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THE EFFECT OF SELECTED INTERGROUP COMPETITION ON GROUP COORDINATION IN THE LIGHT OF THE EXPERIMENTAL RESEARCH

WPŁYW KONKURECJI MIĘDZYGRUPOWEJ GRUP SELEKTYWNYCH NA KOORDYNACJĘ W ŚWIETLE BADAŃ EKSPERYMENTALNYCH

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Summary: In many real-life situations the group's payoffs are contingent on their performance relative to that of other groups, rather than on their absolute level of performance. Economic competitions are more appropriately modeled as a rope pulling than as a "contest" of a single group against nature. Intergroup competition also takes place between subgroups within the same organization. It is a well-documented fact that in single-group settings coordination often fails to produce socially optimal outcomes. Van Huyck, Battalio, and Beil studied the minimal-effort game – an n-person pure coordination game in which there is no conflict of interests among the players. Performance typically falls short of its potential performance as estimated from the capabilities of the individual group members. The purpose of the research is to see whether intergroup competition has a similar effect on intragroup coordination. Rivalry takes place between different economic structures as well as between sub-groups within the same economic structure. The group with higher final output is the one whose members are more cooperative and better coordinated with one another than members of the competing groups.

Keywords: intergroup competition, minimum-effort game.

Streszczenie: W realnych systemach ekonomicznych wyniki działań grupowych spadają poniżej wynikających z estymacji indywidualnych możliwości członków grup. Konkurencja w ekonomii powinna być modelowana raczej jako „drużynowe przeciąganie liny" niż starcie z przyrodą. Konkurencja międzygrupowa często ma miejsce także w jednolitej organizacji. Badania dosyć dobrze pokazały, że konkurencja wewnątrzgrupowa może prowadzić do rozwiązań nieoptymalnych społecznie. Van Huyck, Battalio i Beil za pomocą gry o minimalnym wysiłku badali koordynację, w której nie ma konfliktu pomiędzy graczami. Rywalizacja odbywa się pomiędzy różnymi strukturami ekonomicznymi, jak również pomiędzy podgrupami w tej samej strukturze ekonomicznej. Grupa osiągająca lepsze wyniki końcowe to taka, której

członkowie wykazują większą skłonność do współpracy i są lepiej skoordynowani ze sobą niż członkowie konkurencyjnych grup.

Słowa kluczowe: konkurencja wewnątrzgrupowa, gra „minimalny wysiłek".

1. Introduction

In real life the group actions typically drop of their potential actions as projected from the abilities of the individual group members. This phenomenon was observed by Regelmann [1913], who had students pull on a rope either alone or in groups. The groups used less efforts than could have been estimated from the combined individual ones. The group actions reduction was investigated using a wide variety of tasks [e.g. Latane et al. 1979; Harkins, Petty 1982; Baron, Kerr 2003]. Group productivity fall is attributed to two problems:

- coordination loss, especially when group members do not pull on the rope at exactly the same time or in exactly the same direction [Steiner 1972],
- free riding, especially when they are being evaluated and rewarded as a group, individual group members do not pull as hard as they can [Ingham et al. 1974].

It was demonstrated that intergroup competition increases group performance by decreasing free riding within the competing groups [Bornstein et al. 1990; Bornstein et al. 1993; Bornstein, Erev 1994]. Analogous outcomes were described by Nalbantian and Schotter [1997] and Bornstein, Gneezy and Nagel [2002], who compared group productivity under different group incentive schemes and found that contest-based group incentives led to higher outputs than all other mechanisms investigated. The purpose of the this study was to see whether selected intergroup competition has a similar effect on intragroup coordination.

Van Huyck, Battalio, and Beil [1990] conducted laboratory experiments with a minimum-effort game, with seven effort levels and seven corresponding Pareto-ranked Nash equilibria in pure strategies (regardless of the number of players). The intuition that coordination is more difficult with more players is apparent in the data: behavior in the final periods typically approaches the "worst" Nash outcome with a large number of players, whereas the "best" equilibrium has more drawing power with two players. An extreme reduction in the cost of effort (to zero) results in a preponderance of high-effort decisions. Effort distributions tend to stabilize after several periods of random matching, and there is a sharp inverse relationship between effort costs and average effort levels. The Van Huyck, Battalio, and Beil [1990] minimal-effort game involves numerous players, each of whom simultaneously chooses an integer from 1 to 7. The payoff to any player depends on the integer chosen by that player as well as on the minimal number chosen by any of the other players in the group (including the player). The payoff parameters are chosen such that all the players have a common interest in a high minimum, but there is a penalty for choosing a number higher than the group's minimum.

