INTERNATIONAL
ECONOMICS
OLYMPIAD

Open Question 1. Mortgage Securitization: Innovation or Instability?

Securitization is the process of converting various types of assets into tradable securities. The most common method involves pooling large assets together and issuing a larger number of small securities linked to this pool.

Financial innovation, and particularly securitization, are often cited as key drivers behind the U.S. housing boom of the early 2000s and the subsequent financial crisis. By the end of 2022, the U.S. securitization market exceeded $12.5 trillion, which is about half of the U.S. GDP.

In this question, you'll explore the advantages and disadvantages of securitization and its impact on the housing and mortgage markets. Consider a simple example. A bank issues 100 mortgage loans, each worth $1 million. The bank then creates 10,000 securities, each promising investors a 1/10,000th share of the total payments from the pool.

(a) (9 rp) A bank wants to sell all 100 mortgage loans to investors.
There are two ways to do this:
1. Each loan is individually auctioned to the highest bidder.
2. The loans are pooled together, and securities are issued as described above, then auctioned.
Which method is more profitable, and why? Provide <u>three</u> reasons.

(b) (5 rp) Explain how securitization can lead to house price appreciation.

(c) (8 rp) Provide two reasons why securitization may cause more risks for investors.

(d) (8 rp) Credit Score is the most common indicator of a borrower's creditworthiness, calculated using the borrower's credit history (i.e., how the borrower was making loan payments in the past). To improve housing affordability, the government considers offering subsidized mortgage insurance on mortgages with low risk of default, that is, with the borrower's credit score of 620 and above. Surprisingly, in the years after the policy was implemented, mortgages with a credit score of 620 defaulted more frequently than those with a credit score of 619. Why did this happen?

Solution

(a) **Profitability of auction methods (9 points)**

Pooling mortgages and issuing securities is more profitable than auctioning individual loans for the following reasons:

1. **Affordability:**
   - Securities (may) cost less than individual mortgage loans, making them accessible to a larger pool of investors.
   - More investors can participate, increasing demand and potentially driving up the price of the securities.
2. **Diversification:**

- ○ Each security is backed by a fraction of the entire pool of mortgages, spreading the risk associated with any single mortgage.
- ○ This reduces the risk for investors, making the securities more attractive.
3. **Liquidity:**
   - ○ Securities are easier to trade in the market compared to individual mortgages. (each security is backed by the same pool, while each mortgage is backed by a different house)
   - ○ The high number of securities (10,000) compared to the number of mortgages (100) means there is a larger market, enhancing liquidity and making them more appealing to investors.

(b) **Securitization leading to house price appreciation (5 points)**

Securitization leads to house price appreciation through the following mechanism:

1. Increased profitability for banks:
   - ○ Securitization enhances the profitability of mortgage lending for banks.
2. Higher supply of mortgages:
   - ○ Increased profitability leads banks to issue more mortgages.
3. Lower interest rates and easier access:
   - ○ An increased supply of mortgages lowers interest rates and makes mortgages more accessible to a wider range of borrowers.
4. Increased demand for housing:
   - ○ With more affordable and accessible mortgages, more people can afford to buy homes, increasing the demand for housing.
5. Higher house prices:
   - ○ The increased demand for housing drives up house prices.

(c) **Risks of securitization for investors (8 points)**

1. *"Investors don't know"*: It is more challenging for investors to thoroughly analyze a pool of 100 mortgages compared to a single mortgage, resulting in less informed investment decisions and higher risk.
2. *Moral hazard*: Banks may retain higher-quality loans and securitize riskier ones, knowing that investors cannot scrutinize each loan in detail.
3. *"Investors don't care"*: If house prices are expected to rise, investors might ignore the default risk, assuming the collateral will cover the loan. If prices fall, the risk of large losses increases.
4. *Reduced screening incentives*: Banks have less incentive to thoroughly screen borrowers when they can offload the risk to investors, increasing the likelihood of defaults.

(d) **Credit score threshold (8 points)**

1. Information beyond credit score:
   - ○ Banks have more information about borrowers than just the credit score, such as income, employment status, and other financial behaviors.

- Under the new policy, banks could securitize mortgages with a score of 620, potentially ignoring additional risk factors they would consider if they retained the loans.
  2. Behavioral changes and manipulation:
     - Borrowers with a credit score just above 620 might have manipulated their scores to meet the threshold, thereby increasing their actual default risk.
     - These borrowers applied more frequently, knowing they had a better chance of approval and insurance, even if they were less confident in their repayment ability.

Marking Scheme

(a) Profitability of auction methods (9 points)

- Affordability:
  - Full explanation (3 points)
  - Partial explanation (2 points)
  - Mentioned without explanation (1 point)
- Diversification:
  - Full explanation (3 points)
  - Partial explanation (2 points)
  - Mentioned without explanation (1 point)
- Liquidity:
  - Full explanation (3 points)
  - Partial explanation (2 points)
  - Mentioned without explanation (1 point)
- 1-3 points for plausible other reasons, 3 for complete answers that answer the task
- If more than 3 reasons are given, only the first 3 are graded
- Examples of incorrect answers:
  - Explaining why it's better to sell to investors vs keep on balance (both options imply selling to investors)
  - Explaining why mortgages are profitable

(b) Securitization leading to house price appreciation (5 points)

- Full chain of reasoning (5 points for all five arguments)
- Reduce 1 point for each step missing

(c) Risks of Securitization for Investors (8 points)

Full explanation of each of the risks (4 points)

- Partial explanation (2-3 points)
- Mentioned without detailed explanation (1 point)

Only the first two risks mentioned should take credit.

