

Economics 644 – Final

Please answer ALL questions on this examination. Be sure to explain any non-standard notation that you use and JUSTIFY your answers. Each question's weight is shown in parentheses. Good Luck!

1. (25%) *Simultaneous and Repeated Games*. Consider the following simultaneous move game (G):

Player 2

| | | Player 2 | |
|----------|---|-------------|------------|
| | | L | R |
| Player 1 | T | (10 , 10) | (0 , 20) |
| | B | (30 , 1) | (1 , 1) |

- a. Find all Nash Equilibria of the game.
- b. Suppose the game G is played infinitely many times and players 1 and 2 discount the future at rates $\delta_1 \in (0,1)$ and $\delta_2 \in (0,1)$ respectively. Suppose players follow the following Grim Trigger strategies:

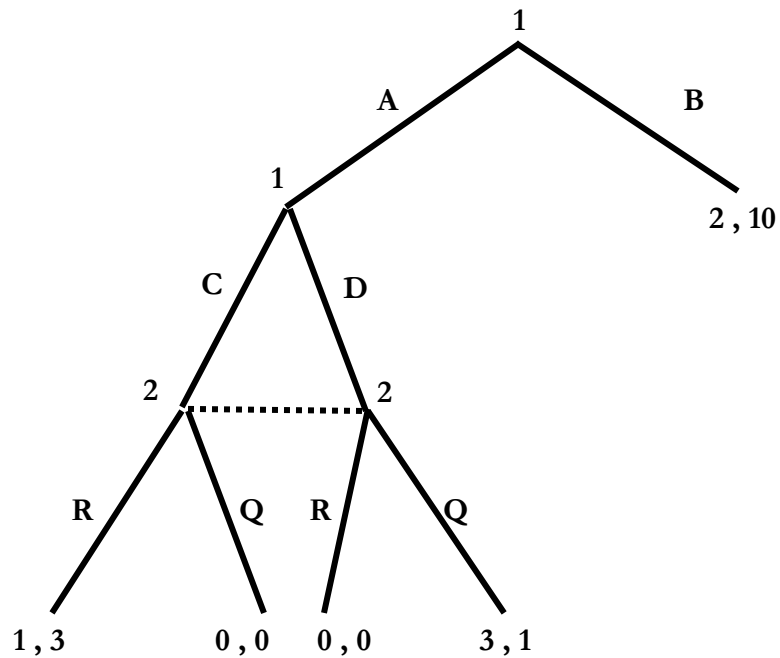
$\sigma_1 = \{\text{Play T in the first period and in all periods such that no player has deviated from playing (T,L) in any previous period. Play B otherwise.}\}$

$\sigma_2 = \{\text{Play L in the first period and in all periods such that no player has deviated from playing (T,L) in any previous period. Play R otherwise.}\}$

Solve for the critical discount factors (δ_1^*, δ_2^*) , separately for each player, such that (T,L) is played in all periods.

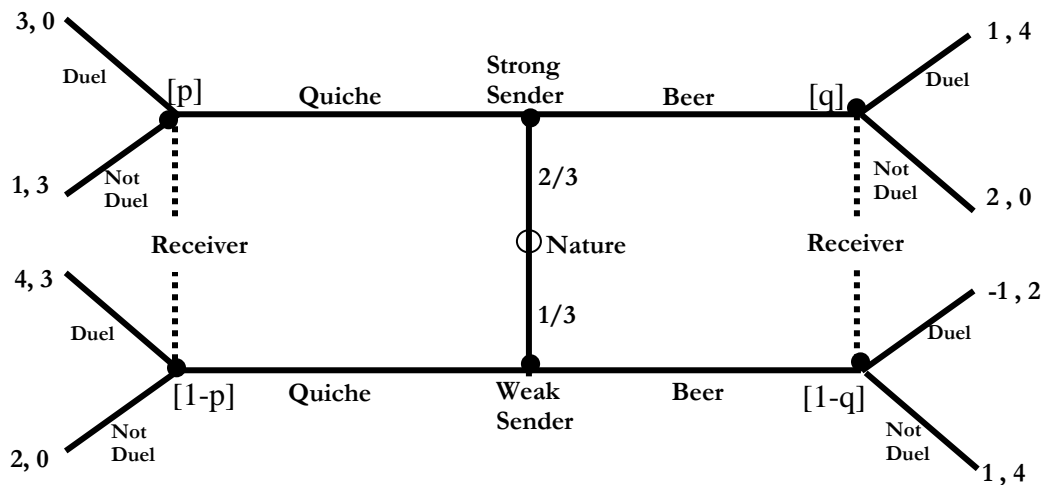
- c. In words, explain why $\delta_1^* > \delta_2^*$.

2. (25%) *Extensive game of Imperfect Information.*



- How many sub-games does the above game have?
- Write down the game in strategic (normal) form and solve for the *pure strategy* Nash Equilibria.
- Which of the NE you solved for in part (b) are sub-game perfect?
- Solve for the Perfect Bayesian Equilibria (PBE).

3. (25%) *Beer/Quiche*.



Nature initially chooses the sender's type (according to the probabilities shown in the tree), which becomes known to the sender but not the receiver. The sender chooses to have Beer or Quiche for breakfast and the receiver chooses whether or not to Duel with the sender after observing the breakfast choice (but not the sender's type).

- In the above game, how many information sets does the sender have? How many information sets does the receiver have?
- Solve for a PBE involving "pooling on Quiche" (i.e., both types of sender have Quiche for breakfast).
- True or False: "There does *not* exist a PBE where a strong sender has a Beer for breakfast and a weak sender has Quiche, because a weak sender would want to deviate and have a Beer." Justify your answer.

4. (25%) *Pay for Delay*. Suppose a drug manufacturer (firm B) is considering an investment in the research, development and testing of a brand new prescription drug. The cost of that development is \$2200, a one time, fixed (sunk) cost. After the drug is developed, it can be produced at a marginal cost of zero. *Annual* demand for the drug is

$$Q(P) = 120 - P.$$

Since firm B is the innovator of the new drug, it is given a patent on the drug which last 2 years and gives it the exclusive right to be the sole producer (firm B is given a 2-year monopoly). After the 2-year period, generic drugs will enter the market, which then becomes perfectly competitive.

- a. Should firm B pay the fixed cost to enter this market? What is the firm's annual profit if it decides to enter?

Suppose firm B has entered the market. Exactly 1 year into the exclusivity period, a generic drug producer (firm G) successfully challenges the legality of the patent, meaning firm G gets to share the market with firm B for the remainder of the patent term (1 year). Firm G has no fixed cost of entry and pays the same marginal cost (zero) as firm B.

- b. Suppose the two firms compete Cournot style. Solve for the equilibrium quantities, price and profits of each firm over the 1 year they share the market. [You can ignore firm B's fixed cost of entry it paid last year, since it is now sunk.]

Finally, instead of sharing the market with firm G for the final year of the patent, firm B offers to pay firm G to delay entry until the end of the patent (i.e., "Pay for Delay").

- c. What is the most firm B would be willing to pay G in order to delay entry? What is the least that firm G would be willing to accept in order to delay entry?