To examine the problem if group members coordinate better if they compete against another group, we adapted the van Huyck at al. [1990] game in the following way: at the beginning the game involved one group which is selectively split after 4 rounds in two non-equal groups:

a) group (a) – selected players who played highest effort in previous rounds,

b) group (b) the other players.

Each group members independently chose an integer from 1 to 7, so the minimum is separately chosen in each group. Introducing competition between the groups does not change the set of strict equilibria. As in the original, single-group game, the best response in the selected intergroup coordination game is for each player in each team to match the minimal number chosen in the team. Consequently, like the single-group game, the intergroup game has seven strict equilibria, with the equilibrium at which all team members choose 7 being the most efficient and the equilibrium at which all players choose 1 being the least efficient.

On the other hand, selected intergroup competition may change the equilibrium on which players coordinate. Schelling and Thomas [1960] demonstrated that players were often able to coordinate by focusing on aspects of the environment that were ignored by economic models. We assume that the competition against the outgroup might constitute such a focal point. This assumption is based on research [Bornstein, Ben-Yossef 1994; Bornstein et al. 1997 Schopler, Insko 1992], which shows that groups are highly competitive – much more than individuals under the same structural conditions. However, since none of these experiments dealt specifically with pure coordination problems, substantiating this hypothesis remains an empirical matter.

2. Experimental procedure

The participants were 47 undergraduate students at the Warsaw School of Economics with no previous experience with the task.

Participants contributed in the experiment in:

- two groups of 19 which were finally split in sub-groups,
- one group of 6.

Upon coming each participant was given a questionnaire in Google forms to test:

- risk aversion (tossing coin game),
- certainty effect (Maurice Allais game),
- reflection effect,
- participants' subjective thrust test.

Each participant was seated in a separate desk facing a personal device (laptop, tablet, mobile phone). The participants were given written instructions concerning the rules and payoffs of the game (see Appendix 1) and were asked to follow the instructions while the experimenter was reading them aloud. Their answers were

checked by the experimenters and explanations were repeated when necessary. The participants were told that, to ensure the confidentiality of their decisions, they would receive their payment on an individual basis.

At the beginning of the experiment:

1. In the first group 19 participants were playing together with supervision (No Competition NC) and after the 4th round they were divided selectively (Selected Intergroup Competition SIC) into two unequal-sized teams, sub-group (a) players with the highest effort before and sub-group (b) other players. Participants played next 7 rounds of the game.
2. In the second group 19 participants were playing together with supervision (No Competition NC) and after the 4th round they were divided randomly (Random Intergroup Competition RIC) and then selectively (Selected Intergroup Competition SIC) into two unequal-sized teams sub-group (a) players with the highest effort before and sub group (b) other players. Participants played next 8 rounds of the game.
3. In the third group 6 Participants were playing together in separate room with supervision (No competition NC) 4 rounds and then without supervision (No Competition with information NCI) 2 rounds.

The number of rounds to be played was not made known in advance. In each round each participant had to choose an integer from 1 to 7. Following the completion of the round, each Participant received feedback concerning:

a) the lowest number chosen by the members of the group in that round,
b) individual earnings in this round and
c) individual cumulative earnings.

Participants did not also receive feedback concerning the lowest number chosen in the outgroup. Each session lasted about 90 minutes.

No Competition (NC). Participants are playing together with supervision. The payoff for each player was determined by his/her own choice and the minimum chosen in the group. The participants were informed only about the minimum chosen by their own group. Two 19-person and one 6-person group took part in the treatment. Since there was no interdependence between the two groups, we obtained 3 independent observations.

No Competition with Information (NCI). Participants are playing together without supervision and can communicate. This treatment is identical to the NC above (that is, each of the one group played an independent coordination game) with one exception: participants can communicate. One 6-person group took part in the treatment.

Selected Intergroup Competition (SIC). Participants are playing under supervision without communication in two unequal-sized groups:

- sub-groups (a) – players with the highest effort before (SIC1),
- sub-group (b) – other players (SIC2).

Four 8-11-person sub-groups took part in the treatment.

Random Intergroup Competition (RIC). Participants are playing under supervision without communication in randomly selected unequal-sized sub-groups. Two 8-11-person groups took part in the treatment.