(d) Credit score threshold (8 points)

If more alternatives are provided, the 2 first explanations are to be graded.

- Information beyond credit score:
  - Full explanation (4 points)
  - Partial explanation (2-3 points)
  - Mentioned without detailed explanation (1 point)
- Behavioral changes and manipulation:
  - Full explanation (4 points)
  - Partial explanation (2-3 points)
  - Mentioned without detailed explanation (1 point)

Partial credit examples:

- Providing one correct reason fully (4 points)
- Alternative plausible explanation fully correct (up to 4 points each)
- Alternative plausible explanation that partially answers question (2-3 points each)

[Note: one of the most common answers to part D was that the problem was adverse selection in the following sense - that borrowers with 620 score received subsidized government insurance and therefore, did not make the necessary efforts to repay the loans because of the safety net provided by the insurance. This answer is incorrect for the following reason. Unlike with fire insurance or flood insurance on a house, mortgage insurance covers investment of the lender. In case of default by the borrower, the government pays out to the lenders (bank or investors), not the borrowers. So borrowers in case of default lose their house, just like without insurance. In this particular case, insurance does not negatively impact incentives of the borrowers to repay their mortgage.

Open Question 2. Water Restrictions

Residents of Catalonia (autonomous community of Spain) during the winter of 2023-24 faced water usage restrictions due to drought. Fountains were turned off, watering lawns, filling pools, washing streets and house facades were prohibited; restrictions also affected public showers and car washes. When the author of this task asked GPT-4 how the introduction of such restrictions could affect the price of water, he received the following response:

> *The reduction in water availability can lead to an increase in its cost to cover expenses for extraction, purification, and distribution. When water becomes a scarce resource, its extraction and delivery to consumers require additional costs, for example, through the use of alternative water sources or enhanced purification.*

Indeed, economics textbooks typically state that a quota (limitation of the quantity of a good) leads to price increases. However, the goal of the restrictions imposed by the government of Catalonia is, on the contrary, to prevent excessive price increases for households — water consumers.

(a) (12 rp) Construct an economic model of the perfectly competitive market with two groups of consumers (car washes and households), which demonstrates that restricting water consumption for one group of consumers (car washes) can lead to a decrease in price compared to equilibrium without intervention. Provide the analytical or graphical solution of your model. Assume that the quota for car washes is below their level of water consumption at equilibrium but above zero, and that car washes can trade quotas, meaning the most economically efficient among them will buy water.

(b) (9 rp) How does such government intervention in your model affect the surpluses of each group of consumers and producers, as well as the overall social surplus (welfare)? Provide calculations or show graphically. Can one specify functions and parameters of the model so that the impact on the social surplus is reversed?

(c) (9 rp) Suppose the government can regulate the price of water for car washes, and resale of water between consumer groups is impossible. Instead of setting a quota for car washes, the government increases the price for them to reduce their consumption to the level of the previous quota. The price for households is set at the equilibrium level. Analyze this approach compared to the quota in terms of the surplus of each group of consumers and producers.

Solution

(a) Assume the water supply is described by the function $Q = P$, the demand of the first group (car washes) is given by $Q_w = 50 - 0.5P$, and the demand of the second group (households) is $Q_h = 50 - 0.5P$. Total demand is $Q = 100 - P$, equilibrium without intervention is $P^* = 50$, and consumption of each group is 25.

If the government imposes a restriction on water consumption for car washes at the level of $Q_w = 10$, then total demand will be $Q = 60 - 0.5P$. With the intervention, the price is $P = 40$, which is lower than the price without restrictions, and household consumption will increase from 25 to 30..

Graphical representation follows below. The red line is the demand function of any group of consumers, the blue line is the new demand function.
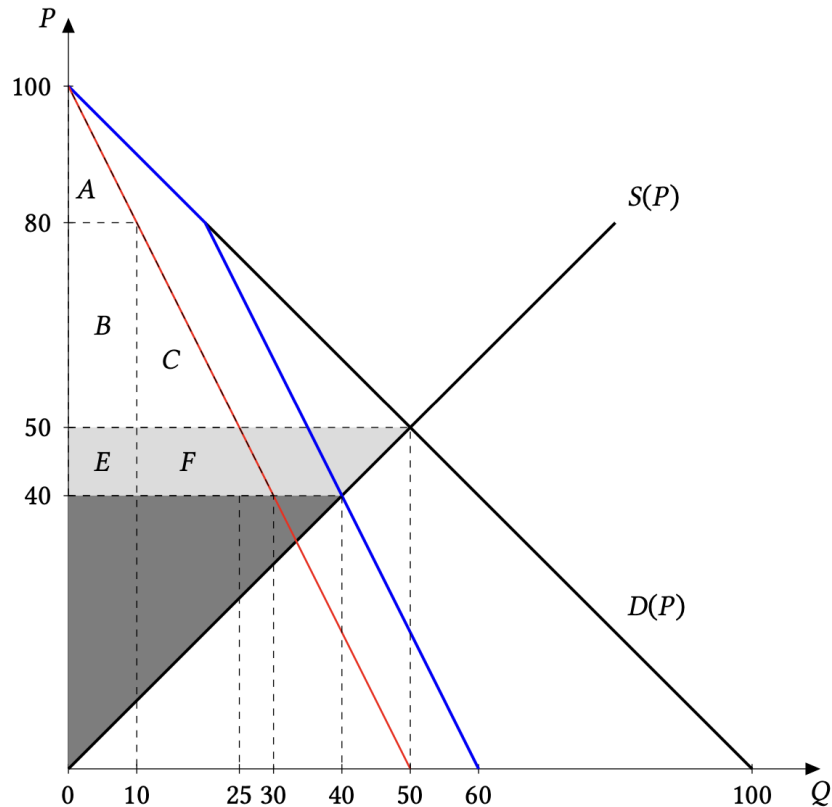
(b) Households benefit: they buy more and cheaper. Their surplus in the model used to be areas **A + B + C**, now it is **A + B + C + E + F**. Numerically, that is an increase from 625 to 900.

