ECONOMICS OPEN-BOOK EXERCISE
FOR
VISITING STUDENT APPLICANTS 2018

Lady Margaret Hall
University of Oxford

Please choose which questions to submit according to the table on the following page.

Unless otherwise indicated, we recommend that you spend no more than one hour attempting each question.

You are welcome to make use of your course notes and textbooks, but you should not seek assistance from any other person.

You are welcome to use a calculator.

This is not an examination or admissions test: the main purpose of this exercise is to allow us to determine the extent to which you meet the prerequisites for various Oxford economics courses and thus determine the most suitable courses. Please attempt each question to the best of your ability, given the courses that you have studied thus far. If you are not familiar with a concept or topic, please write a note to that effect and we will take that into account. You are welcome to attempt questions on topics that you have not previously studied, but there is no need to spend time learning new material.
<table>
<thead>
<tr>
<th>Core Courses</th>
<th>MT</th>
<th>HT</th>
<th>TT</th>
<th>Open-Book Exercise Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculus for Economics (minor only)</td>
<td>✔</td>
<td></td>
<td></td>
<td>None (no prerequisite)</td>
</tr>
<tr>
<td>Intermediate Microeconomics</td>
<td>✔</td>
<td></td>
<td></td>
<td>None (no prerequisite)</td>
</tr>
<tr>
<td>Intermediate Macroeconomics</td>
<td></td>
<td>✔</td>
<td></td>
<td>Q1</td>
</tr>
<tr>
<td>Advanced Microeconomics</td>
<td>✔</td>
<td></td>
<td></td>
<td>Q1, Q2</td>
</tr>
<tr>
<td>Advanced Macroeconomics</td>
<td>✔</td>
<td></td>
<td></td>
<td>Q1, Q3, Q4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Applied and Specialist Courses</th>
<th>MT</th>
<th>HT</th>
<th>TT</th>
<th>Open-Book Exercise Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Econometrics</td>
<td>✔</td>
<td></td>
<td></td>
<td>Q5, Q6</td>
</tr>
<tr>
<td>Applied Econometrics</td>
<td></td>
<td>✔</td>
<td></td>
<td>None (no prerequisite)</td>
</tr>
<tr>
<td>Economic History</td>
<td></td>
<td>✔</td>
<td></td>
<td>Q2, Q3, Q6</td>
</tr>
<tr>
<td>Economics of Developing Countries</td>
<td>✔</td>
<td></td>
<td></td>
<td>Q2, Q3, Q6</td>
</tr>
<tr>
<td>Economics of Industry</td>
<td>✔</td>
<td></td>
<td></td>
<td>Q1, Q2(i), Q8</td>
</tr>
<tr>
<td>Game Theory</td>
<td>✔</td>
<td></td>
<td></td>
<td>Q7, Q8</td>
</tr>
<tr>
<td>International Economics</td>
<td>✔</td>
<td></td>
<td></td>
<td>Q2, Q3</td>
</tr>
<tr>
<td>Labour Economics</td>
<td>✔</td>
<td></td>
<td></td>
<td>Q2, Q3, Q6</td>
</tr>
<tr>
<td>Microeconomic Analysis</td>
<td>✔</td>
<td></td>
<td></td>
<td>Q1, Q7, Q8, Q9</td>
</tr>
<tr>
<td>Money and Banking</td>
<td>✔</td>
<td></td>
<td></td>
<td>Q1, Q3, Q4</td>
</tr>
<tr>
<td>Public Economics</td>
<td>✔</td>
<td></td>
<td></td>
<td>Q2, Q3, Q6</td>
</tr>
</tbody>
</table>

Please submit all questions indicated for all of the courses that you wish to take while in Oxford.
Q1. Arthur lives in a world in which there are just two goods: nutmegs and pears. In his garden there is a tree which yields eight nutmegs and one pear every day. He has no income other than from his nutmegs and pears. Arthur's preferences over nutmegs and pears may be represented by the utility function \( u(n, p) = 2 \ln n + 3 \ln p \), where \( n \) is the number of nutmegs that he consumes and \( p \) is the number of pears.

(i) Show that Arthur's preferences may, alternatively, be represented by a utility function of the form \( v(n, p) = n^\alpha p^\beta \) and explain why this is the case.

(ii) People in Arthur's world are prepared to trade one pear for two nutmegs. Describe the relationship between the prices of pears and nutmegs and draw a carefully labelled graph of Arthur's budget constraint.

(iii) Arthur maximises his utility, subject to his budget constraint. Show that his gross demands are 4 nutmegs and 3 pears. Mark the gross demands on your diagram and sketch in one or two of his indifference curves. What are his net demands?

