2019 Northwestern Economics Tournament

Power Round

TEAM NAME: _____

SCHOOL: _____

There are 6 questions in this packet. You have 1 hour to complete the exam. When the moderator calls time, please put your pencil down and pass the answer sheet and this packet to the aisles for collection.

No calculators, notes, or any other helping tools may be used during the exam.

Use available space in the packet for scratch work. Should you need more scratch paper, we'll be happy to provide with you more.

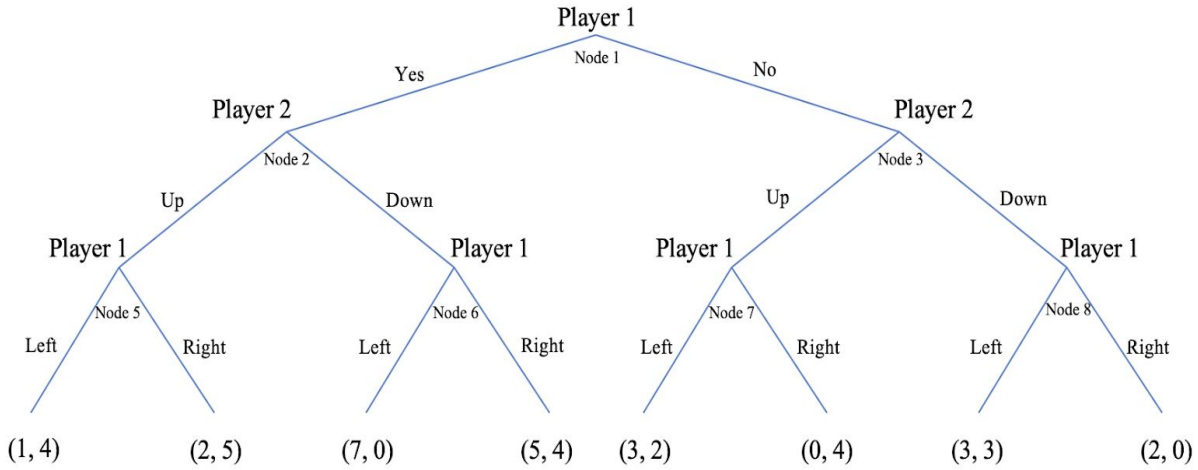
One part of one of the 6 questions will be selected, before the exam, as the tiebreaker question. Among teams that tie, whichever team collects the most points on this question will be declared the winner. In the event that there is still a tie afterwards, a final tiebreaker quiz-bowl style question will be administered.

Place all answers in the blank space under the questions.

Good luck!

SET A (15 points)

Consider the game tree below. The game consists of two players and three rounds of actions. First, player one chooses "Yes" or "No" at node 1 of the game. Then, depending on player 1's choice, player two will choose "Up" or "Down" at either node 2 or node 3. This will take the game to node 5, 6, 7, or 8, where player 1 will move again. Player one will choose "left" or "right," and then both players will receive their payoffs from the game. Every possible outcome's playoffs are listed below the tree in parentheses, where player one's payoff is the first entry, and player two's payoff is listed second.



We will find the equilibrium of this game by using backwards induction.

A. Suppose player one is at node 5, and she must choose between "left" or "right." What is player one's best response in this case to maximize her payoff? Explain why you chose this. (2 points)

B. In the same fashion as above, find player one's best responses at nodes 6, 7, and 8. Explain your answers. (6 points)

C. Now, suppose player 2 is at node 2. What is player 2's best response between "up" and "down" at node 2? Explain your answer. (2 points)

D. In the same way as above, find player 2's best response at node 3. Explain your answer. (2 points)

E. Finally, use all of the information you've gathered to show what player one will choose at node 1. Explain. (3 points)

SET B (15 points)

In a fractional reserve banking system, banks keep only a certain amount of their deposits in reserves. Suppose that all banks in the economy keep (r*100)% of their deposits in reserve, where r is the reserve ratio, and assume that once loaned out, all dollars will re-enter the banking system as deposits.

A. What is the name of the organization within the United States government that is in charge of setting r? (1 point)

B. Suppose that r = 0.1. Bank A has $2000 in deposits, then decides to issue the maximum amount of loans.
   i. How much did Bank A loan out? (1 point)

   ii. How much does Bank A have remaining in reserves? (1 point)

   iii. Draw the balance sheet for Bank A below. (1 point)

Balance Sheet for Bank A

Assets	Liabilities

C. Eventually, the money from Bank A's loans is deposited into Bank B. Bank B then issues loans for the maximum amount possible. Draw the balance sheet for Bank B below. (2 points)

Balance Sheet for Bank B

Assets	Liabilities

D. The money from Bank B's loans is deposited into Bank C. Bank C then issues loans for the maximum amount possible. Draw the balance sheet for Bank C below. (2 points)

Balance Sheet for Bank C

Assets	Liabilities

E. The process described above continues infinitely. Write an expression to describe M, the total money supply in the economy from the original deposit of $2000, in terms of the reserve ratio *r*. Show your work. (3 points)

F. Student A claims that "Fractional reserve banking increases the liquidity of the economy." Student B says that "Fractional reserve banking creates more wealth." Which, if any, of these students are correct? Explain your reasoning. (4 points)

SET C (15 points)

Consider the payoff matrix below, depicting a game involving two players who can each take one of three actions. Player one can choose between "top," "middle," and "bottom," labeled T, M, and B respectively. Player two can choose between "left," "center," and "right," labeled L, C, and R accordingly. Payoffs are listed in each cell of the matrix, and in each cell, player one's payoff is listed first, followed by player 2.