The surplus of car washes may change in any direction: they buy less and cheaper, and with inelastic supply, the price effect may outweigh. In this model, they lose: they used to have a surplus of **A + B + C** = 625, now it is **A + B + E** = 500.

Water producers lose unambiguously: they sell less and cheaper. Their surplus used to be light shaded area (1250), now it is only dark shaded area (800).

The overall surplus inevitably decreases since it was previously maximized (in perfect competition without regulation). In this model, it has decreased from 625 + 625 + 1250 = 2500 to 900 + 500 + 800 = 2200.

(c) The output in the market does not change, nor does the price for households. Therefore:

- Households are unaffected.
- Car washes are worse by area **B** off due to higher prices.
- Producers are better off by area **B** due to higher prices for car washes.

Marking Scheme

(a) Economic Model of Water Market with Quotas (12 points)

- Correct setup of supply and demand functions (curves) (2 points)
- Correct calculation (specification) of equilibrium without intervention (2 points)
- Correct setup of demand function (curve) with quota (4 points)
- Correct calculation (specification) of new equilibrium price (4 points)

The demand and supply can be any functions that satisfy the laws of supply and demand.

(b) Effect on Surpluses (9 points)

- Correct analytical calculation or graphical specification of consumer surplus for households (3 points)
- Correct analytical calculation or graphical specification of consumer surplus for car washes (3 points)
- Correct analytical calculation or graphical specification of producer surplus (2 points)
- Correct analytical calculation or graphical specification of total surplus (1 points)

(c) Price Regulation Approach (9 points)

- Correct analysis for each one group (3 points)

Open Question 3. Lockdown and Inequality

During the first UK national lockdown in 2020, the government announced a furlough scheme for all full-time workers. Under this scheme, firms could apply for government support to pay up to 80% of the wages of workers who were unable to work (for example, because the firm was required to close during the lockdown).

    (a) (6 rp) Use the concept of 'firm-specific assets' to explain why firms may prefer to furlough their workers during a temporary dip in demand (like the UK national lockdowns) rather than fire their workers or make them redundant. Give an example to support your explanation.

Other countries also implemented similar schemes during 2020. The diagram below shows the distribution of income before the COVID-19 pandemic, for a hypothetical country that consists of unemployed workers, employed workers, and owners (of capital). Each employed worker earns the same wage, and there are no unemployment benefits.

Cumulative share of the population, from lowest to highest income (%)
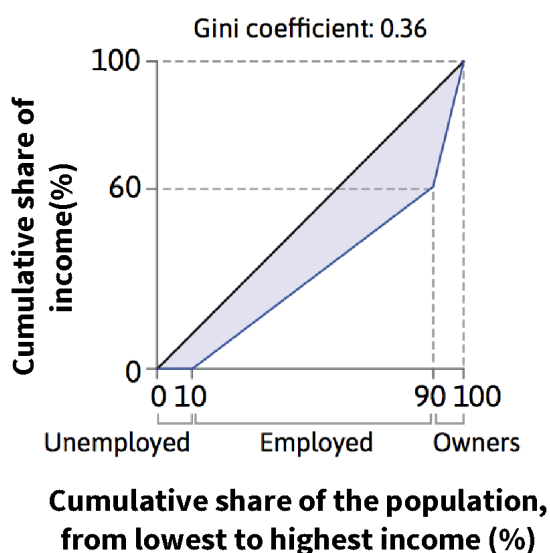
Suppose that this country implemented a furlough scheme during the COVID-19 pandemic (Scenario A). When the scheme was in effect, unemployment increased by 2 percentage points and the cumulative share of income for employed workers fell to 54%. Assume that all workers who remained employed were furloughed. Suppose that if the government had not implemented the furlough scheme, the unemployment rate would have increased by 10 percentage points and the cumulative share of income for employed workers would have been 48% (Scenario B).

    (b) (16 rp) Describe how Scenario A and Scenario B change the shape of the Lorenz curve. By calculating the Gini coefficient in Scenario A and Scenario B (or otherwise), discuss the effect of the furlough scheme on income inequality.

    (c) (8 rp) Suppose that during the pandemic, some of the unemployed workers joined the gig economy, where they could make some income but with a lower hourly wage than from formal employment. Analyze the potential effects of these gig economy workers on income inequality. State any assumptions you make.

Solution

(a) **Firm-specific assets and furloughing workers (6 points)**

Firm-specific assets are resources or skills that are valuable only within a particular firm. These can include specialized training, proprietary knowledge, internal networks, and collaborative relationships.