3. Results

First we compared the three treatments with regard to the average effort level per period averaged across the different periods of the game. The average effort level per period was:

1) 2,01 in group 1 in the NC treatment,
   1,93 in group 2 in the NC treatment,
   1,63 in group 3 in the NC treatment,
2) 6,45 in sub-group 1a and 6,67 in sub-group 2a in the SIC1 treatment,
   3,98 in sub-group 1b and 3,44 in sub-group 2b in the SIC2 treatment,
3) 3,25 in sub-group 2a in RCI treatment (control),
   3,63 in sub-group 2b in RCI treatment (control),
4) 7,00 in group 3 in the NCI treatment.

The difference between the NC and the SIC treatment is statistically significant by a Wilcoxon rank-test ($z = -2.251$, $p < 0.012$).

The difference between the NC and the NCI treatment is statistically significant by a Wilcoxon rank-test ($z = -1.826$, $p < 0.068$).

Participants' initial decisions were affected by NC treatment. The average effort level in four periods in group 1, 2, 3 was 2.01, 1.93, 1.63. These averages do not significantly different from one another.

Participants in sub-groups (a) in the SIC1 and in sub-groups (b) in the SIC2 treatments began increasing their effort level as compared in the NC experimental treatment.

Figure 1 displays the average choice per period in each of the three groups. The difference between the NC treatment and sub-groups in the SIC treatments is already visible in:

- period 5 for SIC1 treatment in sub-groups (a),
- period 6 SIC2 treatment in sub-groups (b) and
- period 5 in group 3 in the NCI treatment.

From period 5 onward, the average effort level in sub-groups in the SIC is significantly higher than that in the NC treatment. In group 3 in the NCI treatment from period 5 onward, it is also significantly higher than that in the NC treatment. The difference between the NC and RCI control treatments remains insignificant in group 2 in round 5 of the game.

Second we compared the three treatments with regard to the minimum effort level per period averaged across the different periods of the game. The minimum effort level per period was:

