially crowded out subjects from the use of the alternation strategy and led to a lower payoff as many subjects used compromise as a way to coordinate. Finally, when the supergame is played for multiple times, subjects learn to adopt the alternation strategy more often across supergames.

This study serves as an attempt to the understanding of the role of focal points in repeated interactions. Different from short-term interactions, players can rely on additional mechanisms to achieve coordination in repeated interactions. Yet, the role of focal points is unclear. Our findings provide evidence that the compromise option retains its salience in repeated games because of its symmetry and simplicity, though less salient compared to that in one-shot games. However, the salience of the compromise option wears off when subjects gain experience in repeated play of supergames. Our results raise an important question on whether other types of focal points can retain their focality in repeated games.

A potential extension of this study suggested by an anonymous referee is to investigate how our findings depend on the payoff of the compromise option relative to the payoff of the alternation strategy. One conjecture is that the compromise option becomes more attractive when its relative payoff increases, as subjects will find it more profitable to compromise. However, subject's incentives to teach each other to use the alternation strategy may decrease, which would result in a slower upward trend in the usage of alternation and the average payoffs across supergames.

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Appendices

Appendix A: Experimental instructions

In this appendix, we provide the experimental instructions that are translated from the original Chinese version.

Instructions (All treatments)

Welcome to this experiment on decision-making. Please read the following instructions carefully. During the experiment, do not communicate with other participants in any means. If you have any question at any time, please raise your hand, and an experimenter will come and assist you privately. This experiment will last about one hour.

This experiment is divided into two parts. In Part I, you are going to take part in an experiment in this room together with other participants. Each participant seat behind a private computer, and no one can ever know the identity of another. In Part II, you are going to conduct your decision-making independently with other participants. All decisions are made on the computer screen.

It is an anonymous experiment. Experimenters and other participants cannot link your name to your desk number, and thus will not know the identity of you or of other participants who made the specific decisions. During Part I, your earnings are denoted in points. Your earnings depend on your own choices and the choices of other participants. At the end of the experiment, your earnings will be converted to RMB at the rate: 100 points = ¥ 1. During Part II, your earnings are denoted directly in RMB currency Yuan. In addition, you receive 10 RMB show-up fee. This show-up fee is added to your earnings from Part I and Part II. Your total earnings will be paid to you in cash privately.

Part I (Treatment R-3)

In this experiment, you will stay in a group of six people. In each round, you will be randomly matched with one person in the room. The two of you are going to play a game. Each person will make a choice between A, B and C. If you and the other person make a different choice, you will both receive 0 points. If you and the other person both choose A, you will receive 250 points and the other person will receive 50 points. If you both choose B, then you will receive 50 points and the other person will receive 250 points. If you both choose C, both of you will receive 100 points.

The possible decisions and payoffs are also shown in the following matrix. In each cell of the matrix, the first number shows the amount of points for you, and the second number shows the amount of points for the other person.

You will play this game for 30 rounds in total. In these 30 rounds, you will be matched within your matching group of six people. You will not be matched with someone with the same preferences as you. Therefore, you will be only matched with 3 different participants in this group. In each round, you will be re-matched to one of the 3 participants. In each round, the chance of meeting any of the three participants is one third. At the end of each round, you will learn the choice of your partner in this round. Your earnings in this experiment equal the sum of the points you earn in all of the 30 rounds plus the show-up fee. Your earnings will be converted to RMB at the rate: 100 point = ¥ 1.

Quiz (Treatment R-3)

1. In each round, what is your payoff if you choose A and the other person chooses C?
2. In one round, what is your payoff if both you and the other person choose B? How about the payoff of the other person?
3. How many rounds are you going to play in this experiment?
4. Which of the following statements below is true? a. I will play with the same person in all the rounds. b. I will never play with the same person for more than one round. c.I might play with the same person for more than one round.
5. Suppose you are now in round 10, which statement below is true? a. I will play with the same person in the next round. b. I might play with a different person in the next round. c.I will definitely play with a different person in the next round.

