INTERNATIONAL ECONOMICS OLYMPIAD

2020

Open Questions

Solve no more than 4 questions out of 5. Indicate your choice of questions.

If you provide solutions for all 5 questions, all of them will be commented by the Jury, but only 4 will add to your score. In this case, if you do not specify which to grade, the maximum grade of 5 will be excluded.

Every open question is worth 30 raw points.

If not stated otherwise, think of all goods, services and assets as of infinitely divisible. Numbers of firms and people may be only integer.

Convey your ideas clearly. Don't skip important logical transitions in your reasoning.

Good luck!

AIFC Astana International Financial Centre

HSE University

In case you forgot,

$$1 + 2 + 3 + \cdots + n = \frac{n(n+1)}{2}$$

Question 1. "Short questions about coronacrisis" *(30 raw points)*

In this task, please answer the following questions related to the economic and econometric aspects of the COVID-19 pandemic.

(a) *(10 rp)* When fighting an "ordinary" recession, it is sufficient for the government to pay out transfers to households only. However, in the current recession, transfers to *firms* (or tax cuts for them) are also required. Explain why.

(b) *(10 rp)* In the first weeks of the epidemic in Europe, there was a dramatic surge in demand for essential goods like toilet paper. Usually, a substantial rise in demand for a particular product leads to a corresponding increase in the producer's stock price. However, the stock prices of major toilet paper producers rose little, if at all. Explain why.

(c) *(10 rp)* Measuring even a seemingly "simple" quantity like the number of COVID-19 deaths is not simple. A substantial number of cases may fail to be counted, and the deaths may be erroneously attributed to something else. Some people argue that measuring so-called *excess mortality*, i.e., the difference between the total number of deaths in a certain period of 2020, and the total number of deaths in the same period of a previous year, may help. Researchers found[1] that excess mortality in Italy in March 2020 relative to March 2019 is roughly twice the reported number of COVID-19 deaths. Does this imply that the reported number of people who died from the COVID-19 disease really underestimates the actual number by a factor of 2? Why?

Solution

(a) Usually, transfers to households are sufficient to support aggregate demand as the households spend the transfers on goods and services; this generates revenue for firms, and the firms keep employing workers. In an epidemic-based recession, however, households are restricted in spending transfers, as people are restricted in leaving their apartment and, for example, can not physically go to a restaurant. It is harder for transfers to become firms' revenue. Thus, to prevent bankruptcies and keep employment, direct transfers to firms (at least those that can not quickly transform their business into an online one) are needed.

(b) The net present value of the companies' expected dividends was affected little by the surge in demand, as people just moved the demand for toilet paper from the future to the present. People did not start to use more toilet paper.

(c) It is quite obvious that great excess mortality in 2020 must be somehow related to the COVID-19 pandemic, but it is far from clear that the COVID-19 *disease* causes all the new deaths. For example, because the capacity of health care systems is limited, COVID-19 patients may have crowded out other patients from hospitals, and those other patients may have started to die more because of that. Similarly, the pandemic caused severe stress that may have had a severe negative impact on health independently of the coronavirus. Thus, one can not attribute all excess mortality directly to the COVID-19 disease.

This part illustrates the difficulty of measuring causal effects in economics and social sciences.

[1] Ciminelli, G, and S Garcia-Mandicó (2020), "COVID-19 in Italy: an Analysis of Death Registry Data", working paper.

Marking Scheme For every part:

0 pt – no answer, wrong answer or answer with very little argumentation.

5 pt – partially correct answer that contains some necessary elements to explain the question, but is missing significant elements.

10 pt – full answer or answer with some minor missing elements.

Question 2. "Optimal lockdown" *(30 raw points)*

As a pandemic caused by a new virus wreaks havoc in the world, no one is yet ill in town M (but some people may be unknowingly infected and may be able to spread the virus). The town administration considers introducing a lockdown to prevent the spread of the virus. How strong should the lockdown be? The stronger the lockdown is, the slower is the spread of the virus, but at the same time, the stronger is the damage to the economy.

