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Does competition enhance performance or cheating?

A laboratory experiment

by

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Does competition enhance performance or cheating? A laboratory experiment

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Abstract:

In this paper we experimentally test whether competing for a desired reward does not only affect individuals' performance, but also their tendency to cheat. Recent doping scandals in sports as well as forgery and plagiarism scandals in academia have been partially explained by „competitive pressures", which suggests a link between competition and cheating.

In our experiment subjects conduct a task where they have the possibility to make use of illegitimate tools to better their results. We find that women react much stronger to competitive pressure by increasing their cheating activity while there is no overall sex difference in cheating. However, the effect of competition on women's cheating behavior is entirely due to the fact that women, on average, are doing worse with respect to the assigned task. Indeed we find that it is the ability of an individual to conduct a particular task and not sex that crucially affects the reaction to competition. Poor performers significantly increase their cheating behavior under competition which may be a face-saving strategy or an attempt to retain a chance of winning.

JEL-classification: C91, J24, J31, M52

Keywords: competition, tournament, piece rate, cheating, experiment

Introduction

Economic theory typically considers competition as desirable, since competition improves the functioning of markets, guarantees efficiency by forcing firms to produce at lowest costs, and reduces possibilities of discriminatory behaviour of employers (Becker, 1957; for a recent experimental study see e.g. Cabrales et al., 2006). Lately, however, economists began to become interested in other than purely economic effects of competition. For example, Shleifer (2004) suggests that competition may favor unethical behavior such as corruption or cheating; Brandts et al. (2006) show that competition has a strong negative impact on the distribution of emotional states of people, their experienced well-being and disposition towards others. Gneezy et al. (2003) found that competition may partly be responsible for women's relatively weak labor market position as women do not increase their effort as systematically as men in a competitive setting.[1]

In this paper we are interested in the effect of competitive pressure on cheating. Cheating can be considered to be a criminal action – according to the economics of crime, as originated by Becker (1968), crime can be viewed as a rational act that is chosen by an individual depending on the benefits and costs involved. Previous economic research has particularly investigated cheating in the classroom and confirmed that people with low grade point average (GPA), who have more to gain, cheat more than students with high GPA (Kerkvliet and Sigmund, 1999; Bunn et al., 1992). Furthermore, it has been illustrated that cheating behaviour can be reduced by increasing the costs of being caught (Kerkvliet and Sigmund, 1999). Nagin et al. (2002) again have investigated cheating behavior in a firm and found that while reductions in monitoring (that reduce the likelihood of being caught) have increased shirking in a significant portion of the employees, other workers do not respond according to the "rational cheater model". Another economic realm in which "cheating" has been investigated is tax evasion. As Franzoni (2000) points out the empirical research in this area is inconclusive but expected punishment appears to negatively affect cheating.

With respect to competition the "rational cheater model" would predict that the higher the competition, i.e. the higher the benefit of doing better than the others, the more cheating we should observe. And indeed, various cases of plagiarism as well as forged research results in academia and doping scandals in sports have been revealed recently which point towards

[1] Indeed there exists a substantial body of research that investigates the effect of sex and competition in the meantime. One particular focus in this literature has been the effect of the sex composition of a group on the performance of an individual of a particular sex which has lead to ambiguous results (Gneezy et al., 2003; Gneezy and Rustichini, 2004; Antonovics et al., 2003; Price, 2006). Further studies have also examined whether there is a sex difference with respect to the choice to enter a competition (Niederle and Vesterlund, 2005; Vandegrift et al., 2004) and whether individuals choose to engage in competition depending on the sex of the other participant Datta Gupta et al. (2005).

the existence of heavy cheating in these areas.[2] As Frank and Cook (1995) argue in these fields we find increasingly that people at the top are disproportionally rewarded, which heightens competition and generates a "winner-take-all society" where many people compete for positions without a realistic chance of obtaining them.

But also behavioural/psychological motives may lead towards increased cheating under competitive pressure. Competition emphasises the importance of personal success. As a result, people who do not bring about the desired achievements may feel pressured to engage in pretence of such. Furthermore, competition draws the attention from the wellbeing of the group towards the individual and thereby lessens the social cohesion within a group. Consequentially, individuals may find themselves less bound to adhere to standards of fairness but may find it legitimate to gain their personal share by cheating.[3] This may be reflected in cases of fraud that have been increasingly reported. Like encouraging fraud, competition may also provide an incentive to strategically misrepresent information to others. For example Hollingshead et al. (2005) have found that individuals with competitive incentives who engage in a cooperative task often strategically share distorted information to promote their preferred task solution and have considerable impact on group decisions.

In our experiment, individuals also have the possibility to distort information among a number of cheating opportunities. Subjects have to conduct a task under two different treatments: a non-competitive and competitive treatment. The level of competitiveness is induced by the structure of the payments awarded which either depend on absolute or relative performance. As we can observe the subjects' behaviour without their knowing we can test whether cheating is indeed increased by competition.

Experimental design

Task

Our experiment was based on the design developed by Gneezy et al. (2003) who measured gender differences in reactions towards competition. The online maze-game applied by them is ideally suited to test cheating, as it provides various functions that allow players with little supervision to systematically better their results.[4] Furthermore, as the game does not automatically count the number of mazes solved, experimenters have to rely on subjects'

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[2] For an overview over cheating in sport contests see Preston and Szymanski (2003).

[3] A related branch of literature looks at sabotage in tournaments which represent situations of heightened competition (for experimental investigation see e.g. Harbring and Irlenbusch, 2003a, 2003b; Harbring et al., 2004; Carpenter et al., 2007). While both phenomena, illegitimately harming others ("sabotage") and enhancing oneself ("cheating"), may be two sides of the same coin, we believe that in the real world individuals have more opportunities (and less moral concerns) to make themselves look better than sabotaging others.

[4] The game can be found at http://games.yahoo.com/games/maze.html.

respective records. While Gneezy et al. avoided cheating through close supervision of subjects, we abstained from exactly that to investigate the cheating behavior of individuals. To collect information on the correct number of actual mazes solved by the subjects and compare it to the number of mazes indicated by them, we applied a spy-ware program[5]. Any cheating was identified only after the experiment, so cheaters remained anonymous to the authors.