Part I (Follow-up experiment)

In this experiment, you will be matched with other people in the room. The two of you are going to play a game. Each person will make a choice between A, B and C. If you and the other person make a different choice, you will both receive 0 points. If you and the other person both choose A, you will receive 250 points and the other person will receive 50 points. If you both choose B, then you will receive 50 points and the other person will receive 250 points. If you both choose C, both of you will receive 100 points.

The possible decisions and payoffs are also shown in the following matrix. In each cell of the matrix, the first number shows the amount of points for you (in red), and the second number shows the amount of points for the other participant (in blue).

Once you are matched with someone, you will play this game with this person for one block. Each block consists of 30 rounds of the game. That is, you will play the game with the same person repeatedly for 30 rounds. At the end of each round, you will learn the choice of your partner in this round. After the first block is finished, you will learn the choices of you and your partner in the entire 30 rounds. Then, you will be re-matched with another person to play the next block, which also consists of 30 rounds of the game. In total, there are 4 blocks in this part. In each block, you will be matched with a different person to play this game repeatedly for 30 rounds.

In this part, your earnings equal the total earnings of two randomly selected blocks. The earnings of each block equal the sum of the point you earn in the 30 rounds of that block. At the end of the experiment, your earnings will be converted to RMB at the rate: 100 point = ¥ 1.

Quiz (Follow-up experiment)

1. In each round, what is your payoff if you choose A and the other person chooses C?
2. In one round, what is your payoff if both you and the other person choose B? How about the payoff of the other person?
3. How many rounds are you going to play in this experiment?
4. Which of the following statements below is true? a. I will play with the same person in all the rounds. b. I will play with the same person in one block. c.I will never play with the same person for more than one round.
5. Suppose you are now in round 60, which statement below is true? a. I will play with the same person in the next round. b. I might play with a different person in the next round. c.I will definitely play with a different person in the next round.

Part II (All treatments)

In the table below, we present six different options. You are asked to select one of the options. Your earnings will depend on the outcome of a fair coin toss generated by the computer. Every option shows the amount in points you earn in case a head shows up or a tail shows up. The chance of head or tail is 50% respectively. When you have made your choices, the computer will randomly decide the result of the coin toss. Please indicate which one of the six options you prefer.

Table 8: Options in the Risk-elicitation task

Option 1	Head: 17	Tail: 0
Option 2	Head: 15	Tail: 3
Option 3	Head: 13	Tail: 4
Option 4	Head: 11	Tail: 5
Option 5	Head: 9	Tail: 6
Option 6	Head: 7	Tail: 7

Appendix B: Supplemental figures

In this appendix, we provide the supplemental figures that are useful for understanding the experimental results.

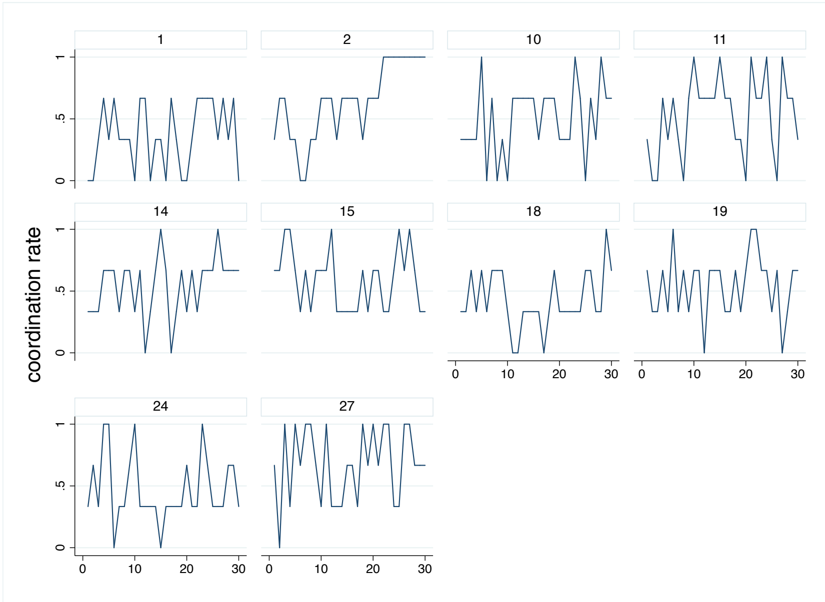

Figure 9: Group-Level Data, R-2. Coordination rate over time. *Notes: X-axis is round number. Y-axis shows the coordination rate.*

