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Why gender based game theory?

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Abstract

The behavior of men and women in a number of games free of social issues is explored. The analysis is conducted for simple (2x2) and complex (guessing) games and in static and repeated settings. No gender effect is observed either in static nor in repeated games. It is concluded that gender bias vanishes in the absence of social issues.

Keywords: Gender bias, dominated strategies, Nash equilibrium, learning.

JEL Class.: C91, J16, C72.

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1 Introduction

Gender is now a salient issue in Economics. Part of this new fashion arises from a number of experimental papers showing that females behave differently than males. Although many cases are well established -- for instance, it is a sufficiently well-known result that women are more risk averse than males (see Byrnes et al. [12], I believe that many other cases deserve more attention. Recently, Binmore [7] argued that the observed non-rational behavior in some (social) games, such as the prisoner's dilemma, might be explained simply by the framing of the game. This frame triggers a social norm that the players are accustomed to using when going about their everyday affairs.

Most of the gender bias reported in experimental games arises, precisely, from contexts attached to clear pro-cooperative features that enlarge the social attributes of the game (in Andreoni & Miller [5] sense). A non-exhaustive list of these "social" games would include dictator's, prisoner's dilemma, ultimatum, trust games and so on.

For instance, regarding altruism, both Eckel & Grossman [16] and Andreoni & Vesterlund [4] report gender bias in favor of more generous women. Harbaugh et al. [20], using a children pool, observe that boys seem to contribute 26% less than girls. Taste for fairness seems to follow a similar pattern: Eckel & Grossman [17] observe larger contributions by females in ultimatum games and find that females were much less likely to reject a given offer. Solnick [29] shows that when proposers know the recipient's gender they increase the ultimatum offers. Reciprocity is also much more pronounced for women. Using a trust game, Croson & Buchan [14] find that women return a larger proportion of the money sent by an anonymous partner than men do.¹

¹ But not all the evidence is positive for women. In public good experiments, Brown Kruse & Hummels [11] find that women contribute significantly less than men.

However, most of the observed gender bias might be explained using both Binmore's [7] and Andreoni & Miller's [5] ideas combined with some well-known and documented results in the field of psychology (see for instance Fabes & Eisenberg [18]): there are sex differences in "prosocial" reasoning whereby females are "better" than men.

Following this argument, games without any social issue should be gender-bias free. This conjecture might explain, for instance, why Mason et al. [25] not find any differences in behavior in duopoly experiments. To verify this idea I revise experimental data arising from a number of previous papers in the search for any gender bias. It is important to note that none of the papers was designed to check gender issues. The criteria I follow to select these games were, precisely, the complete absence of any social issue in the task.

I revise data arising from one-shot and repeated games. The selected games are: a 2x2 solvable game (without any Pareto attractor), a set of lotteries, a beauty contest and a traveler's dilemma game in static and repeated settings. The results are substantive: none of the cases studied supports gender bias.

The rest of the paper is structured as follows. In Section 2 the role of gender in experimental one-shot games is examined, while gender bias in repeated tasks is analyzed in Section 3. Finally, conclusions are drawn in the last section.²

2 One shot games

As a departing point I chose the most basic case: the role of gender in playing dominated strategies and the Nash equilibrium in 2x2 games. Later we will study more

² As the reader may have noted, there is no section devoted to experimental design. In fact I did not run any additional experimental session to check the gender bias since I use data from other experiments that have already been published or are pending publication. Readers may check instructions and so on in the originals. All data, including papers and instructions, are available at:
<http://www.ugr.es/~pbg/material/intro.htm>

complex experimental games involving depth of reasoning (Beauty contest and Traveler's dilemma games). For purposes of simplicity, I will only show the relevant statistics at hand. If the study variable is binary (for instance, women yes/no) I use Pearson χ^2 . However, when there is an insufficient number of observations I use the LM-TR² test. In the case of non-categorical variables I use non parametric tests for non-paired k=2 samples: the Mann-Whitney and the Kolmogorov-Smirnov test.

A dominance solvable 2x2 game

Let us start with the simplest situation: a dominance solvable 2x2 game. The row player has to choose between strategy A and B . For instance, the payoffs associated to A are $pu(A,A)+(1-p)u(A,B)=pu(4)+(1-p)u(8)$, while the corresponding payoffs associated to B are $pu(3)+(1-p)u(0)$. Obviously, strategy B is strictly dominated by A and thus there is a unique Nash Equilibrium (A,A) .