Firms may prefer to furlough their workers during a temporary dip in demand, such as the UK national lockdown, for the following *reasons*:

1. Retention of firm-specific skills and knowledge:
   - Workers possess skills and knowledge that are tailored to the specific operations of the firm. Losing these workers would mean losing valuable assets that are not easily replaceable.
2. Cost of hiring and training:
   - Rehiring and training new employees once demand recovers can be costly and time-consuming. Furloughing allows firms to quickly resume operations with experienced staff.
3. Employee morale and loyalty:
   - Furloughing workers rather than firing them helps maintain employee morale and loyalty. Workers are more likely to return to a firm that demonstrated commitment to their well-being during difficult times.

Example: A boutique hotel faces significant declines in bookings due to lockdowns and travel restrictions. The hotel staff, including concierges, housekeepers, and chefs, are highly skilled in providing personalized guest experiences and have developed strong relationships with repeat customers. Furloughing these employees allows the hotel to retain their expertise and knowledge of the property, ensuring that when travel resumes, they can quickly reassemble a cohesive team that delivers exceptional service, rather than starting from scratch with new hires. Firing them would mean losing this valuable experience and jeopardizing the hotel's reputation in a competitive market.

(b) **Impact of furlough scheme on income inequality (16 points)**

To analyze the impact on income inequality, we compare Scenario A (with furlough scheme) and Scenario B (without furlough scheme).

Scenario A:

To calculate the Gini coefficient using the Lorenz curve, connecting the points (0, 0), (12, 0), (90, 54), and (100, 100), one can follow these steps:
1. **Identify the area under the Lorenz curve (A)**:
This is the area between the line of perfect equality (the diagonal line from (0, 0) to (100, 100)) and the Lorenz curve.
2. **Identify the total area under the line of perfect equality (B)**:
This is the area of the triangle formed by points (0, 0), (100, 0), and (100, 100).
   B = 1/2×base×height = 1/2× 100 × 100 = 5000
3.

Calculate area A under the Lorenz curve:

To find the area A under the Lorenz curve, one can break it down into segments based on the points given.
 - From (0, 0) to (12, 0): This segment contributes no area.
 - From (12, 0) to (90, 54): This can be calculated as a trapezoid.
 - From (90, 54) to (100, 100): This can also be calculated as a trapezoid.

Area from (12, 0) to (90, 54):

  Area = $1/2 \times$ (Base$_1$ + Base$_2$)×Height
        Here: Base$_1$ = 0, Base$_2$ = 54, Height = (90 - 12) = 78.
  A_1 = $1/2 \times$ (0 + 54)×78 = 1/2×54×78 = 2106

Area from (90, 54) to (100, 100):

  A_2 = $1/2 \times$ (Base$_1$ + Base$_2$) ×Height
        Here: Base$_1$ = 54, Base$_2$ = 100, Height = (100 - 90) = 10.
  A_2 = 1/2×(54 + 100)×10 = 1/2×154×10 = 770

Total Area A under the Lorenz curve:

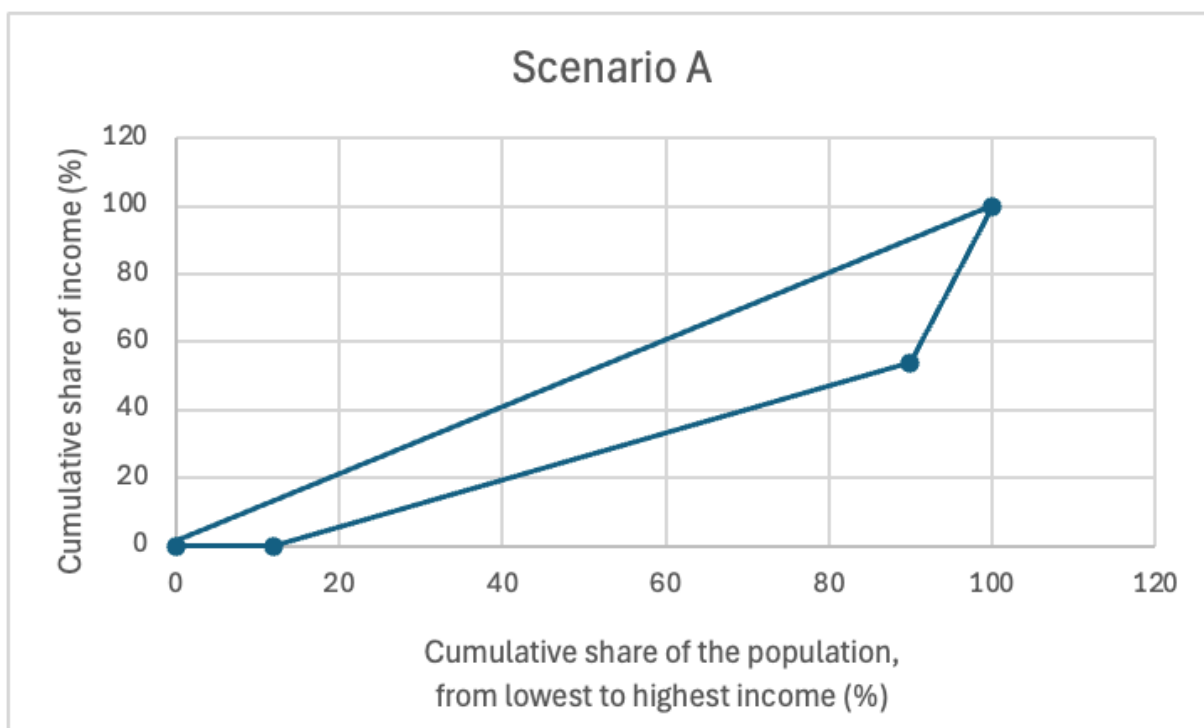 A = A_1 + A_2 = 2106 + 770 = 2876

4.