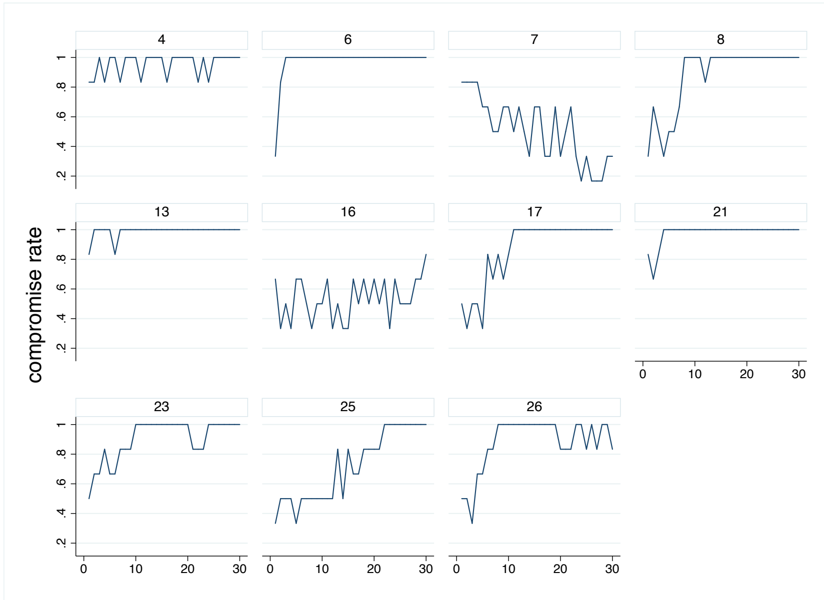

Figure 10: Group-Level Data, R-3. Compromise rate over time. *Notes: X-axis is round number. Y-axis shows the rate of choice Z.*

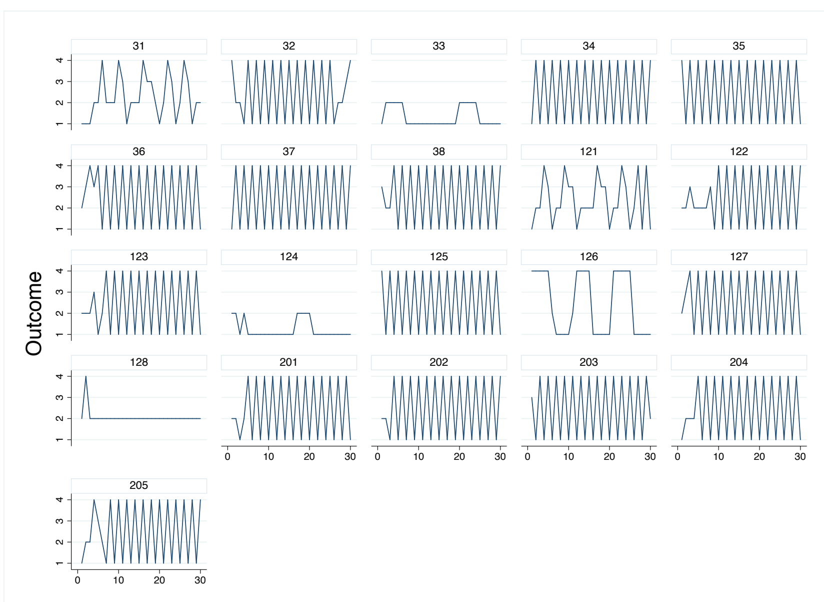

Figure 11: Group-Level Data, F-2. Outcome distribution over time. *Notes: X-axis is round number. Number 1-4 in y-axis indicates outcome (X,X), (X,Y), (Y,X), (Y,Y), respectively.*