There are 200 citizens in the town. Let the economic benefits of every citizen from going outside be 50. The costs of going outside are related to the probability of falling ill. This probability, in turn, depends on the number of people outside. If there are Q people outside *not including* person i, the probability that the person i becomes ill is equal to $Q/200$. Importantly, the costs upon falling ill are different for different people as the costs depend on age, initial health, etc. The costs for the first person are equal to 1, for the second person – to 2, etc. up to 200. Thus, the expected utility of person i from going outside is given by

$$U_i = 50 - \frac{Q}{200} \cdot i.$$

The utility from staying home is equal to 0 (one can not get infected at home).

(a) *(12 rp)* Suppose people decide individually whether to go outside, each of them maximizes his/her expected utility. We say that people's decisions form a *Nash equilibrium* if no one can benefit by changing her/his decision with others' decisions fixed. How many people will go outside in the Nash equilibrium? Call this number N.

(b) *(12 rp)* By introducing a lockdown, the town administration can mandate who can and who can not go outside. The administration knows the individual costs of falling ill of every citizen and maximizes the sum of people's expected utilities. How many people should the administration allow to go outside? Call this number K.

(c) *(6 rp)* Compare N and K. Provide intuition for why is one greater than the other. Which fundamental economic problem does this model illustrate?

Solution

(a) We will identify a Nash equilibrium in which all people with relatively high costs of illness (high index i) stay home, and others go outside. Let N be the highest index of a person who goes outside (then, exactly N people go outside). In the equilibrium, the expected utility from going outside for all people with indexes $i = 1, \dots, N$ must be nonnegative, while for people $i = N + 1, \dots, 200$ this utility must be nonpositive.

In particular, the expected utility of person N from going outside must nonnegative given that $N - 1$ people beside her go outside and the expected utility of person $N + 1$ from going outside must be nonpositive given that N people go outside. Thus, two conditions must be satisfied: (1) $50 - \frac{N-1}{200}N \geq 0$; (2) $50 - \frac{(N+1)-1}{200}(N+1) \leq 0$. It is easy to find that the only whole number N satisfying these conditions is $N = 100$.

Finally, because the expected utility from going outside of person 100 is nonnegative, so it is for all people $i = 1, \dots 99$, because they have lower costs. Likewise, because the expected utility from going outside of person 101 is nonpositive, so it is for all people $i = 102, \dots, 200$ because they have higher costs. Thus, we indeed found a Nash equilibrium.

(b) As staying home yields a utility of zero, the sum of everyone's utilities is just the sum of utilities of people who go outside. Obviously, given that K people go outside, to maximize the sum, the administration should mandate that these are the people with lowest costs. Thus, the sum of utilities (welfare) is

$$W(K) = 50K - (1 + 2 + \ldots + K)\frac{K-1}{200} = 50K - \frac{K(K+1)(K-1)}{400}.$$

To maximize this function, consider a *marginal* increase in the welfare when K is incremented by 1: $MW(K) = W(K) - W(K-1)$. The administration should increase K as long as $MW(K)$ is positive, and stop when it becomes negative.

We have

$$MW(K) = 50 - \frac{1}{400}\left((K+1)K(K-1) - (K)(K-1)(K-2)\right) =$$
$$50 - \frac{K(K-1)}{400}(K + 1 - (K-2)) = 50 - 3\frac{K(K-1)}{400}.$$

Thus, $MW(K) > 0$ when $K(K-1) < \frac{2}{3}10000 \approx 6666$ and $MW(K) < 0$ otherwise. As $80^2 = 6400$, a good guess for the K at which the sign changes is around 80. It is straightforward to check that $81 \cdot 82 = 6642 < 6666$ while $82 \cdot 83 = 6806 > 6666$. Thus, the optimal K is equal to 82.

The administration should let 82 people go outside.