The participants in our experiment were first asked to solve one or two mazes of difficulty level 2 to get familiar with the task. They were instructed to keep the same level of difficulty throughout the entire experiment. If they had questions they could ask the experimenter quietly. One maze game already appeared on the screen in front of them upon entrance in the laboratory (see Figure 1 for a screen shot). The subjects were told to solely use the arrows on the keyboard to track a marker through a maze. They were instructed that each maze was only considered solved when the marker was led through the goal and a pop-up window appeared that said “Yahoo! You have successfully solved the puzzle.” To open a new maze the participants were told to use the mouse, click “OK” and “New maze.” After the participants were sufficiently comfortable with the task the second part of the instructions was distributed that asked them to execute the task for 30 minutes.[6] This part of the instructions also specified a particular payment scheme that induced high or low competitive pressure. The subjects were explicitly told not to use any other functions than the ones described and to carefully record each solved maze into a table, together with the exact time of finishing, as these records provided the basis for their payments. While Gneezy et al. (2003) confirmed that the subjects marked their table correctly, in our experiment we abstained from such a procedure to give individuals the opportunity to cheat. The individuals were given a relatively long work period of 30 minutes[7] to give them sufficient time to discover the different cheating possibilities, but also to increase the spread of actually solved mazes between individuals. As a result a whole range of numbers of mazes would appear plausible to the experimenter and individuals may be more confident to report results that deviate from their actual achievement. After solving mazes participants were requested to fill out a short questionnaire that asked demographic characteristics as well as whether individuals enjoyed the particular game played and whether they like games in general.

At the end of the experiment the experimenter counted the number of mazes indicated by each participant in the distributed tables as solved and payment was done in accordance with the rules for each treatment, privately and in cash.

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[5] This may seem deceptive at first, but it is standard that in laboratory experiments subjects’ entire behaviour is recorded without explicit mentioning.
[6] The translated instructions are available in the Appendix.
[7] In Gneezy et al. (2003) participants had to solve mazes for only 15 minutes.

Cheating

As has been indicated, the maze-game applied allowed participants to cheat in numerous ways. First of all, the online game provides two functions that allow players to simplify or speed up the solution of the maze. The function 'Auto-Solve' simply solves the game automatically – not only without any effort of the player but also in the fastest possible way. The function 'Path Verify' still demands that the player navigates the curser through the maze, however it immediately indicates when a wrong path is chosen (the curser instantly transforms to a red cross when a wrong path is taken instead of drawing a line through the maze). As a result, players can reduce their effort as foresight becomes less crucial for a quick and successful solving of the task. Furthermore, mazes are available in 5 different levels of difficulty. While participants were asked to work with difficulty level 2, they could illegitimately simplify their task by switching to the easier level 1. Most importantly, however, individuals could cheat by indicating in their table to have solved more mazes than they really had.

During the course of the experiment each computer was monitored by a spy-program to observe the actual behavior of our participants. The program took a screen shot at every mouse-click and therefore allowed us to identify all different types of cheating. It did not only record if people made use of the functions 'Auto-Solve' or 'Path Verify,' or when individuals changed the level of difficulty of the maze, it also allowed us to identify the number of actually solved mazes and compare it to the number indicated by the participant. The log files recorded by the spy-program were analyzed by a research assistant who was blind to our hypotheses.[8]

Competitive and noncompetitive treatment

To investigate whether cheating is affected by the competitiveness of an environment, we administered two treatments: a competitive treatment, where individuals have to compete against each other for payment, and a noncompetitive treatment, where payment only depends on the individual's own performance. Following Gneezy et al. (2003) in the noncompetitive treatment participants received a piece-rate payment where they were paid according to the number of mazes solved – irrespective of the amount of solved mazes of other participants. In our experiment subjects received 30 cents per solved maze in addition to their show up fee of 3 €.

[8] As has been pointed out before, we do not believe that this manipulation constitutes deception, as we did not claim that we could not track individuals' behaviour on the computer. Typically in experiments the computer records everything participants do without explicit mentioning this in the instructions. Furthermore, the subjects were strictly paid according to the number of mazes indicated, as stated in the instructions. Finally, cheaters remained strictly anonymous to the experimenter and authors.

In the competitive treatment, following Gneezy et al. (2003), individuals were subjected to a tournament. They were divided into groups of six individuals, where only the person with the highest number of mazes got paid. In this 'the winner takes all' treatment subjects remained ignorant about who their immediate competitors were as several groups simultaneously worked in the laboratory. In this condition the winner earned 1,8 € for each maze, which is six times (number of participants in the group) the piece rate of 30 cents, plus a 3 € show up fee. All other participants only received the show up fee.

Subjects

All participants were students of different majors from the Universitat Pompeu Fabra, Barcelona, where the experiment was conducted. In each session an equal number of male and female subjects participated. Subjects were never explicitly pointed to the sex-distribution in the lab, but they could see that the group composition was always half male and half female when entering the laboratory. In total we have fully recorded the laboratory behavior of 33 men and 32 women[9], 32 of which in the noncompetitive treatment

Results

The descriptive results of our experiment can be found in Table 1. The table illustrates the amount of mazes individuals solved, the number of mazes they indicated as well as individuals' cheating behavior. Contrary to Gneezy et al. (2003) we do not observe an increase of actually solved mazes as a result of increased competition once we allow subjects to cheat ($t = 0.427$, $p = 0.671$, two-tailed).[10] It appears that if individuals realize that there is a possibility to cheat, incentives to increase efforts in a competitive treatment are muted. Furthermore, in our subject pool, women find it significantly harder to solve mazes than men – women solve on average 22.19, men 29 mazes ($t = -3.624$, $p = 0.001$, two tailed). This result corresponds with previous findings, even though the difference in performance between the sexes does not always reach significance (Datta Gupta et al., 2005; Gneezy et al., 2003; Arslan et al., in progress). Figure 2 illustrates the distribution of solved mazes for men and women and shows that all the top players in our sample are male.