Calculate the Gini coefficient:

  The Gini coefficient G is calculated using the formula:
   G = B - A/B = 5000 - 2876/5000 = 2124/5000 = 0.4248

Thus, the Gini coefficient is approximately **0.42**.

Scenario B:

To calculate the Gini coefficient for Scenario B with the Lorenz curve connecting the points (0, 0), (20, 0), (90, 48), and (100, 100), one can follow these steps:

1. **Identify the area under the Lorenz curve (A)**:
This is the area between the line of perfect equality (the diagonal line from (0, 0) to (100, 100)) and the Lorenz curve.

2. **Identify the total area under the line of perfect equality (B)**:
This is the area of the triangle formed by the points (0, 0), (100, 0), and (100, 100).

B = 1/2×base×height = 1/2× 100 × 100 = 5000

3.

Calculate area A:

To find the area A under the Lorenz curve, you can break it down into segments based on the points given.

  - From (0, 0) to (20, 0): This segment contributes no area.

  - From (20, 0) to (90, 48): This can be calculated as a trapezoid.

  - From (90, 48) to (100, 100): This can also be calculated as a trapezoid.

Area from (20, 0) to (90, 48):

$Area_1 = 1/2 \times (Base_1 + Base_2) \times Height$

Here: $Base_1 = 0$, $Base_2 = 48$, Height = (90 - 20) = 70.

$A_1 = 1/2 \times (0 + 48) \times 70 = 1/2 \times 48 \times 70 = 1680$

From (90, 48) to (100, 100):

$A_2 = 1/2 \times (Base_1 + Base_2) \times Height$

Here, $Base_1 = 48$, $Base_2 = 100$, Height = (100 - 90) = 10.

$A_2 = 1/2 \times (48 + 100) \times 10 = 1/2 \times 148 \times 10 = 740$

Total Area A Under the Lorenz Curve

$A = A_1 + A_2 = 1680 + 740 = 2420$

4.

Calculate the Gini coefficient:
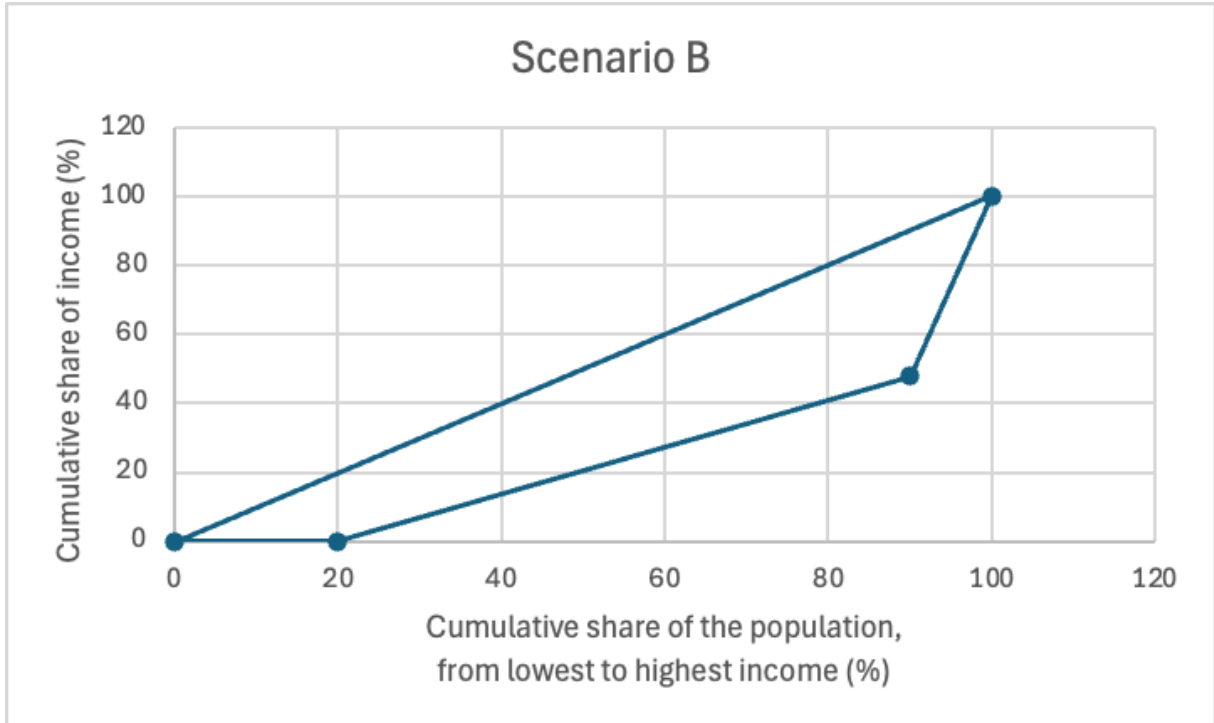
  The Gini coefficient G is calculated using the formula:

    G = B - A/B

Substituting in our values:

  G = 5000 - 2420/5000 = 2580/5000 = 0.516

Thus, the Gini coefficient for Scenario B is approximately **0.52**.

