

NET 2022 Power Round

Introductory Division: Microeconomics

April 2022

Instructions

This is the **microeconomics portion** of the introductory division of the 2022 Northwestern Economics Tournament Power Round. There are three questions of *unequal* weight, accounting for a weighted *half* your score for the Power Round. You are encouraged to work together on these questions. Answer each question as clearly and succinctly as possible. You may write on a blank sheet of paper where you *clearly indicate* where your answer to each part is. It will be useful to note that a question's point value is *not* informative of its difficulty; to ensure a fair test, some (longer) easy questions are worth more points, while some (shorter) hard questions are worth less points, and vice versa. If you are unsure of your answer, take your best guess: there is no penalty for incorrect answers. If you find yourself stuck on a question, skip it and return to it at the end if necessary. It is recommended you spend approximately seventy five (75) minutes of the total exam time on this portion. Remember, we do *not* share your answers or scores with Northwestern admissions, nor do we keep them for ourselves. You are not expected to know how to answer each question on the exam; rather, this test is designed to assess your economic and formal reasoning skills. Have fun, and good luck!

Problem 1: Present Value and Returns on Bonds (12 points)

The present value of a payment is the amount of money that the payment is worth to you today. Especially in investing, present value is important for understanding how returns at various different points of time in the future compare by providing a benchmark for how much value each return has in the present.

Part A (1) Suppose that you own a bank account that accrues interest at an annual rate of 5%. If you deposit \$1,000 into the account, how much money do you have after 1 year?

Part B (1) If the bank account in Part A has interest that compounds annually, how much is your \$1,000 deposit worth 10 years from now?

Part C (1) Given that payments received are deposited into the bank account from Part A, how much more is a payment of \$100 1 year from now worth today compared to a payment of \$110 10 years from now?

Part D (2) Let t denote the number of years from today that you receive a payment and Y the dollar value of that payment. Let the interest rate be i , where $0 \leq i \leq 1$. Find a general formula for the present value of that payment today. Your answer should be an expression in terms of t , Y , and i .

Part E (1) A bond is a type of financial asset where a buyer pays a face value up front to obtain the bond. They are then given yearly payments called coupons for a fixed number of years. In the last year, when the bond expires, the buyer will also receive a dollar amount equivalent to the face value amount they paid initially. Consider a 2-year bond with a face value of \$1000 and coupon payments of \$60. If the annual interest rate is 7%, what is the total return made by buying this bond?

Part F (1) Bonds can be resold for the present value of the remaining payments. For example, if the bond from Part E is resold after 1 year, its resale price is the present value of 1 coupon and the face value one year from now. Suppose after 4 years, a bond holder wants to resell a 7-year bond that they bought with a face value of \$500 and coupon payments of \$50. What is the resale price?

Part G (2) Until now, we have assumed interest rates remain constant. In reality, interest rates fluctuate. Suppose the interest rate is 5% in the first year, 7% in the second year, and 10% in the third year. Knowing this, what is the present value of a 3-year bond with face value \$1000 and coupon payments of \$50 worth in total?

Part H (2) Suppose you buy a 3-year bond with face value \$1000 and coupon payments of \$50. You initially bought the bond when the interest rate was 5%, and you resell the bond after receiving disbursement of the first year's coupon payment. If you resell the bond when the interest rate is 3%, what is your total return on the bond?

Problem 2: Property Rights and Externalities (14 points)

In this question, we examine a scenario which demonstrates the Coase theorem, a statement on bargaining and property rights when externalities occur - no knowledge of the theorem is required to answer the question.

