WHY AND WHEN SOME PEOPLE WOULD THINK A GIRL IS MORE LIKELY TO CHEAT: A GAME-THEORETIC APPROACH

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ABSTRACT

The question, “*Who is more likely to cheat in a relationship?*” has been discussed a lot recently. This short exercise intends to explain that in a world where people subscribe to certain “**Beliefs**” and under a certain condition called the “**No Love Condition**”, a situation can be found such that, in a relationship, the girl is more likely to cheat than the boy. The question of “*Why?*” is answered by the Beliefs and the No Love Condition. The question of “*When?*” is answered by the situation to be found.

KEYWORDS

- 1) Primary Beliefs
- 2) Secondary Beliefs
- 3) No Love Condition
- 4) Pure Strategy Nash Equilibria
- 5) Mixed Strategy
- 6) Mixed Strategy Nash Equilibrium
- 7) Payoff Matrix

INTRODUCTION

The topic of infidelity in romantic relationships is an interesting one, of which many ideas and opinions exist. From academia and scholarly research to common discussions on Twitter spaces, this topic, in the author’s opinion, stands to be one that will be analyzed and debated on for a long time. The use of game theory in the analysis of infidelity in relationships is not new, though uncommon, according to [1]. An example is the paper by Batabyal [1], where it was assumed, without loss of generality, that the husband cheats either openly or in secret, and the wife either monitors cheating or chooses to ignore it. In Batabyal’s paper, it was concluded that both husband and wife should play each of their strategies with equal probability. The analysis in this paper takes a different approach, in that both participants (named Boy and Girl) can either cheat on their partner, or remain faithful to them. The author gives conditions and a particular situation that make it more likely for the girl to cheat than the boy.

ANALYSIS

Suppose we have a game [1] where two persons (players), a Boy (B) and a Girl (G) get into a relationship. They each have two strategies they can play; to “Cheat” (C) or to be “Faithful” (F).

B 's strategies \ G 's Strategies	C	F
C	$C_1(N_b), C_1(N_g)$	$C_2(N_b), F_1(N_g)$
F	$F_1(N_b), C_2(N_g)$	J, J

The payoff matrix [1] above describes the game in question. As is done in games depicted this way, the player on the left is the Boy (B) and the one above is the Girl (G). Note the following:

- i) $C_1(N)$ determines the payoffs when both B and G cheat
- ii) $C_2(N)$ determines the payoff for a person who cheats while their partner is faithful
- iii) $F_1(N)$ determines the payoff of a faithful person when their partner cheats
- iv) J is the payoff for both partners when they are both faithful (we assume that they get the same payoff when they are both faithful)

Where N is the number of options (suitors) a person has.

Let us assume the following are true (as some people would probably like to believe):

- 1) A person always prefers a situation where both partners are faithful (payoff is $J > 0$) to one where both partners cheat
- 2) A person always prefers a situation where both partners cheat to one where they cheat and their partner is faithful (maybe they feel bad about cheating on a faithful person)
- 3) A person always prefers a situation where they cheat and their partner is faithful to one where they are faithful and their partner cheats
- 4) Whenever at least one person cheats in a relationship, both partners are affected negatively

i.e. $J > 0 > C_1(N_0) > C_2(N_0) > F_1(N_0)$, for all positive integers N_0

Beliefs (1) through (4) are called **Primary Beliefs**. Note that C_1 , C_2 and F_1 are assumed to be negative, to reflect the idea that when at least one person cheats in a relationship, it has negative impacts on both partners.

Also assume that:

- 5) When two people, B and G , in a relationship cheat, the one with more “options” has a higher payoff (regrets less)
- 6) When two people are cheating on their faithful partners, the one with more options has a higher payoff (regrets less)
- 7) When two people are faithful to cheating partners, the one with more options has a higher payoff (regrets less)

That is for $N_2 > N_1$,

$$i) C_1(N_2) > C_1(N_1)$$

$$ii) C_2(N_2) > C_2(N_1)$$

$$iii) F_1(N_2) > F_1(N_1)$$

Beliefs (5) through (7) are called **Secondary Beliefs**. They may not be necessarily true in real life but some people (especially some men) believe these to be true.

