NET 2025 Power Round

Introductory Division

April 2025

Instructions

This test consists of six questions. While you are free to attempt all six questions, we will only grade your four best-performing questions, regardless of how well you do on the other two. A question's point value is *not* informative of its difficulty; although questions have different point values, each question is weighted independently of its point value in your final cumulative score. After normalizing point-values of each question to the same weight, your cumulative score will be calculated as the sum of the scores of your four best-performing questions. 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. 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. You will have two hours (120 minutes) to complete the exam. 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: Governing the Debt (20 Points)

This question considers how government expenditure impacts otherwise efficient markets both through expenditure and fundraising.

In a closed economy, the short-run aggregate supply is fixed at $P = 1$. Consumption is given by:

$$C = C_0 + 0.6(Y - T), \tag{1}$$

where C_0 is autonomous consumption, $Y - T$ is disposable income (total income minus net taxes).

Investment is given by:

$$I = 12 - 5r, \tag{2}$$

where r is the real interest rate expressed as a percentage (e.g., $r = 1$ means 1%, not 100%). The supply of loanable funds is:

$$S = 14r. \tag{3}$$

The budget is balanced at $G = 20$, so government spending is equal to taxes.

The economy is balanced when:

$$Y = C + I + G. \tag{4}$$

Part A

(1) *(1 point)* Intuitively explain why investment decreases and the supply of loanable funds increases as the interest rate increases?

(2) *(1 point)* Which component of consumption depends on disposable income and which does not? What could be some expenditures that do not depend on disposable income?

(3) *(1 point)* What should the value of taxes be if the budget is balanced?

(4) *(2 points)* What does the coefficient of disposable income (0.6) represent in this case?
Tip: Think about how consumption changes when disposable income increases by 1. What choices do consumers have when they receive an additional dollar of disposable income?

Part B

(1) *(3 points)* In the balanced economy at $Y = 100$, determine the levels of C, I, T, and r.

(2) *(1 point)* Now, the government wants to increase economic growth, so it decides to increase government spending by 10. Assuming that the government has this money at its disposal and does not need to finance this spending through taxes or investment, what is the change in Y?

(3) *(1 point)* Assume that the government wants to cut taxes by 10 instead. What is the new level of income?

(4) *(2 points)* Why do the two above options create different levels of final income if the government uses the same 10 at its disposal in both situations?

(5) *(3 points)* Now, suppose the government wants to increase G by 10 but has to fund this spending through taxation. What is the new level of Y?

(6) *(3 points)* What if the government decides to fund this spending in the loanable funds market by borrowing 10?
Tip: How does this change the demand for loanable funds? What made up the demand for loanable funds before?

(7) *(2 points)* Let us consider the intermediate case where the government borrows 5 on the market and funds the additional 5 through taxes. Is the increase in Y higher this way? Which of the three options (borrow all, tax all, borrow some and tax some) would a policymaker choose?

Problem 2: When Work Doesn't Work (21 Points)

This question considers two types of unemployment and their theoretical underpinnings. It also demonstrates some features of a minimum wage. In an economy, L is the number of those in the labor force, U is the number of unemployed, and E is the number of those employed.

Frictional Unemployment

(a) *(1 point)* If s is the job separation rate of those who are employed, express the number of people who are separated from their jobs each month in terms of s and E. (i.e. if $s = 0.1$, 10% of those employed quit/lose their jobs every month)

(b) *(1 point)* If f is the job finding rate of those who are unemployed, express the number of unemployed who find jobs each month in terms of f and s?

(c) *(2 points)* What is the condition for the number of employed and unemployed persons to remain the same? (Tip: What happens if more people find jobs than are fired?)

(d) *(2 points)* Using this condition, derive the equation for the unemployment rate, U/L in equilibrium, in terms of s and f. (Tip: what is E in terms of L and U?)

(e) *(2 points)* What is the cause of unemployment in this case, what values of s or f would provide a long-term unemployment rate of 0?

Structural Unemployment

In an economy, the demand for labor is given by $D = 100 - 2w$, and the supply of labor is given by $S = 8w$, where w is real wage.

(a) *(3 points)* In equilibrium, what is the wage rate, unemployment rate, and the number of unemployed?

(b) *(3 points)* Now, assume that the government imposes a minimum wage of $w = 30$, what is the new unemployment rate?

(c) *(1 point)* What does this suggest about the minimum wage?