Effect on Inequality:

- In Scenario A, the Gini coefficient is 0.42, and in Scenario B, it is 0.52.

- Income inequality increases in both scenarios compared to the pre-pandemic level (Gini of 0.36).
- However, the furlough scheme in Scenario A mitigates the increase in income inequality compared to Scenario B.

(c) Impact of Gig Economy on Income Inequality (8 points)

During the pandemic, some unemployed workers joined the gig economy. Assuming gig economy wages are lower than formal employment wages, the impact on income inequality can be analyzed as follows:

Assumptions:

Gig economy wages are lower than formal employment wages.

Potential effects:

- Decreased income inequality:
  - The unemployed workers who join the gig economy now earn some income, reducing the gap between the lowest and highest earners.
  - The Lorenz curve will show a smaller gap between the lower-income group and the median-income group, potentially lowering the Gini coefficient.
- Description of Lorenz Curve:
  - With gig economy income, the Lorenz curve becomes less steep in the lower-income segment, reflecting increased income for previously unemployed workers.
  - This reduces the overall area between the Lorenz curve and the line of equality, indicating decreased income inequality.

Example: If previously unemployed workers earned zero income and now earn 60% of the formal wage through gig economy jobs, their inclusion would shift the Lorenz curve upwards, closer to the line of equality.

Statement: It is clearly stated that unemployed workers join the gig economy, so stating that furlough workers might join too is considered to be wrong/irrelevant.

Marking Scheme

(a) Firm-specific assets and furloughing workers (6 points)

- Explanation of firm-specific assets (2 points)
- Correct application to furloughing during a dip in demand (2 points)
- Relevant/correct example (2 points)

(b) Impact of furlough scheme on income inequality (16 points)

- Correct identification of Lorenz curve points in Scenario A (2 points - one per each "interior"/non-trivial point)

- Correct identification of Lorenz curve points in Scenario B (2 points - one per each "interior"/non-trivial point)
- Accurate Gini coefficient calculation for Scenario A (4 points - 3 if model is used correctly plus 1 if result is correct).
- Accurate Gini coefficient calculation for Scenario B (4 points- 3 if model is used correctly plus 1 if result is correct)
- Explanation of income inequality effect (4 points for complete explanation, 2-3 points for getting the idea of effects on the group of unemployed only, 1 point for pointing out the correct direction of the effect on Gini coefficient and 0 for not relevant explanation)

(c) Impact of gig economy on income inequality (8 points)

- Clear assumptions stated (2 points)
- Analysis of potential effects on income inequality (4 points - 2 points for partially correct analysis of potential effects)
- Accurate description of Lorenz curve changes (2 points)

Partial Credit:

- Partial description of Lorenz curve changes (up to 1 point)
- The gig economy provides an alternative source of income for the unemployed, reducing the total number of completely unemployed workers (2 points)
- If gig workers earn a sufficiently significant portion of the income they previously made, this could decrease overall income inequality (2 points)

Open Question 4. Competition with the Leader

In country B, the market for beer is organized as follows: There is a major brewery, Brewery A, and numerous (potentially very many) microbreweries and craft beer producers. Brewery A is the market leader and sets the price for a bottle that others follow as price-takers. After Brewery A sets the price, each price-taking firm decides how much beer to produce (if any). Any demand not met by these firms is satisfied by Brewery A.

Assume the market parameters are as follows:

- beer is a homogenous product, but the production technologies may differ across firms;
- the demand function is $D(p) = 20{,}000 - 3p$;
- the marginal cost of Brewery A is constant and equal to $MC_A = 30$;
- marginal cost of price-taking firm number i is $MC_i = 3i + q_i$, where i = 1, 2, 3, ..., and q_i is the amount of beer produced by firm i.

Also, just in case you forgot, $1 + 2 + 3 + ... + n = n(n+1)/2$.

(a) (5 rp) Determine the supply function of a price-taking firm i. Don't forget to specify the supply level under **all** prices.

(b) (5 rp) How many price-taking firms will produce beer under different prices set by Brewery A?

(c) (10 rp) What is the profit-maximizing price that firm A should set?

(d) (5 rp) You are the economic advisor to the President of Country B. The President believes that to improve consumers' welfare, the government needs to cease operations of Brewery A because it has enormous power in setting prices, which is always bad for consumers. If this policy is implemented, the market becomes perfectly competitive with only price-taking firms (i = 1, 2, 3, ...). What advice would you give regarding such a policy?

(e) (5 rp) Now assume that instead of shutting down Brewery A's, the government orders it to become one of the price-taking firms. That is, the market becomes perfectly competitive with Brewery A and some other firms. How many firms will there be in the market in equilibrium? Compare this situation with (c) from the perspective of: (1) market concentration, (2) consumers' welfare.

Solution

(a) $p = MC_i$ gives $p = 3i + q_i$, or $q_i = p - 3i$. Production will be positive only if $p > 3i$, otherwise it is 0.

(b) The minimal price for firm i to produce a positive amount of beer is slightly higher than $3i$. If the price is lower or equal to 3, there are no price-taking producers, if it is **higher** than 3 but less or equal to 6, there will be 1 price-taking producer, and so on. This can be summarized by saying that there will be $n = [p/3]$ firms if p is not divisible by 3, where $[x]$ denotes the closest integer not greater than x, and $n = (p/3 - 1)$ if p is divisible by 3.