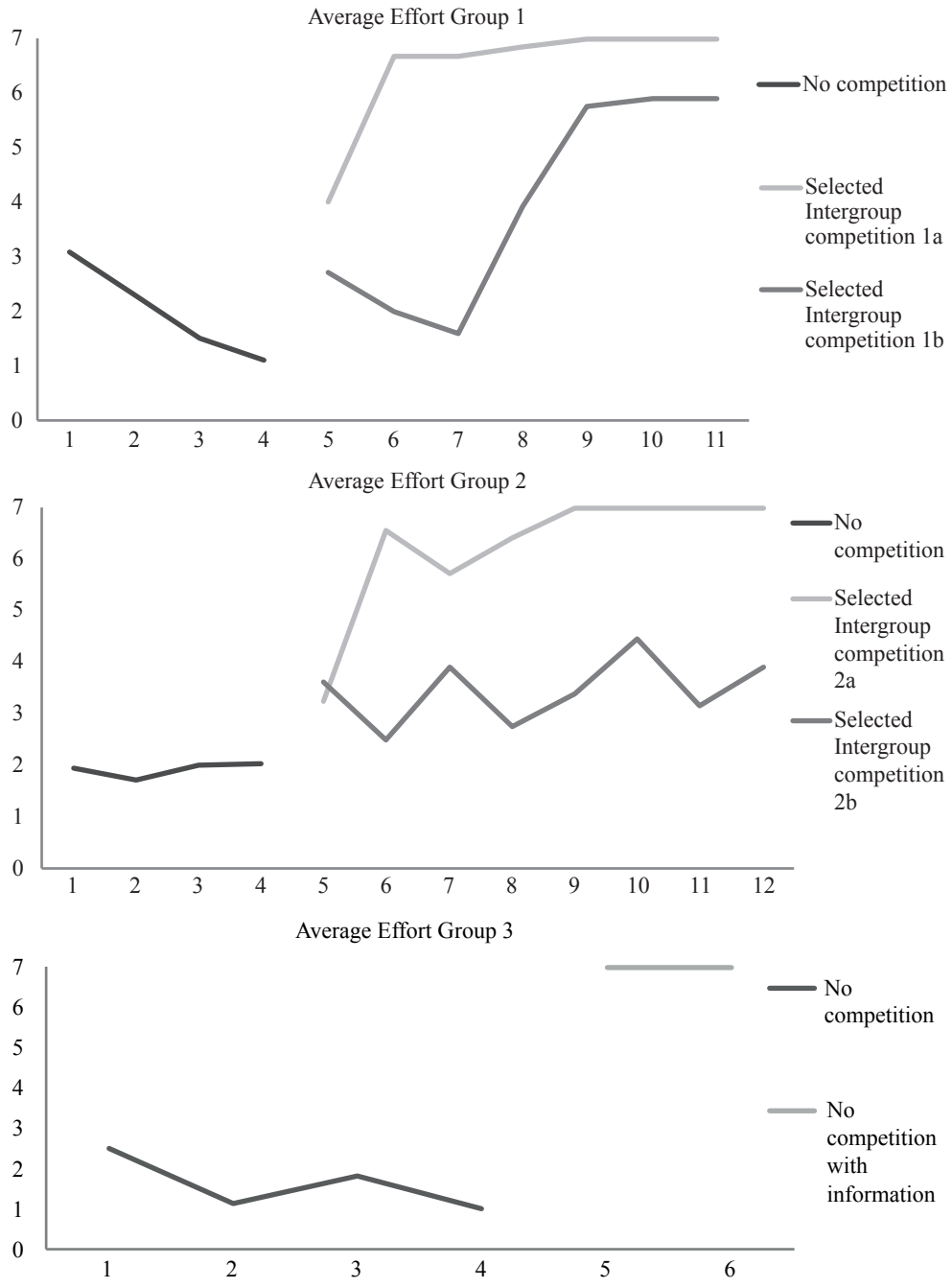

Fig. 1. Average effort in groups

Source: own work.