(iv) There is a shortage of nutmegs in Arthur's world, so the relative price of nutmegs increases. (Arthur's tree still produces the same yield every day.) Illustrate on your diagram what happens to his budget constraint. Will he be better off or worse off after the price change? What can you say about how his gross demands will change?

(v) Consider the effect of the change in the price of nutmegs on Arthur's demand for nutmegs. This may be decomposed into a substitution effect, an ordinary income effect and an endowment income effect. Explain what is meant by these terms and draw a diagram to illustrate this decomposition. (Please draw a new graph for this part of the question.)

Q2. Please write an essay of up to two pages in length in response to part (i) OR part (ii) of this question.

(i) How can all the oligopoly models be right, when their predictions are so different?

(ii) 'The prevalence of externalities implies that the First Fundamental Theorem of Welfare Economics is irrelevant for economic policy.' Discuss.
Q3. Suppose consumers live for 2 periods (the present and future). Each consumer has income $y_1$ in the present and $y_2$ in the future, can borrow and save at the real interest rate $r$ and has well-behaved preferences over current and future consumption $c_1$ and $c_2$.

(i) Write down the consumer's budget constraint and draw a diagram to illustrate the optimal choice of consumption over the two periods.

(ii) Explain carefully why, according to this model, changes in the interest rate may have little effect on saving.

(iii) Discuss how a temporary increase in income, in the present period only, has different effects from an increase in the same size that is expected to be permanent. What would be the effect of a temporary rise in income if there were many periods in the model? What are the implications of your findings for the marginal propensity to consume?

(iv) Suppose the government levies a tax $T$ on each consumer in the present, invests the proceeds in bonds paying interest at $r$ and returns the amount $T$ plus interest, to the consumer in the future. How will this affect $c_1$ and $c_2$? Would the answer be different if consumers faced borrowing constraints?

(v) Compare the policy implications of this model of consumption with those of the Keynesian consumption function.

Q4. 'When expectations are formed adaptively there is a short-run trade-off between unemployment and inflation, but when expectations are formed rationally there is no short-run trade-off between unemployment and inflation.' Discuss. (*Please write an essay of up to two pages in length in response to this statement.*)
Q5. Give concise answers to all parts of this question.

(i) Define and explain what it means for an estimator to be “consistent” and “efficient”.
(ii) Show that the residual $e_i$ in the identity $Y_i = E[Y_i | X_i] + e_i$ is mean independent of $X_i$.
(iii) Using the potential outcomes framework, explain what is meant by selection bias.
(iv) Explain how measurement error causes attenuation bias in the linear regression model.
(v) “Most regression studies rely on the conditional independence assumption in order to argue that the estimated coefficients represent causal effects.” Explain and discuss.
(vi) Consider the following AR(1) time-series model: $y_t = \alpha + \beta y_{t-1} + \varepsilon_t$. What econometric problems arise if $\beta = 1$?
(vii) Suppose we had some time-series data and estimated an AR(1) model, obtaining the following:

$$
y_t = 5.057 + 0.947 y_{t-1}
$$

(2.125) (0.022)

where standard errors are reported in parentheses. Can you reject that $\beta = 1$ at the 5% significance level?
(viii) What problems are caused by structural breaks in time series? How would you test for a structural break?
Q6. Answer both parts of this question.

Part A

The demand for an agricultural product is described by the function:

$$\ln Q_d = \beta_0 + \beta_1 \ln P_i + u_i$$  \hspace{1cm} (A)

and the supply of an agricultural product is described by the function:

$$\ln Q_s = \gamma_0 + \gamma_1 \ln P_i + v_i$$  \hspace{1cm} (B)

(i) Solve for the equilibrium price and quantity in terms of the demand error \((u_i)\) and the supply error \((v_i)\). What do your results tell you about the correlation between \(\ln P_i \) and \(u_i\)?

(ii) If the coefficients of the demand function (A) are estimated by OLS would you expect the estimate of the demand elasticity \((\beta_1)\) to be an over or an under-estimate of the true value of \(\beta_1\)? Explain.

(iii) It is proposed to estimate the demand elasticity by IV using one of the following as an instrument: (a) income per capita in the region; (b) a measure of average rainfall in the region. Comment on the appropriateness of each of these variables as an instrument for this problem.

Part B

The following table contains the regression output of an investigation relating children’s income as adults (aged 35) with the income of their parents (measured when their parents were also aged 35):

<table>
<thead>
<tr>
<th></th>
<th>coefficient</th>
<th>standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>log(parental income)</td>
<td>0.568</td>
<td>0.005</td>
</tr>
<tr>
<td>living in rural area (=1 if rural; =0 if urban)</td>
<td>-0.091</td>
<td>0.003</td>
</tr>
<tr>
<td>constant</td>
<td>1.94</td>
<td>0.017</td>
</tr>
<tr>
<td>Number of observations</td>
<td>3,056</td>
<td></td>
</tr>
<tr>
<td>Sum of Squares</td>
<td>13.42</td>
<td>73.01</td>
</tr>
</tbody>
</table>

(a) Compute the \(R^2\) of this regression and interpret. A researcher claims that the larger the \(R^2\) of a regression, the more likely is that the regression has a causal interpretation. Do you agree? Explain.