Our first example reports evidence from 242 (132 women) individuals arising from Brañas et al. [9]. Subjects faced a situation similar to the one explained above: row players had to choose A or B against a machine (column player) choosing A or B with $p=0.5$. As expected, the vast majority of players chose A (98%) and only a minority played the dominated strategy.³

Interestingly, a mere 0.9 % (1 individual) of the male population chose B in contrast to 2.2% of the women. Nonetheless, this difference is not significant ($LR=0.72$; $p=0.39$). Thus, there is no gender bias.

Traveler's dilemma game

The traveler's dilemma game (TDG for short) is another dominance solvable 2-player game albeit a bit more complex (see Capra et al. [13]). Players are asked to

³ Brañas et al. [10] uses an identical setting in the first round of a three-stage game. The percentage of subjects playing A is the same: 98 out of 102 subjects.

claim a bid in a defined interval, usually [20,120]. The subject who claims a larger bid receives a penalty, whereas the rival (with a smaller claim) receives a reward. Given these rules, no rational player chooses the maximum, that is 120, as this strategy is clearly dominated by $120-\epsilon$.

Brañas et al. [8] reports data from 240 subjects⁴ (126 women) playing the (one-shot) traveler's dilemma. Only 5.8% of the players chose the largest bid: 120. Just 3.8% of the women chose 120, but twice the number of males made the same choice, that is, 8.2%. However, the observed difference is not significant (Pearson $\chi^2 = 2.13; p = 0.14$).

Note that the inverse behavior is precisely to play the Nash equilibrium, that is to choose the lowest claim: 20. Interestingly, a significant number of subjects played the equilibrium, 73 individuals (30.4%). Differences among women and men are clearly negligible (27.5% vs. 32.%) as reflected by the Pearson test: $\chi^2 = 0.79$ ($p = 0.37$). In sum, there is no gender bias in the TDG.

Beauty contest game

The Beauty Contest Game (BCG) is a guessing game that makes it easy to evaluate individuals' level of reasoning (see Nagel [26]). Subjects are invited to play a game in which all of them must simultaneously choose a real number from an interval (generally [0, 100]). The winner is the player who chooses the number that is closest to p -times the mean of all the numbers chosen, where $1 > p > 0$ (see Bosch-Domenech et al. [6], for further details). Stahl [30] notes that the distribution of chosen numbers permits us to analyze the depth of reasoning of the agents. Level 1 includes people who expect the other players to behave randomly so they choose p -mean (where the mean = 50 if

⁴ The participants in experiments [1], [8] and [9] are not the same in all cases but there are some coincidences. Participants in [1] are from Jaen whereas experimental subjects in [8] and [9] are from Granada. Coincidences between the later ones are high ($[8] \cap [9] = 49.5\%$ of 366 subjects).

the choice distribution is uniform), level 2 contains people who expect that the depth of reasoning of others is level 1 and thus choose p^2 -mean, To generalize, at level K there are people who choose p^K -mean. If we repeat the process ad infinitum ($K=\infty$) we reach the theoretical solution, 0 - the highest level of reasoning. Ho et al. [22] (pg. 951) show that analogous results are obtained using iterated reasoning. Note that the interval [66.6, 100] corresponds to irrational behavior since it is dominated. Rational individuals will always choose a number in the [0, 66.6] interval. Applying the same reasoning, $R(1)$ players will choose a number below 66.6, but above 44.4 ($2/3 \cdot 66.6$) ... Following this iterated reasoning level process ad infinitum, we reach the unique Nash equilibrium (0, with $R(\infty)$).

Let us now revise gender bias in data arising from Alba et al. [1]. The sample consists of 139 subjects (91 women). First, we analyze the idea of irrationality proposed by Ho et al. [22]. Any guess within the interval [66.6; 100] is an irrational behavior since it is dominated. As expected, very few individuals chose the dominated strategy (11 subjects, 8%)⁵, but no gender differences are supported. In fact, 93.5% of the men and 91.2% of the women played rationally. The Pearson test supports an identical conclusion: $\chi^2 = 0.27$ ($p = 0.59$).

Secondly, we analyze gender bias when playing the Nash equilibrium. As expected, just 3 subjects chose 0, two of whom were males. However this difference is not significant ($LR = 1.31$; $p = 0.25$).

Finally, we revise the pattern described by Stahl [30] as $k=1$ behavior, that is, subjects who chose 33.3 (p -mean assuming a uniform distribution of the guesses for $p=2/3$). Twelve individuals followed the pattern described by Stahl (9.9% of the women

⁵ In Alba et. al [2] we allowed subjects to talk to each other for the purpose of cooperation. We found that very few subjects played dominated strategies in most of the 11 groups who performed the one-shot BCG although, and amazingly, one of the other groups involved (fig. 8, pag. 378; group A1-B) coordinated within the dominated area.

and 6.3% of the men). The LR test shows that there are no differences between samples, $LR=0.55$ ($p=0.45$). In sum, the static version of the BCG does not support any gender bias.