Table 1 also shows that for the full population the number of mazes indicated by subjects increase in the competitive treatment just like most of our cheating variables. Our variable "any form of cheating" was coded as 1 when an individual made use of any cheating

[9] Due to an activation problem of the spy program in our first laboratory session we suffered a singular loss of data that is responsible for the unequal amount of female and male subjects fully observed.
[10] This is the case even though the variable "solved mazes" includes those mazes that have been solved using illegitimate measures like "Auto-Solve", "Path-Verify" or where the level of difficulty has been adapted.

possibilities and 0 otherwise. With respect to the difference in mazes solved and mazes indicated as solved, we considered as cheating only if a subject indicated a number of mazes solved that was more than 1 above the actually solved amount as reconstructed through our analysis of the spy-ware log-files. The reason for this is that a participant could make a mistake once and we want to make sure to include only conscious acts of cheating.[11]

Comparing the overall frequency of cheating between the non-competitive (37.5%) and competitive treatment (42.4%), a Chi-Square test does not indicate a significant difference in overall frequency of cheating between the two treatments for the entire sample of people (Pearson Chi-Square = 0.164, p = 0.685 (all tests two-tailed)[12]). However, once we split up for the different sexes, women appear to increase their cheating behavior under competition (in our sample from 29.4% to 60%) on a marginally significant level (Pearson Chi-Square = 3.0297, p = 0.082) while men do not significantly change their behavior[13] (Pearson Chi-Square = 1.2615, p = 0.262).

Another possibility to measure "cheating" is to look at how much individuals exaggerate the number of mazes they have solved. The variable "difference mazes" counts the difference between the number of mazes an individual has indicated as solved and the number actually solved. As Table 1 shows, this difference increases from 1.31 in the non-competitive to 2.91 in the competitive treatment. The effect of competition is marginally significant (t = - 1.502, p = .070; one-tailed; t-test for unequal variances; for men alone: t = - .666, p = .255; for women alone: t = - 1.438, p = .081, both one-tailed).

Finally, Table 1 also indicates which particular cheating possibilities individuals make use of. It shows that most people who cheat mainly choose to lie about their actual results (31% in the non-competitive and 39% in the competitive treatment exaggerate their results by more than 1), while fewer make use of the devices "Auto-Solve" and "Path Verify". Almost nobody changes the difficulty level of the task, which indeed is a relatively inefficient way to better one's results.

Sex Differences

Since it is striking that competition induces women to cheat more while we do not observe a significant effect for men, we also test for sex differences in the previously examined measures for cheating. Looking at the overall frequencies of men and women engaging in

[11] Indeed one subject has made such a mistake also to the own disadvantage.

[12] Although we have a clear hypothesis we conduct a two-tailed test, because we observe some reduction in male cheating behaviour under competition that we do not want to systematically rule out.

[13] The descriptive statistics show some reduction in the male propensity to cheat in the competitive treatment, even if not statistically significant. If we consider as cheating also when an individual indicates only one maze more than actually solved, than the sample mean for the frequency of cheating remains virtually constant for men in the two treatments, while women's frequency to cheat still increases under competition.

"any form of cheating" we do not find any sex-difference (Pearson Chi-Square = 0.3693, p = 0.543, two-tailed). However, if we examine each treatment separately (for the respective frequencies see Table 1), we find a marginally significant sex difference in cheating for the competitive treatment (Competitive treatment: Pearson Chi-Square = 3.478, p = 0.062; non-competitive treatment: Pearson Chi-Square = 1.012, p = 0.314, both two-tailed).[14]

When we compare how much individuals exaggerate the number of mazes they have solved, we obtain no significant effect for sex in any of the treatments (competitive: t = .860, p = .396, noncompetitive: t = .086, p = .932, two-tailed).

The probability to cheat in more detail

Table 2 now presents a more detailed analysis of how the probability that a person cheats in any way is affected. The coefficients represent marginal effects. In the first specification we merely control for treatment, sex and the interaction between the two. In the following specifications we further include the main subject studied by participants in the experiment (base category: economics), as well as additional information collected in our survey. While in column 1 the effect of competition just falls short of reaching significance, specifications in column 2 and 3 indicate that the probability of cheating is increased by 41 – 48 percentage points in the competitive treatment. This, however, is only true for women, as for men this effect is offset by a negative interaction effect of similar size (39 – 42 percentage points). Men, therefore, do not appear to significantly change their cheating behaviour under competitive pressure. This confirms our previous results. Furthermore, individuals who enjoyed playing mazes in the experiment were significantly more likely to cheat – however, probably the causality is reversed and those subjects who cheated found the play much more delightful.[15]

Cheating and ability

In the next step we are interested in whether the ability to conduct a certain task affects the cheating behaviour of individuals. Subjects who know that they cannot perform very well in comparison to the people they are competing against may engage in cheating as a 'face saving strategy' – simply to avoid embarrassment. They may also find it necessary to make use of illegitimate tactics to retain some chances to succeed under increased competitive pressure. Studies that investigate cheating in the classroom have indeed suggested that particularly poor

[14] We conduct a two-tailed test since we do not have a hypothesis about the direction of a sex difference with respect to cheating.

[15] If we apply the same specifications to examine how individuals exaggerate the number of mazes they have solved in a Tobit analysis (not shown), we also find a positive effect of competiton that is significant at the 10% level.

performers engage in cheating activity (Kerkvliet and Sigmund, 1999; Bunn et al., 1992). Since women on average performed worse in the task than men (the correlation between male sex and the number of mazes solved is 0.42), this may explain the observed sex difference in cheating in reaction to competition. This sex difference is all the more surprising given that previous research has suggested that women are, if anything, less prone to find acts of cheating justifiable (Torgler and Valev, 2006). To examine the question whether ability is the driving force that induces heightened levels of cheating, we classified our subjects as either 'good' or 'bad players', depending on whether they managed to solve more or less than the median amount of mazes (27 mazes)[16]. Table 3 illustrates the cheating behaviour of the two groups and shows that those who perform poorly do not only increase their probability to engage in any form of cheating (good players: Pearson Chi Square = 1.402, p = .118; bad players: Pearson Chi Square = 2.837, p = .046, both one-tailed) but also cheat more heavily by more severely exaggerating the number of mazes solved when under competition (good players: t = -.146, p = .443; bad players: t = - 1.534, p = 0.069, both one-tailed, for bad players t-test for unequal variances).[17] The latter is also illustrated in Figure 3. For good players, on the other hand, no significant change in behaviour with respect to frequency and intensity of cheating is found between the two treatments.