What about demand?

(a) *(1 point)* Do low-income earners or high-income earners have a higher marginal propensity to consume (MPC)?

(b) *(3 points)* So, does overall MPC increase or decrease with a higher minimum wage? Note that minimum wage increases the income level of the lowest-income earners.

(c) *(2 points)* If labor demand depends positively on income, explain how an increase in the minimum wage could increase employment.

Problem 3: Imperially Empirical (20 Points)

This text considers the research related to the 2024 Nobel Prize in Economics. It attempts to show the empirical difficulties with economics research and some tools we use to circumvent them.

Part A *(3 points)* A long term conversation in development economics is whether geography or institutions are more important to a country's development. What geographic factors contribute to economic growth? Why might these factors not be so important?

Part B *(2 point)* Some economists asserts that institutions are more important than geography. How might we estimate the strength of institutions?

Part C *(1 point)* Let us call institutional strength the variable I. Suppose you find that a 10% increase in I in a given year in a given country correlates with a 20% increase in the country's GDP per capita the following year in the same country. Without considering statistical significance, give three explanations for this result. (Hint: many explanations can be true at the same time.)

Part D *(2 point)* Suppose you get the result shown below. Note that p represents place. We will use y to mean the per capita GDP of a country. This means that y_p represents the GDP per capita in a given year at a given place and y_{France} represents the GDP per capita of France in a given year. The variable ϵ, called the error term, represents everything not determined by p such that $\epsilon_p + I_p$ can estimate the value of y_p for a place with similar characteristics to p but differently strong institutions. What is an effect of a 1 unit increase in I on y_p?

$$y_p = 2 * I_p + \epsilon_p$$

We can represent this as the change in y_p divided by the change in I_p

Part E *(3 point)* Why is this not sufficient as a causal argument? Give three examples.

Part F *(3 point)* In a study of growth in Africa, some economists suggests we can use settler mortality in a region to estimate institutions' strength. Explain why economists might be more interested in using settler mortality than institutional strength.

Part G *(2 point)* Suppose we run some tests and find the effect for settler mortality, denoted M, influencing institution strength can be modeled by equation

$$I_p = 3 * M_p + \epsilon_p$$

And we find the equation for settler mortality influencing GDP per capita can be modeled by

$$y_p = 2 * M_p + \epsilon_p$$

Estimate the effect of a 1 unit increase in institution strength on the GDP per capita of a country assuming that the average error term is 0 and it is evenly distributed. (Hint: Consider part 4)

Part H *(4 point)* Compare your result to part 4. Why might your results be different? Which methodology provides the best evidence of a causal relationship? Explain your answer.

Problem 4: Indifference Curves (20 points)

This problem explores indifference curves, which show the relationship between the relative value of two goods.

Preliminaries A consumer has an income, denoted M, of 100. The price of one apple is set at The price of one apple is set at \$5. Let A represent the quantity of apples purchased by a consumer. The price of one banana is set at \$10. Let B represent the quantity of bananas purchased by a consumer.

A utility function shows how much satisfaction a person gets from different bundles of goods, and an indifference curve represents all the combinations that give the same satisfaction level. The consumer's utility function is $U(A, B) = A^2B^3$.

Part A *(1 point)* Write down an expression that shows how many apples and/or bananas a person can purchase if they append their entire income on only these two goods.

Part B *(1 point)* Would it be ideal for the consumer to purchase only apples or only bananas? Justify using the given consumer utility function.

Part C *(3 points)* Compute the utility for each of the following bundles and determine which one maximizes the satisfaction of the consumer:

a) (A = 8, B = 6)

b) (A = 6, B = 7)

c) (A = 10, B = 5)

Part D *(4 points)* The consumer is currently choosing (A=6, B=4) and is considering moving to (A=8, B=3).

- (2 points) Compute the change in utility
- (2 points) Does this change increase or decrease their overall satisfaction? Justify your answer.

Part E *(2 points)* In a different scenario, suppose a consumer's optimal bundle consists of 12 apples (A) and 9 bananas (B), which uses up their entire income of \$198. The consumer found that the best ratio of apples to bananas was

$$\frac{A}{B} = \frac{12}{9} = \frac{4}{3}$$

,based on their utility function, regardless of their income. Now, assume the consumer's income decreases by one-third due to an economic downturn. If the prices of apples and bananas remain unchanged, use the given ratio to determine how many apples and bananas the consumer would purchase while staying within their new budget.