(c) If there are n price-taking firms with positive level of beer production, their total supply is

$$S = n{\times}p - 3(1 + 2 + ... + n) = n{\times}p - 3n(n+1)/2.$$

Let's assume for simplicity that n = p/3, not [p/3]. Then, S = $p^2/6 - p/2$. In this case, the residual demand (after small firms produce their outputs) is RD(p) = 20,000 – 3p – (p²/6 – p/2) = 20,000 – p²/6 – 2.5p. Given MC_A = 30, the profit is equal to

$$Pr_A = (20,000 - p^2/6 - 2.5p) \times (p - 30).$$

Taking the derivative with respect to p, we get

$Pr_A' = 20,000 - p^2/2 - 5p + 10p + 75 = 20,075 + 5p - p^2/2.$

It equals to 0 under positive p ≈ 205.44. Under this price, exactly 68 price-taking firms will enter the market, so we can recalculate residual demand and profit more accurately:

$$RD(p) = 20,000 - 3p - (68p - 3 \times 68 \times 69/2) = 27,038 - 71p$$

$$Pr_A = (27,038 - 71p) \times (p - 30).$$

The profit-maximizing price is approximately p ≈ 205.41.

(d) Again, let's assume n = p/3. In this case, the equilibrium will be determined by 20,000 – 3p = p²/6 – p/2. This is a quadratic equation, its positive solution is slightly less than 339. If it was exactly 339, then 339/3 = 113 firms would enter the market. But it is slightly less, so, the 113th firm will not produce anything, and there will be 112 firms.
Comparing this with (c), we can infer that the situation with the dominant firm is better for consumers (price is lower). So, even though Brewery A sets the price, the consumers are better off with it being in place. The policy does not help consumers and thus should not be implemented.

(e) Brewery A can sell any amount of beer for price 30 or higher. That is, under perfect competition, no firms with necessary prices >30 will operate, that is, there will be only (30/3 – 1) + 1 = 10 firms with positive production, and the equilibrium price will be 30. 9 firms with MC = $3i + q_i$ will produce only 135 bottles of beer, while Brewery A will cover 20,000 – 3 × 30 – 135 = 19,775 bottles. So, the market concentration is higher than in (c), but the consumers are happier, because the price is lower.

Marking Scheme

(a) Supply Function of a Price-Taking Firm (5 points)

- Correctly equating p = MC_i and solving for q_i = p – 3i (2 points)
- Correctly stating that q_i > 0 only if p > 3i (2 points)
- Providing the correct piecewise supply function q_i = p – 3i if p > 3i; 0 otherwise (1 point)

(b) Number of Price-Taking Firms Producing Beer (5 points)

- Correct identification of the number of price-taking firms in the market (5 points)
- The analysis of specific case n = (p/3 – 1) is not required for a full grade, that is, if the answer is [p/3] for all cases, it also earns full credit
- If a contestant just says that n = p/3 without considering that the number of firms must be integer, the score is 3/5.

(c) Profit-Maximizing Price for Brewery A (10 points)

- Correct setup of total supply function of all price-taking firms (3 points)
- Correct residual demand function after considering price-taking firms (2 points)
- Correct profit function for Brewery A (in terms of price or quantity) (2 points)
- Correct differentiation and solving for profit-maximizing price or quantity (3 points). If maximization is done via choosing q, 1 point for expressing p.

(d) Advice on Ceasing Operations of Brewery A (5 points)

- Correct analysis of market changes if Brewery A ceases operations (3 points)
- Correct discussion on consumer welfare impacts (1 points)
- Clear and logical recommendation based on analysis (1 point)

If a contestant correctly *intuitively* deduces that the overall supply of beer may decrease, thus suggesting the stated policy could be a bad idea, they can earn **up to 3 points** depending on the completeness of their explanation and correctness of the conclusion. (If the analysis just repeats the President's argument from the tasks, the score is 0) This response does not merit full credit because the exit of the dominant firm results in the (at least partial) offsetting effect of new price-taking firms entering the market. The overall impact of these events must be analyzed using the specific functions provided.

(e) Comparison of Equilibrium with Brewery A as a Price-Taker (5 points)

- Correct overall understanding how the market will work (= correct setup of the new supply curve) (2 points)
  - If it is only specified that the price will be equal to MC = 30 of the biggest firm without the analysis of the other firms, 1 point
- Correct calculation of the number of firms in a perfectly competitive market (1 point)
- Correct comparison of market concentration (1 point)
- Correct comparison of consumer welfare (1 point)

Open Question 5.

Lake L is situated near a village. In this task, we will consider different property rights regimes for the lake and explore their implications on the villagers' well-being and the environment.

Assume that the production function of the lake is $f(x) = 100\sqrt{x}$, where f is the total amount of fish (in kilograms) that can be caught in the lake per day, and x is the number of fishing nets used. A kilogram of fish can be sold in the market for $10, and the daily rental price for a fishing net is $25.

(a) (7 points) Suppose Firm A owns the lake and has exclusive fishing rights. It does not have any cost besides fishing nets rental. Calculate the amount of fish that it will catch to maximize profits.

