Mohamed Khidher University

Faculty of economics, Commercial   *Specialty: International Commerce & Finance*
and Management Sciences   *Module: Advanced Econometric*
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Exercise 1: choose the correct answer for the following questions

1. **Which of the following best describes the behavior of the function $y = \alpha e^{\beta x}$ if β>0?**
   a) The function decreases as *x* increases
   b) The function increases at a constant rate
   c) The function increases at an accelerating rate
   d) The function remains unchanged regardless of *x*
2. **Which of the following statements is true about the logarithmic model?**
   a) It grows at a constant rate
   b) It has a horizontal asymptote
   c) It increases rapidly at first and then slows down
   d) It represents exponential decay
3. **If a process follows a logarithmic model, how does its rate of change behave?**
   a) The rate of change remains constant
   b) The rate of change increases exponentially
   c) The rate of change slows down over time
   d) The rate of change is unpredictable
4. **In the power law model $y = \alpha x^{\beta}$, what does the exponent β determine?**
   a) The slope of the linear relationship
   b) How fast y increases or decreases when x changes
   c)The starting value of y
   d) The rate of exponential decay
5. **A power law model is particularly useful for describing:**
   a) Linear relationships
   b) Growth that slows down over time
   c) Relationships with scale-invariance properties
   d) Situations where changes are unpredictable
6. **A population of bacteria follows an exponential growth model given by $P = P_0 e^{0.3t}$, where P$_0$=100. What is the population after 5 hours? At what point in time the population of bacteria will be doubled?**
   a) 100, 3 hours
   b) 134, 2,30 hours
   c) 448, 2 hours and 18 min
   d) 600, 3 hours
7. **What is the primary purpose of Logit and Probit models in statistical analysis?**
   a) To predict continuous outcomes
   b) To model relationships between categorical independent variables

c) To estimate the probability of a binary dependent variable

d) To compute linear regression coefficients

8. **What is the key difference between Logit and Probit models?**
   a) Logit assumes a normal distribution, while Probit assumes a logistic distribution
   b) Probit assumes a normal distribution, while Logit assumes a logistic distribution
   c) Logit is used for categorical data, while Probit is used for numerical data
   d) There is no difference; both models yield identical results

9. **In the Logit model, what transformation is applied to the probability of success?**
   a) Square root transformation
   b) Logarithmic transformation
   c) Log-odds
   d) Exponential transformation

10. **Which of the following is a key assumption of the Probit model?**
    a) The errors follow a logistic distribution
    b) The independent variables must be categorical
    c) The errors follow a normal distribution
    d) The dependent variable must be normally distributed

11. **What is the range of predicted probabilities in both Logit and Probit models?**
    a) $-\infty$ to $+\infty$
    b) 0 to 1
    c) -1 to 1
    d) Depends on the independent variables

12. **If the estimated Logit model is: $\ln\left(\frac{P}{1-P}\right) = -2 + 1.5X$, What is the probability of success (P) when X=2?**

    a) 0.50
    b) 0.73
    c) 0.27
    d) 0.90

13. **If a Probit model estimates: P(Y=1)=Φ(−1+0.8X), What is the probability of success when X=2 using the standard normal CDF (Φ)?**
    a) 0.40
    b) 0.50
    c) 0.73
    d) 0.80

14. **If the coefficient of an independent variable in a Logit model is negative, what does it imply?**
    a) The probability of success increases as the independent variable increases
    b) The probability of success decreases as the independent variable increases
    c) The independent variable has no effect on the outcome
    d) The variable is not statistically significant

10. **If a Probit model produces a coefficient of 2.5 for an independent variable, how should it be interpreted?**

a) A one-unit increase in the independent variable increases the probability by 2.5
b) A one-unit increase in the independent variable increases the Z-score by 2.5
c) A one-unit increase in the independent variable decreases the probability by 2.5
d) The coefficient does not affect probability predictions

Exercise 2

The objective of this study is to investigate the relationship between **Gross Domestic Product (GDP)** and **Foreign Direct Investment (FDI)**. According to economic theory, FDI inflows play a vital role in stimulating economic growth. However, as investment levels rise, the economy may reach a saturation point where the marginal impact of additional FDI begins to diminish, leading to a slowdown in its effect on GDP growth.

The following table provides the results of estimation of this relationship

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C (1)	1.203	0.482	2.497	0.015
C(2)	0.743	0.128	5.805	0.000
R-squared	0.67			
Adjusted R-squared	0.65			

1. Which nonlinqazefc. ear model is appropriate to test this relationship?
2. Perform the model that show the relationship between these two variables?
3. Predict the GDP when the FDI is 10?
4. Interpret the results (coefficients) ?
5. How does **GDP growth** respond to an **increase in FDI** from 15 to 25% and from 25 to 35? What do you think?