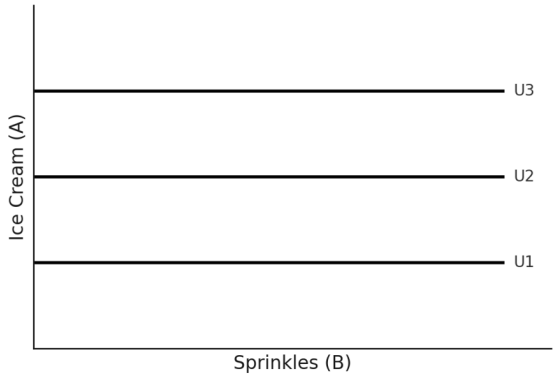
Part F *(5 points)* Initially, the consumer intended to purchase (A=8, B=6) bundles of apples and bananas. However, due to limited stock, the store only had 4 bananas available for sale. As a result, the consumer had to adjust their purchase to (A=12, B= 4) bundle.

To compensate for the unavailability of bananas, the store offered one additional apple to the consumer for free, leading to a final bundle of (A=13, B=4) bundle.

- *(2 points)* Compared to the original intended bundle (A=8, B=6), does the compensated bundle (A=13, B=4) provide greater, equal, or lower satisfaction for the consumer?

– *(3 points)* What is the minimum number of apples the store must provide to ensure the consumer is at least as satisfied as they would have been with their original intended bundle? (Answer in whole numbers.) How would you know that the consumer is just as satisfied or slightly more satisfied?

Part G *(4 points)* Given a graph of an indifference curve between ice cream (Product A) and sprinkles (Product B):



– (2 points) Write a possible equation for the consumer utility function in the format: $U(A, B) = A^x B^y$. Find one possible set of values for x and y.

– *(2 points)* Explain, in words, under what circumstances indifference curves would be represented as horizontal lines. You may use the example from Part G (1) to help you explain. Justify your answer from the consumer's perspective.

Problem 5: Committing to the Bit (20 Points)

This question will explore how the Federal Reserve uses monetary policy to attempt to control interest rates in the economy.

Consider the below Taylor Rule, that prescribes the federal funds rate the Fed should set given inflation and output:

$$i^{FF} = 2\% + \pi + 0.5(\textit{inflation gap}) + 0.5(\textit{output gap})$$

where:

$$\begin{gathered} i^{FF} = \textit{nominal} \text{ federal funds rate} \\ \pi = \text{actual inflation level} \\ \textit{inflation gap} = \textit{actual inflation - target inflation} \\ \textit{output gap} = \frac{\textit{actual output}}{\textit{target output}} - 1 \end{gathered}$$

Part A *(2 Points)* A typical inflation target for central banks to pursue is 2%. Suppose also that the current inflation is 1%, and the output gap is -4%. According to the rule above, what is the nominal federal funds rate the Fed should set?

Part B *(2 Points)* Note that the output gap depends on the target output level, which is purely an estimate. Suppose the Federal Reserve estimated this level incorrectly and let $Y^{correct}$ indicate the *true/correct* target output. How would the economy respond to the interest rate set by the Fed if there is a positive inflation gap, actual output is greater than $Y^{correct}$ and the target output estimate is too high?

Part C *(1 Point)* Suppose the Federal Reserve did indeed estimate the target output level incorrectly. The actual output gap is -7%. What is the actual interest rate the Fed will need to set?

Part D *(2 Points)* You may have noticed that a problem has arisen–what economists call the *zero lower bound*. Why is this a problem? Think about how the economy would respond to the interest rate you found in P3 above.

At the zero lower bound, the Federal Reserve may use a form of monetary policy called forward guidance, in which the Fed indicates the future direction of interest rates in an attempt to control the long term interest rate, which is what the economy actually responds to. Consider the model where the 10 year interest rate is a function of the average short term interest rate and a term premium:

$$i^{10yrs} = \textit{(average short term rate for years 1-10)} + \textit{term premium}$$

For the remainder of this problem, suppose the term premium is fixed at 1.8%.

Part E *(2 Points)* Suppose that the short term interest rate is expected to be 2% for the next 10 years. What will be the long term interest rate, i^{10yrs}?

Part F *(2 Points)* The chair of the Federal Reserve is only willing to deviate from the standard 2% short term rate for at most 5 years. How low will the short term rate need to be kept so that the long term interest rate is 2.8%?