		Player 2		
		L	C	R
Player 1	T	(7, 6)	(3, 4)	(8, 0)
	M	(3, 2)	(4, 5)	(1, 1)
	B	(3, 4)	(3, 3)	(2, 2)

Find the Nash Equilibria of this game. Do this by following these steps:

A. Consider if player 1 is playing action T. What is player 2's best response? Why is this true? (2 points)

B. In the same way as above, find player 2's best responses when player 1 chooses M, and do the same for when player 1 chooses B. Explain your thought process. (4 points)

C. Now, similarly, find player 1's best response for each of player two's actions: L, C, R. (6 points)

D. Use the information above to state the Nash Equilibria of the game. (3 points)

Set D (15 points)

Consider the following economy.

- There are 4000 children, aged 0-16; 6000 young adults, aged 17-30; 4000 adults, aged 31-64, and 5000 senior citizens, aged 65 and up.
- In this economy, 4000 young adults (aged 17-30) currently have a job. Out of the remaining 2000, there are 1000 young adults are currently searching for a job, and the other 1000 are not.
- In addition, out of the 4000 adults aged 31-64, 3000 adults currently have a job. The other 1000 adults are currently searching for a job.
- Finally, 1000 senior citizens currently have a job, and the other 4000 are retired.

A. What is the size of the labor force in this economy? Show your work. (5 points)

B. What is the labor force participation rate? Show your work. (5 points)

C. What is the unemployment rate in this economy? Show your work. (5 points)

Set E (20 points)

According to the Carbon Tax Center, the United States is one of the few large and industrialized nations on Earth that does not implement a carbon tax. To curtail carbon emission, an alternative to carbon tax (a tax on every square metric of greenhouse gases (GHGs) emission) is a cap-and-trade schema, which is giving every citizen a right to a certain quantity of GHGs emission and allowing them to freely trade that right. Nonetheless, there is a "supply curve" in the carbon market, which shows the cost to environment of a certain amount of GHGs emission, and a demand curve which represents the benefit of companies to emit the gases (so in the market without any regulation companies will emit GHGs until the marginal benefit is 0).

A. Suppose the supply is upward sloping and the demand is downward sloping (with price on the y axis and quantity emitted on the x axis), please draw a graph to illustrate why there is a market failure when there is no carbon tax or carbon cap. (Mark clearly the optimal quantity of emission and the actual quantity). If we know exactly where these two curves are, is there any difference between the two policies in terms of getting the market to the equilibrium? (7 points)

B. If we know that the marginal cost of every square metric of GHGs emission is a constant *c* but we don't know anything about the demand curve except that it's a downward sloping curve that goes to 0 at some point, should we implement the carbon tax or cap-and-trade? If you think a carbon tax is better, what should be the tax per square metric of GHGs emission? If you think cap-and-trade is better, what quantity should be the cap for the entire market? (7 points)

C. Now suppose there is actually a certain fixed amount of GHGs emission we know that will bring catastrophe to our world and before that point the marginal cost of every square metric of GHGs is a constant *c* (you can think of this as at that quantity the marginal cost of GHGs emission is infinity) and we know the same information about the demand curve as in Problem B. Does your answer to Problem B change and why? (6 points)

Set F (20 points)

An important principle in financial economics is the Principle of No Arbitrage, which states that there's no opportunity of making money with zero investment. An example would be the pricing of a stock. Since the payoff of a stock when you sell it is always going to be non-negative, the holder has no risk of losing money by holding the stock. The price of buying a stock, therefore, should always be positive. Please apply this principle to the following questions.

A. A call option is a financial derivative that gives you the option of buying a stock at a predetermined strike price K at a fixed future time T (the trader will pay you cash amount equal to the stock price minus the strike price). It's clear that if the stock price at time T is lower than the strike price, you should not exercise the call option to lose money. Please use the Principle of No Arbitrage to explain why the price of a call option will always be positive. (6 points)

B. A portfolio is a combination of some assets and liabilities. A long position (an asset) is shown by a positive sign and a short position (a liability) is shown by a negative sign. For example, if you buy a share of Stock1 (a long position) and owe someone else a share of Stock2 (a short position), the value P of your portfolio will be P = S1 - S2. Now, if the strike price of a call option of a stock is 0, construct a portfolio consisting of the call option and the stock and use Principle of No Arbitrage to prove that the price of this call option will be exactly the current stock price. (6 points)

C. A put option is a financial derivative that gives you the option of selling a stock at a predetermined strike price K at a fixed future time T (the trader will pay you cash amount equal to the strike price minus the stock price). In contrast to a call option, this time you won't exercise the put option if the strike price is lower than the stock price. Suppose that there is no interest rate and no inflation in the market (so a cash amount of K now is the same as a cash amount of K in any future time), use the Principle of No Arbitrage to derive the difference between the price of a call option and a put option on the same stock with the same strike price K (this is often called the put-call parity). (Hint: it might be helpful to draw the graph of a call option and a put option with the payoff on the y-axis and stock price at exercise time on the x-axis) (8 points)