Summary 1: In 2x2, TDG and BCG no gender bias is supported when playing the dominant strategy nor in the best response.

Summary 2: also, no gender bias appears when playing the Nash equilibrium.

Remark 3: In static tasks without any social issue, women and men behave in a similar way when they have to choose.

3 Repeated tasks

As in daily life, most of the data reported in experimental papers arise from repeated decision tasks where learning plays a definitive role. Now I analyze gender bias in repeated versions of the BCG and TDG with transfers. Finally I study the role of gender in consistency across lotteries following Georgantzis et al. [19].

Feedback learning in BCG

In most of the repeated games subjects learn not only from their own actions (feedback-free learning, see Weber [32]), but also from the information provided (or observed). This feedback may refer to the outcome (and payoff) or any other variable, for instance how other players have performed the same task. A simple and well-documented feedback learning is the one observed in a repeated BCG in which subjects are informed about the average of the previous rounds. Ho et al. [22] or Nagel [26] show that this sort of information accelerates convergence to the Nash equilibrium.

Let us now check for gender bias in the learning process using data from Alba et al. [1]. Two-thirds of the individuals (86 out of 139; of which 91 are women) reacted to the average of other players' choices by converging to the equilibrium (comparing the

second round guess with the first round guess, $\Delta g_{i,t} = g_{i,t} - g_{i,t-1} < 0$); 32.6% of the males (38.8% for women) did not react. As in static cases, no gender effect is observed (Pearson $\chi^2 = 0.51$, $p = 0.47$).

Given that Alba et al. [1] use four rounds of BCG, we have the chance to study the intensity of learning, that is, the total amount of reaction weighted by their initial guess⁶: $\Delta g_{i,T} = g_{i,T} - g_{i,1} / g_{i,1}$, $T=4$). Very few subjects did not learn at all (26 out of 136, 19.1%) and we did not find any noticeable gender effects (17.3% of males vs. 20% of women). When comparing the full spectrum of values of the sample of men who learned to the subsequent distribution of women, we do not find any differences: the Mann-Whitney ($Z = -1.12$; $p = 0.26$) and the Kolmogorov-Smirnov ($Z = 0.66$; $p = 0.77$) do not reject the null of equal distribution. In sum, feedback learning in BCG does not support any gender bias.

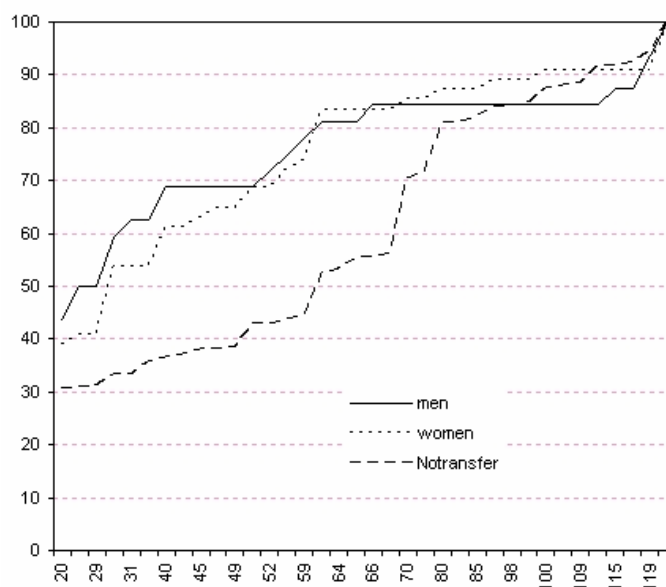
"Transfer" learning in TDG

We will now go on to a more complex concept of learning. Transfer refers to the idea that experience in any task may be transferred to another similar action (see Weber [31]). For instance, a number of subjects play a series of rounds of a game and then they switch to another (related) task. Thus transfer indicates how individuals may use their own previous experience in other game-related tasks.

Although the final version of Alba et al. [1] does not show this data, 86 subjects of the 139 who performed the repeated BCG played a TDG after the last round of the previous game. Figure 1 (guesses are on the horizontal axis whereas the vertical axis shows the cumulative %) compares the cumulative frequency of two one-shot TDGs.

⁶ The 3 subjects who began playing the Nash equilibrium are not considered.