In the town of Quintville, there live two neighbors, Ossian and Percy. Ossian enjoys playing loud music late during the night, between the hours of Midnight and 4am. Percy, on the other hand, highly values peace and quiet. Their utilities, in dollar terms, are given in the chart below:

Hours of Music	Hours of Silence	Ossian's Utility	Percy's Utility	MU of Music	MU of Silence
0	4	0	10	X	
1	3	4	9		
2	2	7	7		
3	1	9	4		
4	0	10	0		X

Part A (2) Fill in the columns giving the marginal utilities of Ossian's music and Percy's silence. That is, report Ossian's marginal utility value of one additional hour of music in dollar terms and Percy's marginal utility value of one additional hour of silence. As indicated above, the 0 rows do not have values.

Part B (2) How many hours of music would a social planner choose? In other words, which of these outcomes maximizes the total welfare (measured in utility) in this society?

Part C (3) Every day, Ossian and Percy get into a shouting match about how much music should be allowed during the night. Ossian and Percy hire Judge Ronald as an arbitrator to help them resolve this dispute. Judge Ronald rules that Percy has the right to peaceful sleep, but that the two neighbors can mutually agree to a non-zero level of music through a payment from Ossian to Percy. What level of music will the two agree to, and how much will Ossian pay Percy to let him play this amount of music? (HINT 1: At each level of music/silence, how much is Ossian willing to pay to add 1 more hour on music? How little is Percy willing to accept to allow 1 more hour of music?) (HINT 2: Marginal Benefit equals Marginal Cost)

Part D (4) Suppose instead that Judge Ronald had decided that Ossian has the right to play as much music as he liked, but that the two neighbors can mutually agree to a non-zero level of silence through a payment from Percy to Ossian. What level of silence will the two agree to, and how much will Ossian pay Percy to let him play this amount of music? How does this compare to your answer from Parts B and C?

Part E (3) Suppose now that, before Judge Ronald makes his ruling, he must be paid for his mediating services. Judge Ronald demands a flat fee of \$21 for his services. Can the two neighbors ever agree on a way to split the payments such that they choose to hire him?

Problem 3: Oligopoly Types (14 points)

In this question, we explore the mathematics behind three different models of market competition with two firms (Cournot, Bertrand, and Collusion), comparing the resulting competitive equilibria.

Suppose two profit-maximizing firms operate in the same market and sell identical products. The products have a constant marginal cost of 5 per unit and there are zero fixed costs. The market price depends on the total quantity of goods in the market. The inverse demand function is

$$P = 149 - Q$$

where we take $Q = q_1 + q_2$ (the quantities produced by firm 1 and 2 respectively). This is a duopoly, where a firm's decision on how much to produce affect the profits of both firms.

Part A (2) Assume that there is no collusion and that the firms operate independently. Also firms choose their quantities at the same time: we call this the Cournot duopoly. Write the profit functions for each firm in terms of q_1 and q_2 .

Part B (3) For the firms above, their marginal revenues are equal to $MR_1 = 149 - 2q_1 - q_2$ and $MR_2 = 149 - q_1 - 2q_2$ for firms 1 and 2 respectively (this can be derived with calculus, but you can take this as given). Solve for the quantities, price, and profits in equilibrium (HINT: $MR = MC$ for both firms gives you a system of 2 equations in 2 unknowns!).

Part C (3) Now continue to assume no collusion occurs. Consider the case where firms instead choose prices at the same time. We call this the Bertrand duopoly. What will the equilibrium prices and profits be for the firms in this case? (HINT: What is the lowest price either firm would be willing to operate at? If one firm offers a higher price than the other, how would consumers respond?)

Part D (1) Now we return to the Cournot case (firms choose quantities), but instead assume that collusion occurs. If we model this by treating these two colluding firms as one unified firm, then what market type is this?

Part E (2) If the marginal revenue of this new "colluding firm" is $MR = 149 - 2Q$ (where Q now represents the sole quantity chosen by the colluding firm), then solve for the equilibrium quantity, price, and profit in the market type you stated in part D.

Part F (3) Compare the three market equilibria you just calculated in parts B, C, and E. Rank them in order of the combined profits of the firms and then in terms of consumer surplus.