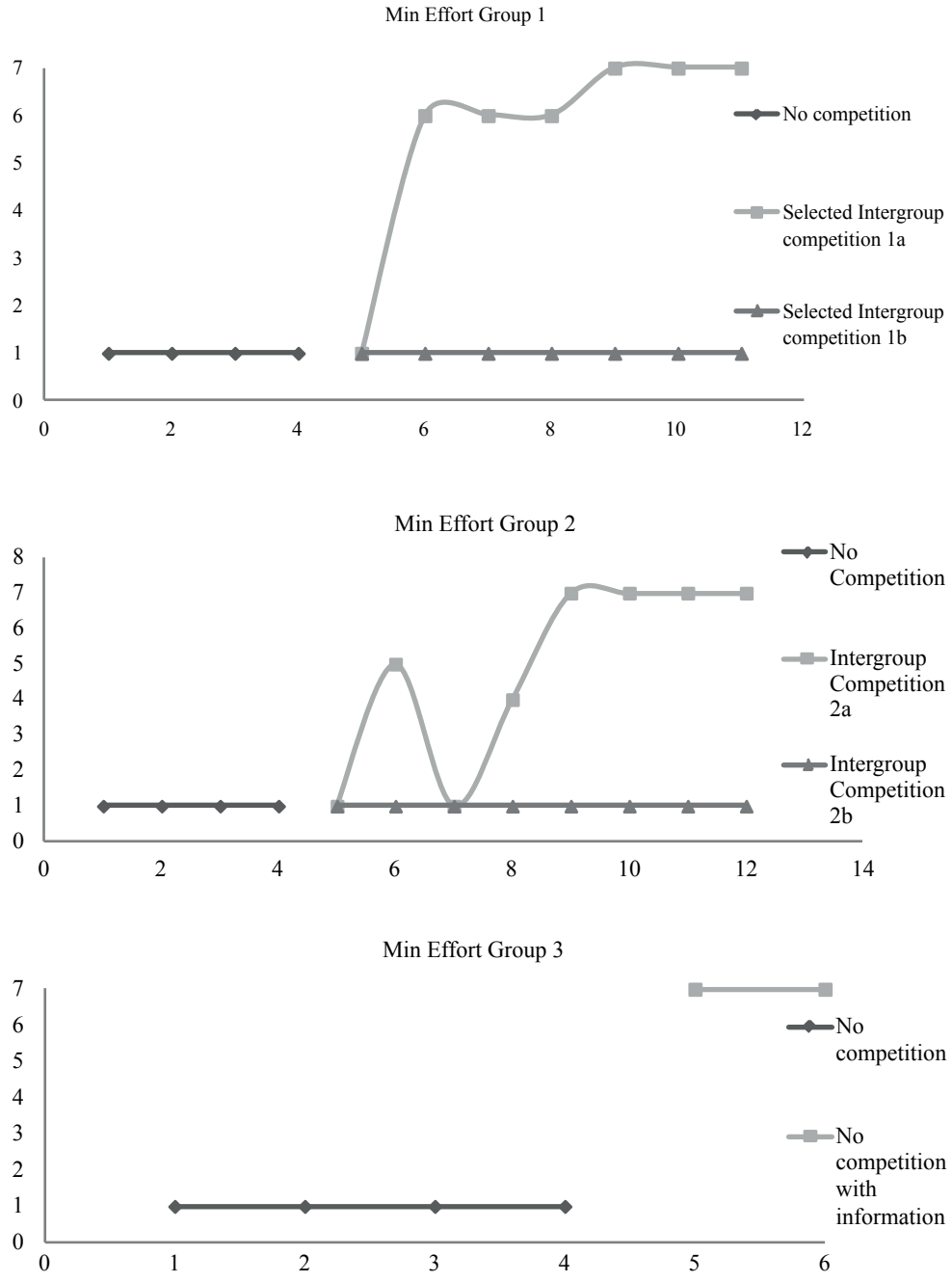

Fig. 2. Minimum effort

Source: own work.

1) 1,00 in group 1 in the NC treatment,
   1,00 in group 2 in the NC treatment,
   1,00 in group 3 in the NC treatment,
2) 5,71 in sub-group 1a and 4,88 in sub-group 2a in the SIC treatment,
   1,00 in sub-group 1b and 1 in sub-group 2b in the SIC treatment,
3) 1,00 in sub-group 2a in RCI treatment (control),
   1,00 in sub-group 2b in RCI treatment (control),
4) 7,00 in group 3 in the NCI treatment.

Next, we compared the minimum effort level in our treatments. The average minimum choice per period in each of the treatments is shown in Figure 2. As it can be seen the minimal effort level is identically low in NC and SIC2 treatments, but identically high in SIC1 and NCI treatments. In fact, SIC1 and NCI treatments coordinated their actions and achieved Pareto-optimal solution.

4. Conclusions

The research shows that selected intergroup competition improves output in the minimum effort coordination game by moving group members in the direction of the cooperatively rational equilibria. The economic theory presents limited methods for improving coordination: limiting group size, imposing participation costs such as coordinating some equilibria results in losing money [Van Huyck et al. 1993; Cachon, Camerer 1996], allowing one-sided communication [Cooper et al. 1989] or repeating the game for a great number of periods [Berninghaus, Ehrhart 1994. Selected group competition appears to be more useful as it can be applied in any group size, communication form, participation cost, and number of periods.

Selected intergroup competition mechanisms are quite common in real economy. Rivalry takes place between different economic structures as well as between subgroups within the same economic structure. The group with higher final output is the one whose members are more cooperative and better coordinated with one another than the members of the competing groups.

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Appendix 1

The Coordination Game

Idea:

Players participate in an *N* player minimum effort coordination game.

Purpose of the player is the maximization of individual pay-off Π(m, x).

- In each iteration, each player independently chooses an integer from 1 to 7 (an effort level $\mathbf{x} \in [1,7]$).
- Each player's payoff in given iteration depends upon his (her) effort level **x** and the minimum effort level **m** chosen by all players:

$$\Pi (m, x) = 0{,}2m - 0{,}1x + 0{,}6,$$

where: x – effort level $\mathbf{x} \in [1,7]$; m – $\min[x_i]$, $i \in [1, N]$ (minimum effort among all participants in a game).

Rules:

- Players cannot communicate.
- Players select an effort level **x,** fill first column in the table below and give it to coordinator.
- Coordinator finds minimum **m** and puts payoff result in column Π of each player in given iteration,
- Coordinator gives the table to a player to make next iteration.

Iteration	x – effort level	Π (m, x) – payoff
1		
2		
3		
4		
5		
6		
7		
8		
…		

Appendix 2

Wilcoxon rank-test

Test statistics[a]	
Z	−1,826[b]
Asymp. Sig. (2-tailed)	,068

[a] Wilcoxon Signed Ranks Test; [b] Based on negative ranks.

Test statistics[a]	
Z	−2,521[b]
Asymp. Sig. (2-tailed)	,012

[a] Wilcoxon Signed Ranks Test; [b] Based on negative ranks.