In Table 4 we now replicate the previous analysis but additionally control for the ability of a player and furthermore account for an interaction effect of ability and competition in column 4-6. As it turns out, once we include the latter, the interaction effect of competition and male sex becomes insignificant. Indeed, good players cheat significantly less under competitive pressure than bad players (-44 – 49 percentage points) and the correlation of the ability of players and sex is responsible for what has previously appeared as a sex effect of competition on cheating.

The probability that an individual is prepared to cheat is probably the most interesting but not the only available variable to investigate the effect of economic competition on cheating. We can also examine whether people cheat more heavily under competitive pressure. For example, under competition they may increase the number of levels on which they cheat – as has been pointed out, subjects could lie about their results or use various

[16] Following this definition those players who solved >= 27 mazes were considered "good players", those who solved < 27 mazes were classified as "bad players".

[17] Potentially not all our "bad players" are of low ability, but merely put less effort in actually solving mazes as they substitute effort for cheating. While we cannot rule out this possibility, we think it is of a minor problem. First, as mentioned above, women have been found to perform less well in solving mazes also without a possibility to cheat in previous studies. As mainly women constitute the poor performers, this can at least partially be attributed to their lower general ability in solving mazes. Second, if there is a substitution of effort against cheating, women would constitute "irrational cheaters" as not only their number of actually solved mazes is lower than that of men but also the number of indicated mazes. If they would compensate low effort for cheating they were still doing insufficiently so.

illegitimate measures to facilitate the task. Furthermore, individuals could lie more heavily under competitive pressure. We will examine these questions in the following.

The cheating of an individual in, for example, two different ways instead of one way represents heavier cheating. However, it is unclear whether to judge this behaviour as double as severe as the cheating of a subject who merely uses one single cheating strategy. Consequentially we estimated an ordered probit of the number of ways an individual cheated as presented in Table 5. We find that in the competitive treatment individuals significantly increase the ways they use for cheating. Again it turns out that this effect primarily holds for low ability players, as the effect of competition is muted for the good players. The interaction effect of good player and competition does not always reach significance though. Again people who enjoy the game cheat more – or rather the other way around.

Finally, in Table 6 we look at the intensity of cheating as represented by the difference of the number of mazes indicated versus actually solved by an individual. Since this difference has a natural cut-off point at zero, we conduct a Tobit estimation. Again, the effect of competition is positive, but less significant.[18] It appears that good players may generally exaggerate less with respect to the number of mazes they indicate as solved – not only in the competitive treatment. Interestingly those subjects who like games of the kind used in the experiment lie less with respect to the amount of mazes they have solved while they do not appear to cheat less in general. This may mean that these individuals, who seem to represent 'game afficiados', happily cheat with the tools such a game supplies itself, while they may perceive it as dishonourable to blatantly lie about one's result.

Conclusion

In this paper we investigated how increased competitive pressure affects individuals' work behavior if there is a possibility to lie about one's performance or to cheat in the acquisition of a certain work outcome. First of all, when there is an opportunity to cheat we do not find that individuals increase their effort under competition as commonly assumed and empirically found in some experiments (e.g. Gneezy et al., 2003; Gneezy and Rustichini, 2004).[19] It seems that if individuals recognize a possibility to cheat, their incentives to increase effort under competition are muted. Second, while we do not find any significant sex difference in the overall amount of cheating in our experiment, women do significantly increase their cheating activity under competitive pressure while men do not significantly change their

[18] Apart from column 5 and 6 where the effect is significant at the 5% level, only a significance level of 10% is reached.
[19] Also Brandts et al. (2006) do not find an increase in efficiency as a result of heightened competition.

behavior. However, further investigation shows that it is not sex but ability that drives these results. In our sample women are doing significantly worse in the task at hand and are disproportionally clustered in the category of poor performers. Once we control for the fact that an individual is of high or low ability the sex-difference in cheating disappears. Instead it turns out that individuals who are less able to fulfill the assigned task do not only have a higher probability to cheat, they also cheat in more different ways. It appears that poor performers either feel entitled to cheat in a system that does not give them any legitimate opportunities to succeed, or they engage in a "face-saving" activity to avoid embarrassment for their poor performance.[20] This result corresponds with earlier findings that cheating in the classroom is particularly common among poor performers (Kerkvliet and Sigmund, 1999; Bunn et al., 1992).

However, we caution to generalize that it is necessarily individuals with little chances to win who decide to cheat, but believe that this finding may depend on the specific setting. For example in sports also top performers have been found to be involved in doping scandals. In contrast to sport or many other real-life tournaments, in our experiment the ability of players is relatively heterogeneous.[21] As a result in our tournament top players do not face such strong competition from others – even if these cheat. In sports (or top management), however, the competition is primarily between individuals of much more identical ability. As a result, a little cheating may determine whether one becomes the "winner" or not, while players of lower ability may have little chance to get to the top – no matter whether they cheat or not. Also with respect to scandals in academia, where for example research results have been feigned, or accounting frauds in management it can hardly be argued that the people involved are of "low ability." It may be, however, that a temporary lack of luck or the feeling that in a competitive "dog eats dog" society one has to assist one's luck, also drives individuals of higher ability into the temptation to cheat.

[20] Indeed, in our sample only one cheater actually wins a tournament as a result of her cheating behavior.
[21] It also has to be noted that in our experiment the stakes to cheat may be much lower as the "price" of winning can barely be compared with any real-life tournament price.

References

Antonovics, Kate; Peter Arcidiacono and Randall Walsh (2003): Competing Against the Opposite Sex, Working Paper.