Exercise 3

Innovation is a crucial driver of economic growth and competitiveness. Research and Development (R&D) expenditure plays a significant role in fostering innovation, often leading to an increase in innovation. The relationship between R&D expenditure and innovation is in initial investments yield moderate increases in innovation, but as funding rises, innovation accelerates at an increasing rate. The following table provides the results of estimation of this relationship

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)		0.217	8.072	0.000
C(2)	0.312	0.041	7.610	0.000
R-squared	0.78			
Adjusted R-squared	0.76			

1. Which nonlinear model is appropriate to test this relationship?
2. Perform the model that show the relationship between these two variables?
3. Predict the Innovation value when the R&D expenditure is X= 4 unit.
4. Interpret the results (coefficients) .

5. What is the estimated growth rate of patent applications concerning changes in R&D investment?
6. How does **innovation** respond to an **increase in R&D** from 2 to 4 and from 4 to 6?
7. To what extent does an increase in R&D spending contribute to innovation output ?

Exercise 4

The relationship between economic growth and energy consumption has been a significant topic in environmental economics. Researchers suggest that this relationship follows a **Power Law Model**, The following table provides the results of estimation of this relationship.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C (1)	1.2456	0.3452	3.61	0.0012
C(2)	0.8723	0.0921	9.47	0.0000
R-squared	**0.8794**			

1. Perform the model that represents the relationship between the variables under study, and convert it into a linear form.
2. What is the estimated power law exponent ?
3. Is the relationship statistically significant?
4. What is the economic interpretation of the elasticity coefficient?
5. How well does the model fit the data?

Exercise 5

A bank wants to assess the likelihood of loan default among borrowers based on their financial characteristics. The bank collected data from 500 customers, including their **income, debt-to-income ratio, credit score, and loan amount**. Using a **logistic regression model**, the bank aims to determine which factors significantly influence the probability of default and how they impact loan risk. The following table provides the results of estimation of this relationship

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-3.2154	0.9852	-3.26	0.0011
Income	-0.0028	0.0009	-3.11	0.0019
Debt-to-Income	0.0735	0.0152	4.83	0.0000
Credit Score	-0.0146	0.0021	-6.95	0.0000
Loan Amount	0.0012	0.0005	2.40	0.0163

McFadden R-squared   0.245

1) What type of regression model is appropriate for predicting loan default? Write the model?
2) What are the estimated coefficients for **income, debt-to-income ratio, credit score, and loan amount** in the logit model? Write the logit regression, with known coefficient?

3) What is the interpretation of each coefficient in terms of its effect (sign & magnitude) on the probability of default?

4) Given the following borrower profile, estimate the probability of default:
- **Income = 50,000**
- **Debt-to-Income Ratio = 40%**
- **Credit Score = 650**
- **Loan Amount = 15,000**

5) How would an increase in credit score from **650 to 700** impact the probability of default, holding other variables constant?

6) Based on the regression results, what recommendations would you provide to the bank to reduce loan default risk?

Exercise 6

The transition to renewable energy is a key step toward sustainability, yet many households hesitate to adopt technologies such as solar panels. Understanding the factors influencing this decision can help policymakers design effective incentives and awareness campaigns. This study seeks to identify the key factors that affect a household's decision to adopt renewable energy technology. Specifically, we analyze whether **income, education level** (Number of years of education of the household head)**, environmental awareness** (A score (1 to 10) measuring the household's awareness of environmental issues)**, and electricity costs** (Monthly electricity expenditure) significantly impact adoption. To model this decision, we use a **binary dependent variable, and assuming the error is normally distributed**. The following table provides the results of estimation of this relationship

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-2.5	0.7	-3.57	0.0004
Income	0.05	0.02	2.5	0.012
Education	0.10	0.03	3.33	0.001
Awareness	0.20	0.05	4.00	0.000
Costs	0.15	0.04	-3.75	0.0002

1) What type of regression model is appropriate for predicting renewable energy? Write the model?
2) What is the interpretation of each coefficient in terms of its effect on the probability of adopting renewable energy?
3) What are the key determinants of household adoption of renewable energy technology?
4) Does higher household income increase the likelihood of adoption?
5) Do rising electricity costs encourage or discourage adoption?
6) Calculate the probability of adoption renewable energy technology is for a household with income 70,000$, education 10, awareness 5 and costs is 140$
7) Which variable has the strongest influence on adoption, and how can policies be designed to promote renewable energy adoption?