Market and Information Economics
Preliminary Examination

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Instructions: This examination consists of six questions. <u>You must answer the first question</u> and you must answer <u>four of the remaining five</u> questions (i.e. answer four of the questions numbered 2-6). Each question answered (five in total) has a weight of 20% in the final examination score. Please read through the entire examination before making a decision on the particular set of five questions you actually answer. The examination proctor will review the content of the exam at the beginning of the time period (9:00 am). He or she will answer general questions for the entire set of students writing this prelim. You have until 1:15 pm to complete the exam. Good Luck!

You Must Answer this Question

1. The total and marginal cost functions for a typical soft coal producer are:

$$TC = 75,000 + 0.1Q^2 \quad and \quad MC = 0.2Q,$$

where Q is measured in railroad cars per year. The industry consists of 55 identical producers. The market demand curve is:

$$QD = 140,000 - 425P,$$

where P is the price per carload. The market can be regarded as competitive.

(a) Calculate the short run equilibrium price and quantity in the market. Calculate the quantity that each firm would produce and the firm's profit (or loss).

(b) The Federal government is considering the imposition of a $15 per carload tax on soft coal. Calculate the short-run equilibrium price and quantity that would exist under the tax. What portion of the tax would be paid by producers and what portion by consumers? Calculate the firm's profit (or loss) under the tax.

Answer four of the following five questions

2. Consider an i.i.d. sample $\{Y_i, X_i\}, i = 1, ..., N$ of real estate transactions, where Y_i is transaction price, and X_i includes three variables: house size, lot size and number of bedrooms.

   (a) Propose a Gaussian Process model of house price based on the three explanatory variables. Explain the construction of the covariance function of your model.

   (b) Derive the predictive mean and variance of the proposed model for a given testing point X_*.

   (c) Explain how to calculate the predictive distribution at X_*.

3. An analyst estimates the following specification over the period 2010.1 to 2021.4 using OLS:

$$ln(SALES) = 3.95 - 322.08P + 163.15PS + 0.0173Q1 - 0.0586Q2 - 0.0677Q3$$

Q1, Q2, and Q3 are quarterly dummy variables to account for seasonality; P denotes own-price, and PS denotes the price of a substitute/complementary product.

In addition, suppose that the sample means of the respective variables over this time period are as follows:

$$SALES = 55.74; \quad P = 0.0043/unit; \quad and \quad PS = 0.0035/unit.$$

(a) On the basis of this information, what is the own-price elasticity of demand?

(b) Is the demand for this product elastic? Why or why not?

(c) If PS were to change by $0.001/unit, what is the impact on SALES? Use the sample means of SALES in this calculation. Does PS refer to a substitute or a complement? Defend your answer.

(d) Characterize the level of sales in quarter 1 relative to quarter 4.

(e) What additional explanatory variable(s) would you add, if any, to the specification of this demand model? Defend your answer.

(f) Suppose that the Jarque-Bera test statistic associated with the residuals has a p-value of 0.75. The partial autocorrelation function for the residuals at a lag of 2 is statistically significant. All other partial correlation coefficients are not statistically different from zero. What can be said about the behavior of the residuals?

(g) From your answer in (f), what would you recommend econometrically?

(h) How would determine if any of the quarterly observations exerts undue influence? If so, what would you recommend econometrically?

(i) Let h_t represent the variance of the error or disturbance term. Suppose that $h_t = 2.3 + 0.17(e_{t-1})2 + 0.74h_{t-1}$, where e_{t-1} represents a 1-period lag of the residuals. What can be concluded from the information about the residual variance of this model? Assume that each of the estimated coefficients associated with the residual variance are statistically different from zero.

4. Consider a Bayesian Probit Regression model with latent variable representation

$$y* = X\beta + u, \ u \sim N(0,1),$$
$$y = 1 \ \text{if} \ y* > 0; \quad y = 0 \ \text{if} \ y* \leq 0,$$

where y is an $n \times 1$ binary vector, X is an $n \times k$ data matrix, β is a $k \times 1$ vector, and u are independent and identically random variables from the standard normal distribution. Note that you only observe y and X.

(a) Specify a prior distribution of β. Derive the posterior distribution of β by combining the prior distribution and the likelihood function.

(b) Briefly discuss how the choice of prior distribution of β would impact the estimation results.

(c) Propose a method to obtain the posterior distribution of β. Briefly explain how you are going to implement the proposed method in R.

(d) According to Bayes' Rule, the marginal likelihood of y is of the form: $p(y|X) = \int p(y|\beta, X)p(\beta)d\beta$. Suppose now you already have sufficient draws of β from the posterior distribution of β via a numerical method. Explain how to calculate the marginal likelihood of y with these draws.

5. Consider the following system of two equations

$$
\begin{aligned}
Y_{i,1} &= \beta_{1,0} + \beta_{1,1} X_{i,1} + u_{i,1} \quad &(1)\\
Y_{i,2} &= \beta_{2,0} + \beta_{2,1} X_{i,1} + \beta_{2,2} X_{i,2} + u_{i,2} \quad &(2)
\end{aligned}
$$

Let $u_i = (u_{i,1}, u_{i,2})^T$. Suppose $E[u_i u_i^T | X_{i,1}, X_{i,2}, X_{i,3}] = \Omega = \begin{bmatrix} \Omega_{11} & \Omega_{12} \\ \Omega_{21} & \Omega_{22} \end{bmatrix}$.

(a) Propose an asymptotically efficient estimator for the above system of equations.

(b) Further suppose $\Omega_{11} \neq \Omega_{22}$ and $\Omega_{12} = \Omega_{21} = 0$. Propose an asymptotically efficient estimator for the above system of equations under these additional conditions.

6. Frito-Lay is a subsidiary of PepsiCo located in Plano, TX that manufactures, markets, and sells corn chips, potato chips, and other snack foods. As a recent hire of this company, your primary responsibility is to investigate the demand for Lay's Potato Chips for the period 2015M1 to 2021M12 (monthly data from January 2015 to December 2021).

   (a) Develop and justify a theoretical model to analyze the consumer demand of Lay's Potato Chips. Be sure to pay specific attention to cross-price effects, advertising, and seasonality.

   (b) What are the data requirements for this analysis? Discuss sources of the data for this analysis. Describe and justify any data transformations.

   (c) How would you estimate the model econometrically? What aspects of the model would you emphasize in your presentation to members of the PepsiCo Board?

   (d) How would you determine the next best substitute for Lay's Potato Chips?

   (e) How would you determine if Lay's Potato Chips is a necessity or a luxury in economic parlance?

   (f) How would you assess the effectiveness of advertising to members of the PepsiCo Board?

   (g) How would assess the impact of COVID-19 on the demand for Lay's Potato Chips?

   (h) Explain the process of providing ex-ante forecasts of sales of Lay's Potato Chips for the period 2022M1 to 2022M12.

   (i) Suppose that after making these ex-ante forecasts, a year later you now know the actual sales of Lay's Potato Chips for 2022M1 to 2022M12. How would you evaluate the accuracy of your ex-ante forecasts?