(c) As $100 > 82$, $N > K$. This happens because (at least in this model) people do not take into account the negative externality they inflict on others when going outside (or the positive externality when they stay home). This model illustrates the classic problem of the underprovision of a public good (the public good here is the empty street). Equally correct, one may say that this model represents an instance of *tragedy of commons*: a common resource – the street and other common places – is, in a sense, over-exploited here when there is no regulation.

Remark. Please note that even though $N > K$, the difference is not that big. Thus, the administration's intervention does not have to be strong: people themselves are already rational enough so that half of the town's population stays home without any mandatory lockdown. Roughly speaking, the strength of the mandatory lockdown ($N - K$) should correspond only to the strength of *externalities* people produce but not to the total costs of the disease.

Marking scheme.

(a)

- 2 points for the idea that people with lowest costs will go outside
- 8 points for writing the correct conditions for N
- 2 points for solving the conditions taking into account that N is an integer (thus, if the answer is off by 1, these points are not awarded).

Special cases:

- 4 points if the maxmin solution concept is used instead of Nash equilibrium. That is, a contestant assumes that a player does not know how other players will act (e.g., because she cannot assess others' rationality) and resorts to worst-case analysis. In a Nash equilibrium, players do know what others are doing!

(b)

- 2 points for the idea that people with lowest costs will should be allowed to go outside
- 8 points for writing the correct objective function and conditions for optimization (plotting the graph instead of writing the conditions is OK).
- 2 points for solving the conditions taking into account that N is an integer (thus, if the answer is off by 1, these points are not awarded).

Special cases:

- If a correct solution to (a) is presented as a solution to (b), only the first two points are awarded.

(c)

- 4 points for the idea of externalities
- 2 points for mentioning the under-provision of a public good or tragedy of commons

Special cases:

- If externalities are already mentioned, mentioning Prisoner's dilemma does not yield points, as this game is not technically a Prisoner's dilemma – the players do not have dominant strategies
- If externalities are not mentioned, mentioning Prisoner's dilemma yields 2 points as Prisoner's dilemma does suggest the idea of externalities
- If a contestant mentions negative externalities from going outside but (s)he actually gets $N < K$, (s)he is penalized by 2 points as this shows that the contestant did not detect a contradiction in her/his results, and thus her/his understanding is likely incomplete
- If no correct intuition is written, but the comparison is right ($N > K$), 1 point is awarded

Finally, in any part 1 or 2 encouragement points may be awarded if there is some plausible reasoning possibly hinting in the right direction but insufficient to get "main" points.

Question 3. "Central Bank Cryptocurrency" *(30 raw points)*

Imagine a small country IEOnia, in which the Central Bank has abandoned its old national currency with a substantial share of cash and introduced a new virtual sovereign currency based on blockchain. The new system is cashless, and all other (private) currencies are prohibited. Instead of holding cash, every person and every firm has a digital wallet operated by the Central Bank. The money in this wallet can be disposed of freely; the Central Bank may set an interest rate for the money in the wallet. The commercial banks' sector in the economy is highly competitive.

In this task, you are asked to discuss the possible features of the IEOnian economy.

(a) *(10 rp)* The monetary policy in traditional systems has a fundamental problem called 'zero lower bound.' How will this be affected by the introduction of the new system?

(b) *(10 rp)* How will the Central Bank digital currency affect interest rate spreads (lending rate minus deposit rate) of commercial banks?

(c) *(10 rp)* Provide one more economic consequence of the new system that you find significant.

Solution

(a) The zero lower bound problem means that it is difficult to decrease interest rates (conduct expansionary monetary policy) when the deposit rate is near zero. This is because people will withdraw money from commercial banks and keep them in cash. A cashless system removes this problem; banks (including the CB) may effectively pay the negative interest rate because depositors have no other option of storing money.

(b) Short answer:

- Either: same deposit rates, more concentration in the lending market – higher spreads.
- OR: higher deposit rates by commercial banks to attract funds, more transparency in credit history – lower spreads.
- OR: higher deposit rates by commercial banks to attract funds, funding risk hence higher lending rates – ambiguous effect on spreads.

