

# Final Exam - EconS 424

May 3rd, 2021 at 11:10am

Name: \_\_\_\_\_

**Instructions.** *Show all your work clearly and make sure you justify all your answers.*

1. **The Vaccination Game.** Based on evidence from clinical trials, the Pfizer-BioNTech vaccine is effective at preventing laboratory-confirmed COVID-19 illness in people without evidence of previous infection. Two friends, Ana and Felix, are deciding whether or not to get vaccinated tomorrow. If both decide to get the vaccine each receives a payoff (think about utility) of 20, they are both protected and can start planning their vacation trip. If only Ana decides to get the vaccine, then they receive a payoff of 10 (Ana) and -1 (Felix). However, if only Felix decides to get the vaccine they receive a payoff of -5 (Ana) and 10 (Felix). In this case, protection is just partial and their trip plans are jeopardized. If both decide to stay home and, hence, they do not get the vaccine, each receives a payoff of -1.
  - (a) Illustrate the normal form game. Can you find a strictly dominant strategy for either player? [7 points]
  - (b) Find the NE of the game assuming pure strategies. [8 points]
  - (c) Consider that Ana gets the vaccine with probability  $p$  and Felix with probability  $q$ , where  $p, q \in [0, 1]$ . Identify the MSNE and graphically represent your results. [10 points]
  - (d) Now consider the case in which Ana and Felix sequentially receive the vaccine. That is, first Ana has to decide whether to receive the vaccine and then, Felix (after observing Ana's decision) decides whether or not to get vaccinated. Illustrate the extended form game of the vaccination game and solve it by backward induction. [10 points]
  - (e) Let us consider a setting of *Incomplete Information*. Ana is able to observe the effectiveness of the Pfizer-BioNTech vaccine, which can be *High* (H) or *Low* (L). She works in the Pfizer labs and has participated in several studies related to the vaccine. However, Felix is unable to observe this information. He does not know if the effectiveness of Pfizer-BioNTech vaccine is *High* or *Low*. Consider that the probability that the Pfizer-BioNTech vaccine is highly effective is 95%. First, Ana (after observing the vaccine effectiveness) chooses whether or not to get vaccinated. Then, Felix (after observing Ana's decision about the vaccine) decides whether or not to get the vaccine. If both get the vaccine, each of them receives a payoff of 10 when the vaccine is highly effective (H) and 5 when its effectiveness is low (L). If one of them gets vaccinated while the other does not, then the vaccinated friend is protected against Covid-19 and receives a payoff of 5 when H and 2 when L. The friend who does not get vaccinated receives a payoff of 0, independent of the vaccine effectiveness. Finally, if no one receives the vaccine they both obtain a payoff of -1.
    - i. Illustrate this vaccination game under Incomplete information (Hint: this game is similar to an Entry Game). [10 points]
    - ii. Construct the matrix representing the Bayesian normal form of the game and obtain the BNE. [20 points]
    - iii. Consider now that the probability that the Pfizer-BioNTech vaccine is highly effective decreases to 35%. Do your results change? [15 points]
  - (f) Finally, consider the following game in Figure 1 (note that payoffs are different than those in part e). In this case, Felix is still uninformed about the vaccine effectiveness, but they both need to

*simultaneously* decide whether or not to get vaccinated (V or NV in Figure 1).

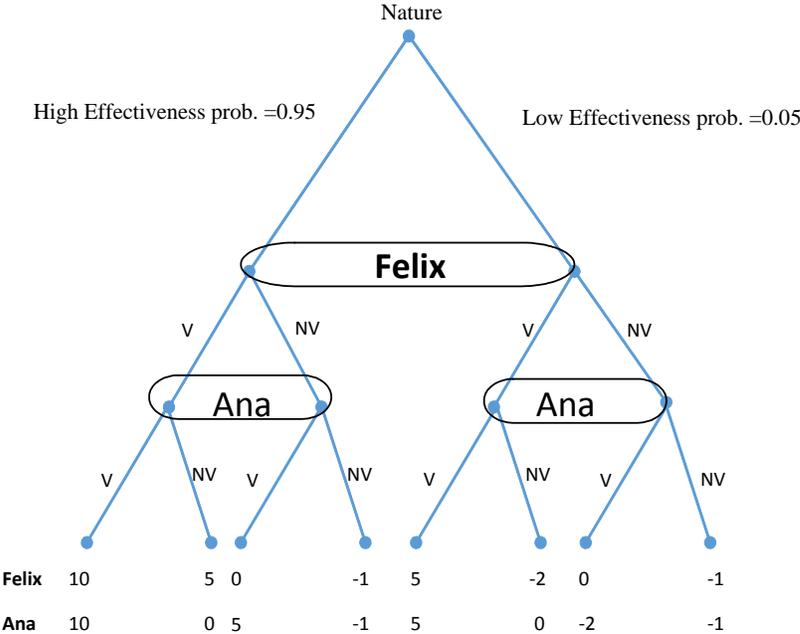


Figure 1

- i. Represent the game using two matrices: (a) one for the case in which the vaccine is highly effective and (b) the other for the case in which its effectiveness is low. Discuss the strategic behavior of the informed player (Ana) and consider that  $\alpha$  represents the probability that Felix decides to get vaccinated. [10 points]
- ii. Discuss the strategic behavior of the uninformed player (Felix) and find the BNE. Does the value of  $\alpha$  affect your results? [10 points]

**GOOD LUCK!**