Part G *(5 Points)* Suppose the Federal Reserve has committed to the policy above and five years have passed. However, an exogenous shock hits the economy that causes the long term rate to increase. To achieve the desired 2.8% long term rate, the Fed decides to discard their previous commitment and keep rates low for longer. What problems might arise from this decision?

Part H *(4 Points)* Before the chair is able to implement the policy from P2., some outside shock causes the desired long term interest rate to decrease to 2.5%. Assuming the Federal Reserve is still unwilling to deviate from the standard 2% short term rate for more than five years, what problem arises? Without altering the standard 2% interest rate, how could you change the situation above to address this problem?

Problem 6: Congestion Pricing for Dummies (20 points)

In this problem, we explore the economic rationale for congestion pricing on urban roadways.

Mayor X wants to tackle traffic in the booming downtown district of their city. She considers funding infrastructure improvements, like street widening and bus rapid transit (BRT) expansion, to address the issue, but her plans are costly and lack support from the city council. Disheartened, Mayor X prepares to declare defeat in the war on traffic until one of her aides suggests congestion pricing.

When a road is empty, each additional driver has no practical impact on other vehicles; the total cost of that trip for the is simply their own time and fuel expense. Once the road becomes sufficiently crowded, however, each additional car slows down its peers. In other words, the marginal driver imposes a congestion cost on other road users. Congestion pricing seeks to correct this negative externality.

Part A *(10 points total)* Suppose that the average cost per driver is:

$$AC = 3 + 0.3x^2$$

where x is the number of vehicles downtown in thousands. This is the cost that an individual driver faces to traverse the district. Also suppose that the marginal cost of each additional driver to society is:

$$MC = \begin{cases} 5 + 0.1x^2 & x < 3.16 \\ 3 + 0.3x^2 & x \geq 3.16 \end{cases}$$

(1) *(3 points)* City officials estimate the demand to drive downtown on Sunday evening as:

$$X_D = 6 - P_x + 0.5 * P_{BRT}$$

where P_{BRT}, the price of a downtown bus ticket, is set at 2. How many drivers will use the road? What is the optimal number of drivers on the road? Should a congestion toll be levied? For simplicity, round your answers (and all following answers for this question) to the nearest hundredth.

(2) *(3 points)* The city anticipates demand the next Monday morning to be:

$$X_D = 12 - P_x + 0.5 * P_{BRT}$$

How many drivers will use the road? What is the optimal number of drivers on the road? Should a congestion toll be levied?

(3) *(2 points)* For the case where a toll was useful, what amount should the city charge? [Hint: You can conceive of the toll as a tax that raises AC to the level of MC at the optimal traffic level.]

(4) *(2 points)* Given the previous questions in this section, would it be economically optimal for the city to implement a static or dynamic congestion price? Identify a potential drawback to your chosen policy.

Part B *(5 points total)* The availability of other transport options, such as bus rapid transit, also influences drivers' road use.

(1) *(3 points)* Mayor X wonders how expensive it would have been to use BRT subsidies alone to reduce downtown traffic. Using the cost equations and P_{BRT} from Part A, as well as the demand equation from A.2, calculate the BRT subsidy necessary to induce the optimal traffic quantity. [Hint: remember that the cost faced by individual drivers is equal to AC.]

(2) *(2 points)* Perhaps Mayor X elects to take a hybrid approach to downtown traffic. Suppose she introduces a congestion price and a BRT subsidy as a linked, revenue-neutral program: all funding from the toll is used to sponsor transit. What is the smallest congestion charge the city can impose to reach the optimal traffic level?

Part C *(5 points total)* Anticipating a tight re-election campaign, another of Mayor X's staffers advises her to avoid potential political blowback from congestion pricing and utilize other programs to tame traffic.

(1) *(3 points)* Rather than tolling drivers entering the crowded downtown, the staffer proposes, Mayor X should simply set a limit on the number of vehicles in the district at any given time. All drivers above the cap would be redirected to less busy external routes. Aside from administrative burden, why might such a quota system be economically inefficient?

(2) *(2 points)* The aide then suggests raising the existing fuel tax to a level sufficient to achieve the optimal level of downtown traffic. The fuel tax would be implemented at all gas stations within municipal boundaries. Does this solution present an efficient alternative to congestion pricing? If not, why?