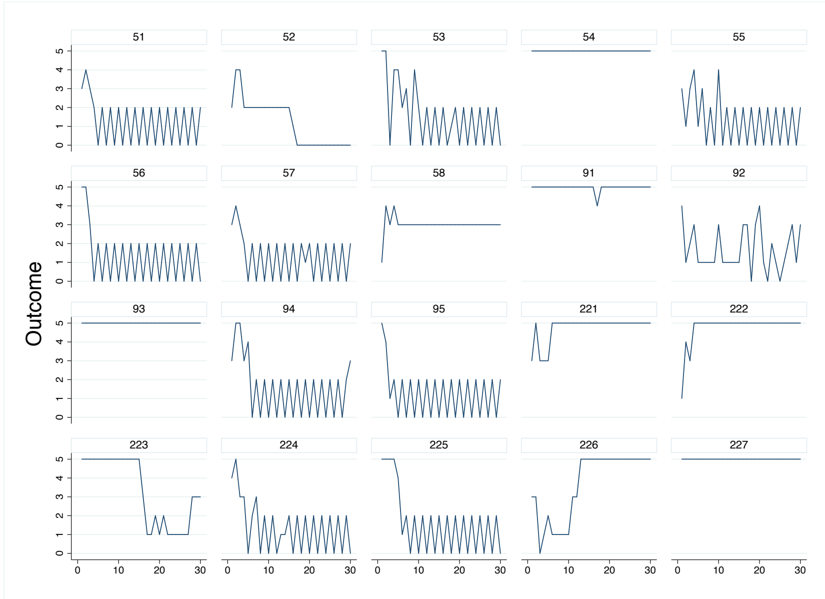

Figure 12: Group-Level Data, F-3. Outcome distribution over time. *Notes: X-axis is round number. Number 0-5 in y-axis indicates outcome (X,X), (X,Y) or (Y,X), (Y,Y), (X,Z) or (Z,X), (Y,Z) or (Z,Y), (Z,Z), respectively.*

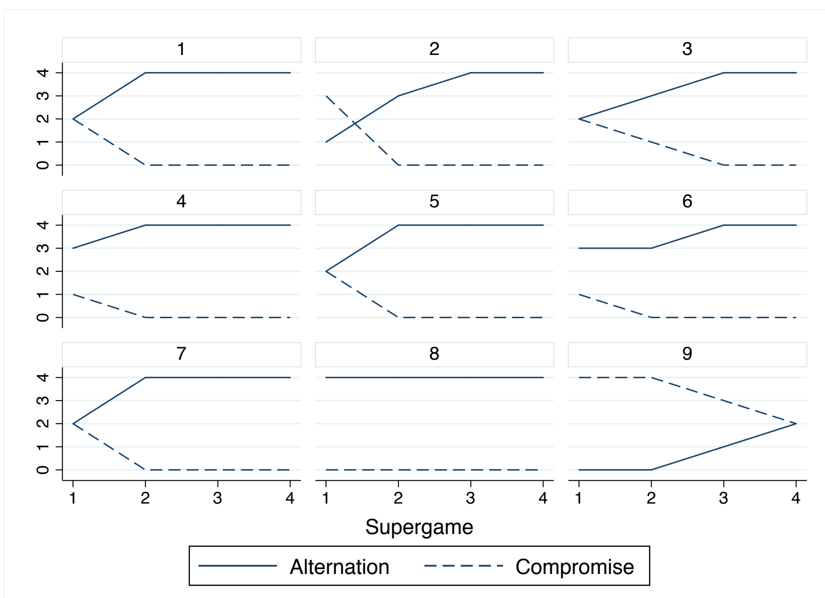

Figure 13: Group-Level Data, Follow-up experiment. Number of each strategy ("alternation" and "compromise") in each supergame.