Longer answer: Commercial banks and CB will be in competition for the depositors' money. While commercial banks could default and endanger deposits (that is why deposit insurance is necessary to avoid bank runs), CB offers effectively safe deposits. Banks will face a withdrawal of funding by people and firms because many will prefer a riskless wallet with CB given that the deposit interest rates are the same. Competeing with each other and with the CB, commercial banks will raise the deposit rates and thus decrease the spreads.

For commercial banks to stay in business, they would need to rely more heavily on other sources of funding, like issuing bonds. Provided a highly competitive environment, some banks will leave the market. Note that CB does not lend to firms or individuals, hence the lending market will be more concentrated. Remaining banks will charge higher interest from borrowers both because of higher cost of funding and more market power in lending.

So, there are effects both ways.

(c) Key ideas: decreased tax evasion and money laundering, increased tax revenues, more opportunities for financial surveillance, potentail issues with international trade, higher consumer spending because of lower "pain of paying", etc.

Marking Scheme

(a) 5pts Zero lower bound – hard to enforce negative nominal interest rates.
5pts Possible to enforce with crypo money because of no outside option.

(b) Full points for some consistent set of arguments about (i) deposit rate, (ii) lending market rate, and (iii) corresponding spread between them.

Question 4. "A common answer in micro and macro" *(30 raw points)*

This task consists of two parts. They are indirectly related, and the answers to them are somewhat similar. If you answer part (a) correctly, it'll be easier for you to come up with a correct answer to (b), and vice versa.

(a) *(15 rp)* It often happens that, under the threat of entry of a competitor, an incumbent monopolist lowers the price even *before* the entry actually occurs. But this monopolist's behaviour is, at first glance, irrational as the price *before entry* has no effect on the prices and quantities *after entry* and thus the pre-entry price cannot affect the entrant's decision to enter and eventually deter entry. Lowering the pre-entry price relative to the optimal price only causes the incumbent to lose the pre-entry profits. Propose a simple verbal model in which such monopolist's behaviour is nevertheless rational.

(b) *(15 rp)* Different individuals and firms have different inflation expectations. Research shows that when the expectations differ little, contractionary monetary policy (raising the interest rate by a central bank) leads to a decrease in inflation. However, when the inflation expectations differ a lot, raising the interest rate can paradoxically lead to an increase in inflation. Explain this phenomenon.

Solution

(a) Short: signaling by the monopolist its low level of costs. **Long**: The key is that the entrant doesn't have complete information about the monopolist's costs. Hence the entrant doesn't know how painful the price war or quantity competition will be in case of entry.

(b) Short answer: raising the interest rate by a CB is a signal for the economic agents that the aggregate demand is high (because the tightening of monetary policy is only necessary when the aggregate demand is high). Upon realizing that the demand is high, the firms raise prices. **Long answer**: Irrespective of the variance of inflation expectations, the classic monetary policy transmission mechanism is at work: when the interest rate grows, investment (and, possibly, consumption) contract (consumption through the effect of the interest rate on consumer loans). This lowers the aggregate demand and slows down inflation. However, when the differences in inflation expectations are large, there is a high level of uncertainty about the economy, and the agents are not likely to have right information about the aggregate demand. The CB, on the other hand, is likely to have better information as it sees the full picture and has overall better data, models, and economists. Thus, in times of high uncertainty, actions of the CB convey valuable information to the agents. In particular, raising the interest rate signals that the AD is high. Upon realizing that the demand is high, the firms raise prices. If this second informational effect is strong enough, it outweighs the classical transmission mechanism, and inflation increases.

Bibliographic note: The signaling explanation of the phenomenon in the first part of the problem (called "limit pricing") was proposed by Milgrom and Roberts in 1982.[2] The second part is based on the recent work of Falck and coauthors.[3]

[2]Milgrom, P. and J. Roberts. "Limit pricing and entry under incomplete information: An equilibrium analysis", Econometrica 1982.

[3]Falck, E., M. Hoffmann & P. Huertgen (2019), "Disagreement about inflation expectations and monetary policy transmission", Journal of Monetary Economics 2019.