Arslan, Neslihan; Christina Günther, Christiane Schwieren and Martin Strobel (in progress): Women Do Not Compete? The Role of Stereotype Threat, Manuscript.

Becker, Gary (1968): Crime and Punishment: An Economic Approach, Journal of Political Economy, 76(2), 168-217.

Becker, Gary S.: The Economics of Discrimination, University of Chicago Press, Chicago, 1957.

Brandts, Jordi; Arno Riedl and Frans van Winden (2006): Competition and Well-Being, CEPR Working Paper.

Bunn, Douglas N.; Steven B. Caudill and Daniel M. Gropper (1992): Crime in the Classroom: An Economic Analysis of Undergraduate Student Cheating Behavior, Journal of Economic Education, 23(3), 197-207.

Cabrales, A, Charness, G, Villeval, M.-C. (2006) Competition, Hidden Information and Efficiency: An Experiment, IZA Discussion Paper No. 2296

Carpenter, Jeffrey; Petter Hans Matthews, John Schirm (2007): Tournaments and Office Politics: Evidence from a Real Effort Experiment, IZA Discussion Paper No. 2972.

Datta Gupta, Nabanita; Anders Poulsen and Marie-Claire Villeval (2005): Male and Female Competitive Behavior: Experimental Evindence, IZA Working Paper 1833.

Frank, Robert H. and Philip J. Cook (1995): The Winner-Take-All Society, New York: Free Press.

Franzoni, Luigi Alberto (2000): Tax Evasion and Tax Compliance, in: Bouckaert, Boudewijn and Gerrit de Geest (eds.), Encyclopedia of Law and Economics, Vol. 4, Cheltenham: Edward Elgar, 52-94.

Gneezy, Uri; Muriel Niederle and Aldo Rustichini (2003): Performance in Competitive Environments: Gender Differences, Quarterly Journal of Economics, 1049-74.

Gneezy, Uri and Aldo Rustichini (2004): Gender and Competition at a Young Age, American Economic Review, 94(2), 377-81.

Harbring, Christine and Bernd Irlenbusch (2003a): How Many Winners are Good to Have? On Tournaments with Sabotage, Journal of Economic Behavior and Organization, forthcoming.

Harbring, Christine and Bernd Irlenbusch (2003b): Sabotage and the Endogenous Design of Tournaments, University of Bonn Working Paper.

Harbing, Christine; Bernd Irlenbusch, Matthias Krackel and Reinhard Selten (2004): Sabotage in Asymmetric Contests – An Experimental Analysis. International Journal of the Economics and Business, forthcoming.

Holingshead, Andrea; Gwen M. Wittenbaum; Gwen Costa Jacobsohn and Samuel N. Fraidin (2005): The Impact of Competitive Members, Working Paper.

Kerkvliet, Joe and Charles L. Sigmund (1999): Can We Control Cheating in the Classroom? Research in Economic Education, 30(4), 331-343.

Nagin, Daniel S.; James B. Rebitzer; Seth Sanders and Lowell J. Taylor (2002): Monitoring, Motivation, and Management: The Determinants of Opportunistic Behavior in a Field Experiment, American Economic Review, 92(4), 850-873.

Niederle, Muriel and Lise Vesterlund (2005): Do Women Shy Away From Competition? NBER Working Paper 11474.

Preston, Ian and Stefan Szymanski (2003): Cheating in Contests, Oxford Review of Economic Policy, 19(4), 612-624.

Price, Joseph (2006): Gender Differences in the Response to Competition, Working Paper.

Torgler, Benno and Nevent T. Valev (2006): Women and Illegal Activities: Gender Differences and Women's Willingness to Comply over Time, Andrew Young School of Policy Studies Research Paper.

Vandegrift, Donald; Abdullah Yavas and Paul M. Brown (2004): Men, Women and Competition: An Experimental Test of Labor Market Behavior, Working Paper.

Shleifer, Andrei (2004): Does Competition Destroy Ethical Behavior? American Economic Review, 94(2), 414-418.