Assume that G has more options, N_g , than B which has options N_b . i.e $N_g > N_b$. Then the Secondary Beliefs can be written as:

- I) When both persons in the relationship cheat, the girl has a higher payoff (regrets less)
- II) When both persons are cheating on faithful partners, the girl has a higher payoff (regrets less)
- III) When both persons are faithful to cheating partners, the girl has a higher payoff (regrets less)

In the game described above, (C, C) and (F, F) are **Pure Strategy Nash Equilibria** [2]. If B knows that G will play strategy C , he will also play C , and vice versa. Likewise, if B knows G will play strategy F , he will also play F , and vice versa. Since both players do not know which strategy the other will play, and we

also see both strategies usually being played by both players (i.e both boys and girls cheat), we can assume that each player plays a **mixed strategy** [2].

In other words, player B cheats with probability, say p (and is faithful with probability $1 - p$), and player G cheats with probability, say q (and is faithful with probability $1 - q$).

In a **Mixed Strategy Nash Equilibrium** [3], each player plays a strategy mix such that the other player's strategy choice makes no difference (same expected payoff for any strategy played). In the context of our game, each player "cheats" and "is faithful" in such a proportion (or with such probability) that it makes no difference what the other player does (same expected payoffs). Let us call this the **No Love Condition** (maybe when there's a big fight, or a long-distance relationship, for some people?).

Given the No Love Condition, We find p and q to be [3]:

$$p = \frac{J - C_2(N_g)}{J + [C_1(N_g) - C_2(N_g)] - F_1(N_g)}$$

$$q = \frac{J - C_2(N_b)}{J + [C_1(N_b) - C_2(N_b)] - F_1(N_b)}$$

From the Primary and Secondary Beliefs, we know that $0 > C_2(N_g) > C_2(N_b)$. Hence, $0 < -C_2(N_g) < -C_2(N_b)$. Therefore the $num(q) = J - C_2(N_b) > J - C_2(N_g) = num(p)$, where $num(p)$ means numerator of p , $den(p)$ means denominator of p , etc.

Therefore, If $den(q) \leq den(p)$, then we can say with certainty that $q > p$ (i.e G is more likely to cheat than B).

Now $den(q) \leq den(p) \Leftrightarrow den(p) \geq den(q) \Rightarrow$

$$J + [C_1(N_g) - C_2(N_g)] - F_1(N_g) \geq J + [C_1(N_b) - C_2(N_b)] - F_1(N_b)$$

Canceling J on both sides of the inequality and rearranging terms, we get an equivalent statement

$$[C_1(N_g) - C_1(N_b)] \geq [C_2(N_g) - F_1(N_b)] + [F_1(N_g) - C_2(N_b)]$$

Thus when the inequality above is satisfied, $q > p$ with certainty, and therefore the girl (player G) is more likely to cheat than the boy (player B). The inequality represents the “situation” discussed in the abstract and introduction.

In the inequality above,

- i) The term on the LHS can be interpreted as, “*how much better player G does than player B when they both cheat*”.
- ii) The first term on the RHS can be interpreted as, “*how much better player G does than player B when player G cheats and player B is faithful*”.
- iii) The second term on the RHS can be interpreted as, “*how much better player G does than player B when player G is faithful and player B cheats*”.

Therefore we can say that,

Given the (i) **initial beliefs (primary and secondary beliefs)** and (ii) **No Love Condition**, If it is true that how much better G does than B when they both cheat is **greater than or equal to the sum** of how much better G does than B when G cheats and B is faithful, and how much better G does than B when G is faithful and B cheats, then G is certainly more likely to cheat than B .

To state it differently,

“Given the initial beliefs (primary and secondary beliefs) and the No Love Condition, if it is true that how much better the girl does than the boy, when they both cheat, is greater than or equal to the sum of how much better she does, when she cheats and he is faithful, and how much better she does, when she is faithful and he cheats, then, with certainty, the girl is more likely to cheat”.

It is interesting to note that this result does not depend on the value of J , the “benefits” that both the boy and girl get when they are both faithful. Also note that if $C_1(N)$, $C_2(N)$ and $F_1(N)$ are known, then given a particular N_b (number of options for the boy, Player B), a critical N_g (number of options for the girl, Player G) can be calculated, beyond which it would not be advisable for the boy to be in a relationship with the girl.

References

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