(b) (6 points) Now, suppose Firm A makes money by charging villagers a per-net fee to fish in the lake, rather than selling the fish directly. Assume that all fishermen fish with the same intensity, collectively catching the maximum possible fish with the given number of nets and selling it in the market. In addition to the per-net fee charged by Firm A, each fisherman must pay $25 per day to rent a net. What will the per-net fee be?

(c) (7 points) The government decides to nationalize the lake, making it open-access for the villagers. Now, every villager can fish using one or more nets, which still need to be rented for $25 each. Assuming each villager only considers their own benefit, determine the number of nets that will be used and the total amount of fish that will be caught. Compare your answer to parts (a) and (b) and explain the differences.

(d) (4 points) What are the likely long-term consequences for the fish population in the lake? What is the economic term for the problem that arises in this situation?

(e) (6 points) If you have solved the previous parts correctly, you will find that the economic position of the villagers (the fishermen) is unfavorable under both private and public ownership of the lake. However, there is hope. Elinor Ostrom's research highlights that community members can successfully manage common-pool resources through cooperation and the establishment of social norms, even with limited or no official government regulation. Suggest two principles for designing these norms and institutions to enhance their effectiveness. Explain the importance of each principle in ensuring the sustainable and efficient use of common-pool resources. You can either rely on Ostrom's research or suggest your own principles.

Solution

(a) The firm's profit is $Profit(x) = 10 \times 100\sqrt{x} - 25x$. It is maximized at x = 400 and f(x) = 2000.

(b) The lake owner can basically collect all (or almost all) the profit that fishermen will earn from selling fish, the maximum of which will be equal to profit that it used to earn by selling fish itself. So, it should sell 400 fishing nets licenses and let the villagers catch 2000 kilos of fish per day. Every net catches 5 kilos of fish that can be sold for $50, so the profit from one net is

$50 − $25 = $25. A profit-maximizing lake owner should charge this amount (or slightly lower).

(c) Now, every fisherman will decide to rent a fishing net in case it brings more revenue than its rental cost. Therefore, additional nets will be used until profit reaches zero. That is, $Profit(x) = 10 \times 100\sqrt{x} - 25x = 0$. This brings $x = 1600$. More nets are used and more fish is caught because the fishermen fail to internalize the externality that exists here: due to diminishing returns, adding each net makes the situation worse for every existing net, but a fisherman in this situation does not care. In parts (a) and (b), there was a 'central planner' (Firm A), which internalized the externality, because it maximized overall profit and had no incentives to overfish.

(d) This will likely cause excessive fishing (overfishing), which can lead to the ecosystem of the lake being destroyed (the fish just won't be able to reproduce). The lake is a common-pool resource, and the problem is called 'the tragedy of the commons'[1] in economics. Other relevant terms are: the free rider problem, the prisoner's dilemma, negative externality.

(e) Some of these principles may be suggested[2]:

Clearly defined boundaries. The boundaries of the resource system, such as a fishery, and the individuals or households with rights to harvest resource units are clearly defined. (For example, only those who live in the nearby village for more than a year are eligible to fish.)

Proportional equivalence between benefits and costs. Rules specifying the amount of resource products that a user is allocated are related to local conditions and rules requiring labor, materials, and/or money inputs.

Collective-choice arrangements. Many of the individuals affected by harvesting and protection rules are included in the group who can modify these rules.

Monitoring. Monitors, who actively audit biophysical conditions and user behavior, are at least partially accountable to users and/or are users themselves.

Graduated sanctions. Users who violate rules-in-use are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other users, officials accountable to these users, or both.

Conflict-resolution mechanisms. Users and their officials have rapid access to low-cost, local arenas to resolve conflict among users or between users and officials.

Minimal recognition of rights to organize. The rights of users to devise their own institutions are not challenged by external governmental authorities, and users have long-term tenure rights to the resource.

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[1] G. Hardin, "The Tragedy of the Commons," Science 162, no. 3859 (13 December 1968): 1243–48.

[2] Source: E. Ostrom, Governing the Commons: The Evolution of Institutions for Collective Action (New York: Cambridge University Press, 1990), 90.

Marking Scheme

(a) Firm A's Profit Maximization (7 points)

- Correct setup of profit function or clearly implied (2 points)
- Correct solving for x (3 points)
- Correct calculation of f(x)=2000 kg (2 points)

The firm's problem can be also set through a function of output, not x. In this case, correct maximization brings 5 = 3 + 2 points immediately.

(b) Per-Net Fee by Firm A (6 points)

- Correct idea that overall number of nets and output will be the same because Firm A wants to maximize fishermen's profit to collect it from them through access payments (3 points)
- Correct calculation of per-net fee (3 points)

(c) Open-Access Regime (7 points)

- The idea that fishermen will add nets until profit reaches 0 (2 points)
- Correct solving for equilibrium number of nets and fish caught (2 points)
- Comparison with parts (a) and (b) and explanation of the externality idea (3 points)

(d) Long-term Consequences (4 points)

- Correct identification of overfishing problem (2 points)
- Correct use of "tragedy of the commons" term (2 points)

Partial Credit:

- Mentioning one of the terms that has some relation but is not exactly correct (free rider problem, the prisoner's dilemma, negative externality), not mentioning the tragedy of the commons (1 point of 2)

(e) Principles for Managing Common-Pool Resources (6 points)

- Correct and clear specification of two principles (4 points)
- Explanation of importance for two principles (2 points)

Partial Credit:

- Correct specification of only one principle (2 points)
- Explanation of importance for only one principle (1 point)