Figures

Figure 1: The maze game

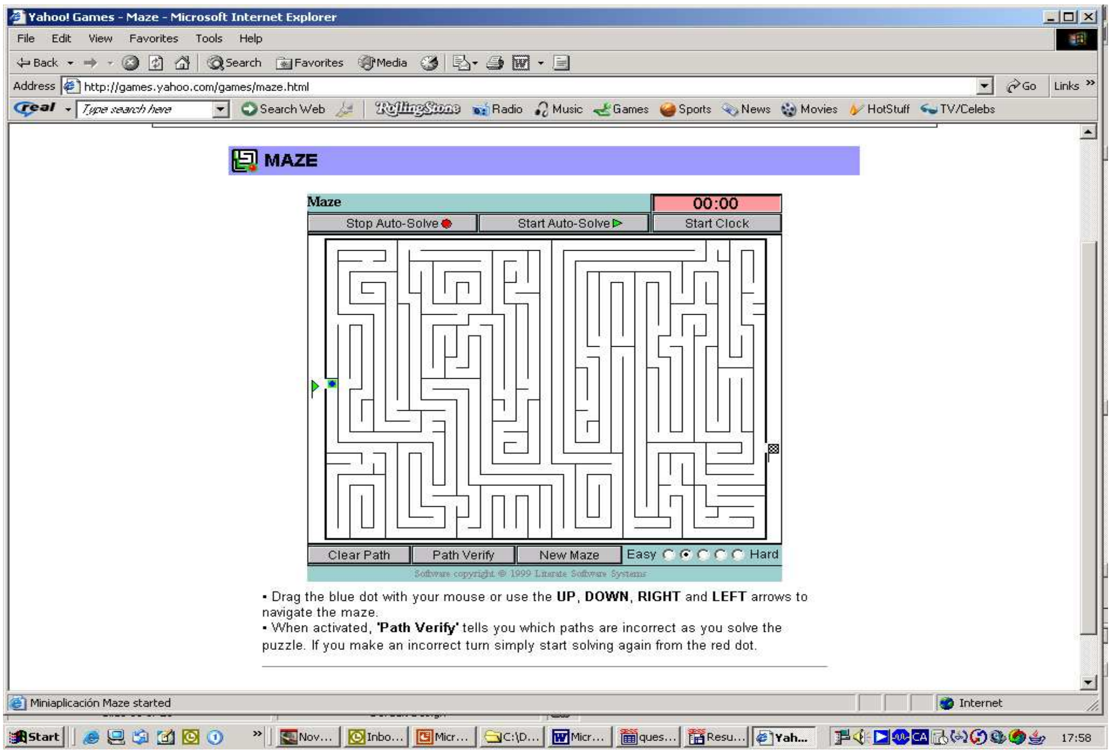


Figure 2

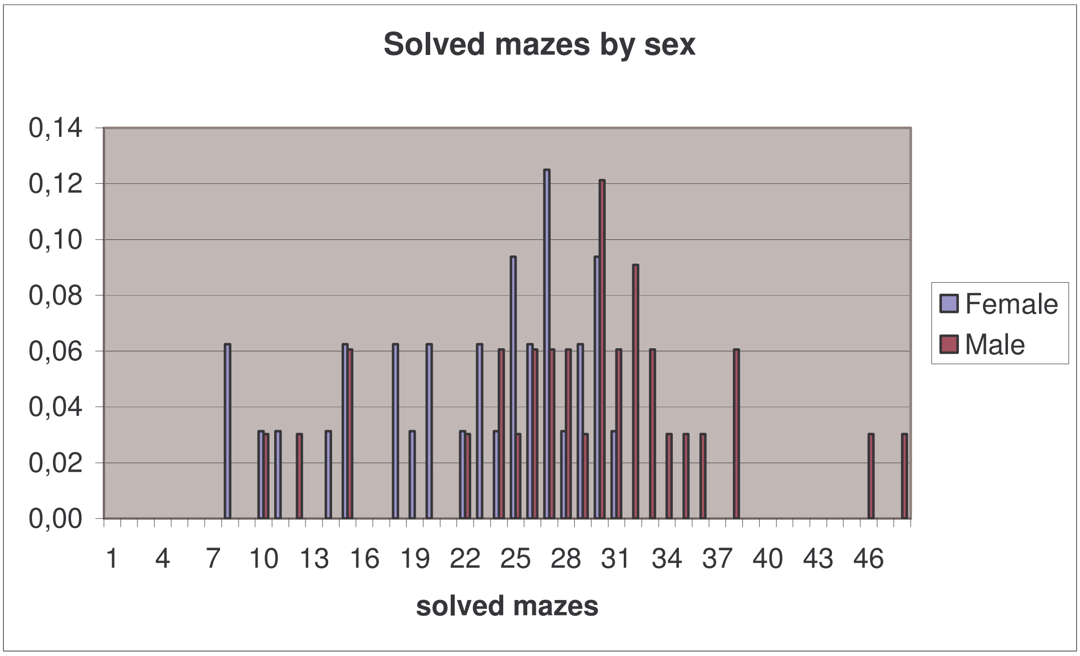
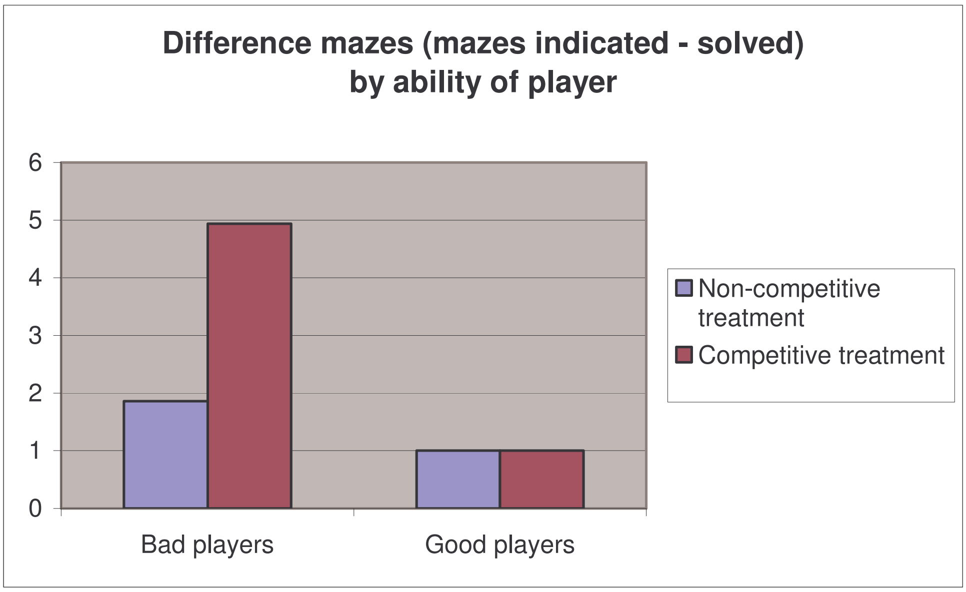


Figure 3


Difference mazes (mazes indicated - solved)
by ability of player
6
5
4
3
2
1
0
Bad players
Good players
Non-competitive treatment
Competitive treatment

Tables

Table 1 : Descriptive statistics[22]

Non-competitive treatment

Variable	All (N = 32) Mean	SD	Women (N=17) Mean	SD	Men (N=15) Mean	SD
Mazes indicated	27.47	7.79	23.65	6.66	31.8	6.76
Mazes solved	26.09	8.17	22.23	7.11	30.47	7.17
Cheating						
Any form of cheating	0.375	0.491	0.294	0.47	0.467	0.516
Difference mazes (= mazes indicated – solved)	1.31	2.79	1.35	3.48	1.27	1.83
Use of difference mazes (>1)	0.312	0.471	0.235	0.437	0.400	0.507
Use of Auto-Solve	0.062	0.246	0.059	0.242	0.067	0.258
Use of Path Verify	0.062	0.246	0.059	0.242	0.067	0.258
Change of level of difficulty	0.031	0.177	0	0	0.067	0.258

Competitive treatment

Variable	All (N = 33) Mean	SD	Women (N=15) Mean	SD	Men (N=18) Mean	SD
Mazes indicated	28.24	7.52	25.93	6.23	30.17	8.11
Mazes solved	25.21	8.46	22.13	6.71	27.78	9.07
Cheating						
Any form of cheating	0.424	0.502	0.600	0.517	0.278	0.461
Difference mazes (mazes indicated – solved)	2.91	5.41	3.8	5.97	2.17	4.95
Use of difference mazes (>1)	0.394	0.50	0.533	0.516	0.278	0.461
Use of Auto-Solve	0.121	0.331	0.200	0.414	0.055	0.236
Use of Path Verify	0.121	0.331	0.133	0.352	0.111	0.323
Change of level of difficulty	0	0	0	0	0	0

[22] The difference between subtraction of the mean of mazes solved from the mean of mazes indicated with the difference-mazes variable is due to the fact that the latter excludes differences = 1, as described before.