(b) Interpret the coefficient on the variable log(parental income). Compute and interpret the \(p\)-value for the hypothesis that the parameter of log(parental income) is zero.

(c) Test at the 1% significance level, the hypothesis that all other things being equal, children living in rural areas have lower income than children living in urban areas. Explain fully the null and alternative hypothesis, test statistic, decision rule and conclusion.
Q7. [30 minutes]

(a) Explain what is meant by the ‘iterated deletion of strictly dominated strategies’.

(b) Use the above notion to find the Nash equilibrium of the following two-player, simultaneous-move, full-information game when it is played once.

<table>
<thead>
<tr>
<th></th>
<th>Left</th>
<th>Centre</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>8</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Middle</td>
<td>5</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Bottom</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

(The row player receives the payoff in the bottom-left corner of the cells, and the column player receives the payoff in the top-right corner of the cells.)

(c) Now assume that the above game is played infinitely often, and that the players have a common discount factor $\delta < 1$.

Consider the following strategies: the Row player plays Top and the Column player plays Left unless either player has deviated, in which case they both switch to the equilibrium actions of the one-shot game forever.

Show that the above collusive strategies constitute a Nash equilibrium when $\delta$ is large enough. How large does $\delta$ have to be?

(d) Is the equilibrium in part (c) subgame perfect? Explain.
Q8. Answer both parts of this question.

Part A

"When firms compete in prices, prices fall to marginal cost and the firms make no profits."

(a) Describe carefully a game-theoretic model of a price-setting duopoly that illustrates this statement.

(b) Briefly describe a modification of your model in which the statement would not hold. Explain intuitively why in this case firms are able to make profits in equilibrium.

Part B

Suppose that two firms produce horizontally differentiated products. The firms compete for a single period and choose prices simultaneously. Each firm has the same constant marginal cost of production $c \geq 0$, and fixed costs are zero. The linear demand functions are given by:

\[
q_1 (p_1, p_2) = 100 - \alpha p_1 + \beta p_2 \\
\text{and} \quad q_2 (p_1, p_2) = 100 - \alpha p_2 + \beta p_1.
\]

Assume that $\alpha > \beta > 0$ and that $100 > \alpha c$.

(a) Explain the difference between horizontally differentiated and vertically differentiated products, giving examples of each. Explain why the demand functions above represent horizontally differentiated products.

(b) Show that the symmetric pure-strategy Bertrand-Nash equilibrium prices are:

\[
p_1^* = p_2^* = \frac{100 + \alpha c}{2\alpha - \beta}
\]

Find the corresponding quantities, and check that the prices and quantities are positive at the equilibrium.

(c) Show how the equilibrium prices change in the parameters $\alpha$, $\beta$ and $c$. Provide a brief economic explanation of these comparative statics results.

(d) Suppose now that the two firms merge. The new firm acts as a monopolist, choosing $p_1$ and $p_2$. Find the profit-maximizing price assuming that the monopolist sets the same price for both products, that is $p_1 = p_2$. Is this price higher or lower than the equilibrium price from part (b)?
Q9 [30 minutes]

Arthur is a risk-averse farmer whose income will be $y$ if the weather is fine during harvest, and $y - L$ if it rains. The probability of rain is 0.5.

(a) Draw a carefully-labelled 2-state diagram to illustrate: his endowment point; his expected income; his certainty-equivalent income.

(b) Use the diagram to illustrate and explain (i) how he would benefit from buying insurance in a competitive insurance market; (ii) the maximum expected profit that his risk-neutral neighbour Bertha could make by offering him full insurance.

(c) Suppose instead that Arthur was risk-seeking. Describe, and illustrate on a 2-state diagram, an agreement with Bertha that would make Arthur better off, and that Bertha would be just willing to accept.

Now suppose Arthur and Bertha are both risk-averse farmers with utility of income, $y$, given by $u(y) = \ln y$. On each farm, income will be 8 if it is fine, and 2 if it rains. As before, the probability of rain on each farm is 0.5. Furthermore, with probability $p \leq 0.5$, both will have fine weather, with probability $p$ it will rain on both farms, and otherwise just one of them will have rain.

(d) Find the increase in utility that each of them could achieve by pooling their incomes, as a function of $p$. How do the benefits of pooling change as $p$ increases? Explain intuitively why this happens.