Marking Scheme For both parts:

15 points: both the answer and the reasoning are correct. Model is presented in clear and consistent way, and leads to correct conclusions

14 points: the reasoning or the actual answer are correct, but it lacks clarity or specificity. The answer could be improved with few sentences, or the argument needs more flashing out of the main idea. Overall, the answer conveys that student understood the question, but may fall short in persuading and explicitly describing their argument.

10 points: either the reasoning or the answer is incorrect, but answer raises few good points that potentially could have led to a correct outcome.

5 points: there's at least one correct idea in the response that warrants points, but typically the answer and the model is incorrectly specified, or question is misunderstood. In some cases, a correct answer is given, to the wrong but related question

0 Points: both the reasoning and the answer is incorrect or question is completely misunderstood.

Question 5. "Why is it so expensive to live in London?" *(30 raw points)*

The richer the country, the higher the cost of living. Prices that you see in supermarkets and cafes of London generally are higher (in nominal terms) than those in Baku or Gaborone.

(a) *(10 rp)* For different goods and services, this effect is different. Provide examples of goods or services which typically cost almost the same across the world. Provide examples with high price differences. Explain.

(b) *(10 rp)* Provide a verbal model to explain this phenomenon: why in more developed countries (with greater labor productivity), certain goods are likely to be more expensive than in developing countries.

(c) *(10 rp)* What approach do economists use to account for these differences and compare gross domestic products between countries? If we calculate GDPs per capita utilizing this approach, will we observe more or less between-country inequality?

Solution

(a) Goods that are easier to trade across the board are more likely to cost roughly the same (economists call it the *law of one price*). Otherwise, exporters and importers will find profit opportunities and drive the prices closer together. A typical example is consumer electronics.

On the other hand, *non-tradable* goods and services must be produced locally and cannot be easily exported and imported. Food, most services (haircuts, taxi, etc.) are examples of it.

Relevant economic terms (not graded): *law of one price*, *arbitrage*.

(b) Technological advancement increases productivity in tradable sectors (like producing electronics) more than in non-tradable and labor-intensive (like hairdressing). The wages of tradable sector workers go up.

Demand side: Tradable sector workers have high wages so their demand is less elastic for non-tradable services. This increases their prices.

Supply side: Tradable and non-tradable sectors within a country are connected through the labor market: higher (real) wages in the tradable sector in advanced countries attract workers. So, the non-tradable sector wages also rise above the level of developing countries, even though the productivity of hairdressers across the world is roughly the same. Increased salaries lead to an increase in prices.

Relevant economic terms (not graded): *Balassa-Samuelson effect*, *Baumol's cost disease*.

(c) This concept is called purchasing power parity (PPP). Similar baskets of goods and their price difference between countries are used to adjust the nominal exchange rate and consider relative prices. Since similar baskets are more expensive in developed countries (with higher GDP), PPP-adjustment will decrease the difference of nominal GDPs. Less between-country inequality will be observed.

Marking Scheme

(a) 3 pts for examples of each kind, 4 pts for explanation (tradability). If one of the examples is missing but the other one is present and correctly explained through tradability, no penalty for lack of explanation.

(b) Correct demand or supply side explanation gets full grade.

Demand-side explanation:

- higher productivity leads to higher wages in some sectors – 5 pts;
- higher wages lead to greater demand (and less elastic) for goods and services – 2 pts;
- conclusion: this increases the prices *that can be increased* – namely, of non-tradables – 3 pts.

Supply-side explanation:

- higher productivity leads to higher wages in some sectors – 5 pts;
- due to the market dynamics, the costs of all domestic producers go up – 3 pts;
- conclusion: this increases the prices *that can be increased* – namely, of non-tradables – 2 pts.

Explanation which relies only on higher demand in developed countries per se (for example, because of the immigrants who want to live there) earns 0 points because the supply must also increase in this case, so the effect on prices is unclear.

(c) 5 pts for PPP identification, 5 pts for correct answer regarding inequality with explanation.