Table 2: Marginal probability of any kind of cheating

	(1)	(2)	(3)
	cheated in any way	cheated in any way	cheated in any way
Competitive treatment	0.298	0.414	0.481
	(0.164)	(0.175)*	(0.184)**
Male	0.175	0.079	0.132
	(0.171)	(0.218)	(0.227)
Competitive treatment * male	-0.424	-0.391	-0.422
	(0.162)**	(0.191)*	(0.181)*
Studies (base: economics):			
Humanities		0.296	0.264
		(0.269)	(0.320)
Technology		0.439	0.446
		(0.214)*	(0.235)
Law		-0.058	-0.139
		(0.263)	(0.248)
Business		0.209	0.323
		(0.178)	(0.196)
Other studies		0.245	0.367
		(0.219)	(0.230)
Age			0.027
			(0.026)
Enjoyed the play			0.229
			(0.082)**
Enjoys games in general			-0.158
			(0.096)
Observations	65	65	65

Standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 3: Descriptive statistics by ability of players

Non-competitive treatment

Variable	All (N = 32) Mean	SD	Bad players (N=14) Mean	SD	Good players (N=18) Mean	SD
Cheating						
Any form of cheating	0.375	0.491	0.286	0.469	0.444	0.511
Difference mazes (= mazes indicated – solved)	1.37	2.78	1.86	3.90	0.89	1.45

Competitive treatment

Variable	All (N = 33) Mean	SD	Bad players (N=17) Mean	SD	Good players (N=16) Mean	SD
Cheating						
Any form of cheating	0.424	0.502	0.588	0.507	0.25	0.447
Difference mazes (mazes indicated – solved)	3.03	5.35	4.88	6.90	0.81	1.60

Table 4: Marginal probability of any kind of cheating considering quality of player

	(1)	(2)	(3)	(4)	(5)	(6)
	cheated in any way	cheated in any way	cheated in any way	cheated in any way	cheated in any way	cheated in any way
Competitive treatment	0.298	0.412	0.477	0.422	0.606	0.691
	(0.164)	(0.176)*	(0.185)**	(0.174)*	(0.175)**	(0.170)**
Male	0.222	0.142	0.158	0.129	0.080	0.071
	(0.178)	(0.225)	(0.234)	(0.193)	(0.230)	(0.240)
Competition*male	-0.439	-0.406	-0.427	-0.347	-0.312	-0.315
	(0.159)**	(0.187)*	(0.180)*	(0.198)	(0.228)	(0.230)
Good player	-0.109	-0.152	-0.069	0.105	0.131	0.303
	(0.133)	(0.142)	(0.160)	(0.196)	(0.205)	(0.228)
Good player*comp				-0.344	-0.445	-0.493
				(0.192)	(0.166)**	(0.152)**
Studies:						
Humanities		0.264	0.261		0.367	0.332
		(0.277)	(0.320)		(0.266)	(0.319)
Technology		0.440	0.449		0.412	0.395
		(0.218)*	(0.236)		(0.236)	(0.264)
Law		-0.115	-0.161		-0.223	-0.255
		(0.254)	(0.243)		(0.212)	(0.190)
Business		0.238	0.328		0.278	0.380
		(0.180)	(0.195)		(0.182)	(0.197)
Other studies		0.247	0.358		0.292	0.435
		(0.222)	(0.233)		(0.231)	(0.239)
Age			0.024			0.042
			(0.027)			(0.029)
Liked game			0.224			0.214
			(0.082)**			(0.083)*
Likes games			-0.150			-0.144
			(0.098)			(0.100)
Observations	65	65	65	65	65	65

Standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 5: Ordered probability of number of ways an individual cheated (0-4)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	nr of ways cheated	nr of ways cheated	nr of ways cheated	nr of ways cheated	nr of ways cheated	nr of ways cheated	nr of ways cheated
Competitive treat	0.777	0.772	1.016	1.217	1.096	1.545	1.921
	(0.422)	(0.422)	(0.481)*	(0.527)*	(0.486)*	(0.578)**	(0.660)**
Male	0.426	0.470	0.232	0.324	0.242	0.068	0.117
	(0.428)	(0.452)	(0.551)	(0.574)	(0.479)	(0.560)	(0.583)
Competition*male	-1.076	-1.095	-0.924	-1.029	-0.772	-0.587	-0.638
	(0.595)	(0.599)	(0.666)	(0.693)	(0.642)	(0.698)	(0.727)
Good player		-0.097	-0.229	-0.025	0.425	0.442	0.910
		(0.322)	(0.345)	(0.387)	(0.494)	(0.516)	(0.621)
Good player*comp					-0.925	-1.271	-1.597
					(0.658)	(0.716)	(0.807)*
Studies:							
Humanities			0.429	0.476		0.639	0.621
			(0.683)	(0.770)		(0.708)	(0.796)
Technology			1.020	1.051		0.912	0.880
			(0.617)	(0.641)		(0.622)	(0.651)
Law			-0.474	-0.700		-0.773	-1.026
			(0.727)	(0.785)		(0.752)	(0.819)
Business			0.507	0.669		0.612	0.819
			(0.430)	(0.459)		(0.438)	(0.474)
Other studies			0.375	0.660		0.416	0.760
			(0.506)	(0.548)		(0.518)	(0.569)
Age				0.059			0.102
				(0.064)			(0.069)
Liked play				0.578			0.563
				(0.198)**			(0.201)**
Likes games				-0.373			-0.358
				(0.237)			(0.241)
Observations	65	65	65	65	65	65	65

Standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 6: Tobit analysis of difference mazes solved and mazes indicated

	(1) Diff. mazes	(2) Diff. mazes	(3) Diff. mazes	(4) Diff. mazes	(5) Diff. mazes	(6) Diff. mazes	(7) Diff. mazes
Competitive treat.	6.853	6.582	6.987	6.448	8.059	8.892	8.624
	(3.910)	(3.684)	(3.824)	(3.809)	(4.007)*	(4.317)*	(4.324)
Male	2.254	4.856	-0.927	-2.381	3.229	-1.555	-3.281
	(4.000)	(4.052)	(4.769)	(4.974)	(4.253)	(4.661)	(4.880)
Competition*male	-7.139	-8.157	-3.090	-1.395	-5.997	-1.695	0.405
	(5.513)	(5.275)	(5.523)	(5.548)	(5.582)	(5.555)	(5.602)
Good player		-5.604	-7.734	-5.632	-2.446	-4.589	-1.706
		(2.821)	(2.860)**	(2.886)	(4.255)	(4.139)	(4.382)
Good player*comp					-5.335	-5.522	-6.500
					(5.602)	(5.571)	(5.724)
Studies:							
Humanities			-1.447	-7.698		-0.277	-7.124
			(6.050)	(7.790)		(6.045)	(7.735)
Technology			12.268	11.466		11.339	10.212
			(5.183)*	(4.978)*		(5.129)*	(4.982)*
Law			-3.928	-4.067		-5.094	-5.401
			(5.545)	(5.378)		(5.615)	(5.471)
Business			5.775	6.155		6.062	6.384
			(3.491)	(3.406)		(3.492)	(3.400)
Other studies			0.812	1.318		1.069	1.628
			(4.116)	(4.051)		(4.098)	(4.022)
Age				0.812			0.957
				(0.542)			(0.554)
Liked play				2.982			2.732
				(1.481)*			(1.465)
Likes games				-3.720			-3.402
				(1.847)*			(1.826)
Constant	-6.327	-4.094	-4.516	-19.710	-4.893	-5.750	-24.312
	(3.206)	(3.058)	(3.944)	(11.906)	(3.210)	(4.208)	(12.760)
Observations	65	65	65	65	65	65	65

Standard errors in parentheses
* significant at 5%; ** significant at 1%

Appendix

INSTRUCTIONS

Thank you for participating in this experiment and for contributing to a research project of the Economics Department. The money you earn in the experiment will be paid privately at the end of the experiment. From now until the end of the experiment you are not allowed to communicate with the other participants. If you have any questions, please raise your hand and one of the experimenters will answer your questions privately. Pease, do not ask aloud!

In this experiment we ask you to solve mazes. In the first part you have the possibility to solve some mazes for trial to get familiar with the task. In the second part we will pay you for what you do.

Trial:
In this first part you are asked to solve one or two mazes in difficulty level 2 to get familiar with the task. You find a maze with difficulty level 2 on your screen.

Computer use:
You are only allowed to use the arrows to move the marker through the maze. Each game is only finished and solved when the marker reaches the end of the maze together with the sign with the phrase "Yahoo! You have successfully solved the puzzle". You need to use the mouse to click "OK" and "New maze".

If you have questions, please ask the experimenter privately.

Second part: [competitive treatment]

In this part of the experiment you are part of a group of 6 randomly selected subjects (including you). We ask you to solve mazes for exactly 30 minutes.

Please wait until the experimenter tells you to load a new maze to start.

Payment:
In each group of 6 subjects, only the participant who solved the largest number of mazes is paid € 1,80 for each maze he or she solved. In case of a tie, the winners share the payment equally. In addition you will receive € 3,- for having participated in the experiment. The other participants receive no pay in addition to the € 3,- show-up fee.

Computer use:
You are only allowed to use the arrows to move the marker through the maze. Each game is only finished and solved when the marker reaches the end of the maze together with the sign with the phrase "Yahoo! You have successfully solved the puzzle". You need to use the mouse to click "OK" and "New maze". Then you can start the new maze using the arrows. Do not use any other function available.

After finishing a maze, record the current time in the following table to document the numbers of mazes you have solved. Only this way we can know how many mazes you solved for paying you. The experiment closes after this part of the experiment (30 minutes). You will be paid in cash directly afterwards.

If you have questions, please ask the experimenter privately.

Second part: [piece rate condition]

In this part of the experiment we ask you to solve mazes for exactly 30 minutes.

Please wait until the experimenter tells you to load a new maze to start.

Payment:
The amount of money you get paid at the end of the experiment depends of the number of mazes that you solve. For each maze that you solve, you will receive 30 cents. In addition you will receive € 3,- for having participated in the experiment. You will be paid directly after finishing the experiment in cash.

Computer use:
You are only allowed to use the arrows to move the marker through the maze. Each game is only finished and solved when the marker reaches the end of the maze together with the sign with the phrase "Yahoo! You have successfully solved the puzzle". You need to push the mouse to click "OK" and "New maze". Then you can start the new maze using the arrows. Do not use any other function available.

After finishing a maze, record the current time in the following table to document the numbers of mazes you have solved. Only this way we can know how many mazes you solved for paying you. The experiment closes after this part of the experiment (30 minutes). You will be paid in cash directly afterwards.

If you have questions, please ask the experimenter privately.

Maze	Time finished (hour:minutes) e.g. 12:13
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48	
49	

Maze	Time finished (hour:minutes) e.g. 12:13

Questionnaire

How much did you enjoy solving mazes?

Very much 1 2 3 4 5 not at all

How good do you think you are in solving mazes, compared to other students?

☐ Better
☐ Equal
☐ Worse

[In the competitive treatment:]

How much do you like competitive games like this?

Very much 1 2 3 4 5 not at all

What is your age? ________

What is your sex? M F

What do you study? ________