Figure 1



The only difference between both TDGs is that in the "No-transfer" case subjects did not perform any task beforehand, whereas in the other case, subjects played several rounds of BCG. Figure 1 below gives two clear ideas. *i)* previous experience has an effect on how subjects play the current game, that is, there is transfer. For instance, 70% of the subjects with transfer bid a number above 50, while in the other group less than 35% of the players showed a parallel behavior. *ii)* the cumulative distribution of females and men is very similar (none of them stochastically dominates each other).

A series of non-parametric tests reports identical results. The transfer effect is clearly reported in both the Mann-Whitney ($Z=-5.14$; $p=0.00$) and the Kolmogorov-Smirnov tests ($Z=3.14$; $p=0.00$), meaning that the data are not drawn from the same population. The absence of gender bias is also observed when comparing both distributions (of women and men): neither the Mann-Whitney ($Z=-0.46$; $p=0.64$) nor the Kolmogorov-Smirnov test ($Z=0.41$; $p=0.99$) rejects the null hypothesis of equal distribution.

Consistency across lotteries

That women are less risk takers is a well-known result in the experimental literature (see Byrnes et al. [12] for a meta-analysis). Risk aversion is something intrinsic to the individual that might not affect repeated interactions once it is controlled. In contrast, in repeated tasks the outcomes might lead to variations in risk (or premiums) that may generate other sources of gender bias. I want to determine if women - in the repeated context- react to variations in the risk/premium trade-off in a different manner than men. Sabater & Georgantzís [28] provide the proper mechanism for studying this problem.

They design a revised version of the ternary lotteries approach to study consistency across lotteries (see Holt and Laury [22]). To do so, they run a four-panel design. Each panel consists of 11 alternatives. The first alternative (on the left-hand side) is 1€ for sure, while the subsequent alternatives (on the right-hand side) show larger premiums with smaller probabilities.⁷ Individuals are asked to choose the lottery that they prefer most for each panel. By inspection, the farther to the right (the larger premium with the smaller probability) the subject chooses, the less risk averse he is. Risk neutral (loving) subjects would choose $p=0.1$ in all panels. Note that increasing risk is compensated for by a different linear increase in the expected return. As Georgantzís et al. [19] explained, EUT maximization would imply that behavior is consistent across different panels if subjects choose more (or, at least, equally) risky lottery in a panel whose alternatives entail a higher compensation for risk.

⁷ The 4 panels are:

Panel 1:	1€	1.12€	1.12€	...	5.4€	10.9€
p_{win}	100	90	80		20	10
Panel 2:	1€	1.2€	1.5€	...	9€	19€
p_{win}	100	90	80		20	55€
Panel 3:	1€	1.66€	2.5€	...	25€	10
p_{win}	100	90	80		20	10
Panel 4:	1€	2.2€	3.8€	...	45€	100€
p_{win}	100	90	80		20	10

Georgantzís et al. [19] check two patterns of consistency: strong and weak. The former regards behavior that never violates EUT, whereas the latter refers to behavior that violates EUT once (like an error).

We revise data reported in Brañas-Garza et al. [9] to search for gender bias in the risk-premium trade-off. Two-thirds of the subjects did not pass the exam! Only 35% of men and 30% of women were consistent with the EUT. Once more, no gender bias is supported (*Pearson* $\chi^2 = 0.64$, $p = 0.42$).

The relaxed version of the analysis, the weak consistency, allows subjects just one error. The percentage of subjects passing the test does not vary greatly (from 33% to 44.4%) and no gender bias appears as reported by the Pearson test, $\chi^2 = 0.51$ ($p = 0.47$).

Summary 4: In repeated versions of guessing games no gender bias is supported for feedback and transfer learning

Summary 5: also, no gender bias appears in the study of consistency across lotteries.

Remark 6: In repeated tasks, without any social issue, gender bias is not observed.

4 Concluding remarks

This paper shows a series of static and repeated experimental games in order to check gender bias. We use data arising from other papers that were not designed to explore these issues. The most relevant aspect of this paper is that we analyze differences in men and women's behavior in games free of social issues.

The analysis is done for 2x2, TDG and BCG. No gender bias was found when playing the dominant strategy nor in best response. Moreover, no gender bias appears when playing the Nash equilibrium. Thus I conclude that men and women behave in a

similar way in static tasks without any social issue as well as in complex (guessing) games and static and repeated settings.

The second part of the paper is devoted to repeated versions of guessing games. However, I am once again unable to support any gender bias for feedback and transfer learning. Nor was gender bias observed in the study of consistency across lotteries. Hence I may summarize that, in repeated tasks, without any social issue, gender bias is not observed.

I therefore conclude that gender bias vanishes in the absence of social issues.

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