Question 1.

Consider a simple linear econometric model where y is dependent variable and x is independent variable.

a)Explain what is meant by the statement «x is an exogeneous explanatory variable in the econometric model “. Discuss possible reasons why this statement is often unrealistic, and the properties of the OLS estimator if the statement is not valid.

Table 1 shows regression results for a number of estimated relationships based on data for the variables y, x, z1, z2 and z3.

Variables e3 og e4 are residuals based on the estimates in columns (3) and (4), respectively, while e5 is the residuals based on the estimates in column (5).

b)Discuss the concept of instrumental variables and explain briefly what type of problems the instrumental variable method can solve.

c) Explain the assumptions required for the methods used in columns (1), (2), (3), and (4), respectively, to give consistent estimators for the effect of x on y.

d) Use the information in Table 1 to construct and perform F-tests for the relevance of the instrumental variables used.

e) Use the information in Table 1 to test the hypothesis that x is exogeneous.

f) Explain what is meant by identification, exact identification and over-identification for an econometric model. Explain how you can use the information in Table 1 to test for overidentification and perform the test.

Table 1. Estimation results. Estimated standard errors are in parentheses. Dependent variables are stated in the upper row of the table.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variable	y	y	y	y	x	x	x	y	e3	e4
x	1.703	1.192	1.040	1.353				1.192		
	(0.0899)	(0.193)	(0.192)	(0.124)				(0.158)		
z1					0.571	0.570	0.539		0.0881	-0.103
					(0.0915)	(0.0888)	(0.0700)		(0.119)	(0.0977)
z2						0.207	0.234		-0.182	-0.235
						(0.0772)	(0.0608)		(0.103)	(0.0849)
z3							0.443			0.180
							(0.0569)			(0.0794)
e5								0.714		
								(0.187)		
Cons	0.979	1.101	1.138	1.063	0.220	0.195	0.165	1.101	0.0189	0.0207
	(0.0883)	(0.108)	(0.115)	(0.0958)	(0.0814)	(0.0795)	(0.0627)	(0.0887)	(0.106)	(0.0875)
Method	OLS	IV	IV	IV	OLS	OLS	OLS	OLS	OLS	OLS
Obs	100	100	100	100	100	100	100	100	100	100
R-sq	0.785				0.284	0.334	0.591	0.813	0.036	0.131

Question 2.

a) You are hired by The Norwegian Ministry of Finance to analyze how the use of electric energy in manufacturing industry is affected by the price of electricity using the following simple model.

(1)$y = \beta_0 + \beta_1 p + \beta_2 pb + u$

where y is the logaritm of the electricity use, p is the logaritm of the electiricty price, and pb is the logaritm of the prices of other inputs in the production process and u is a stochastic error term. Comment briefly on the interpretation of the coefficients in the model.

b) Suppose you have data for the variables in the model for the period 1975 to 2018. Explain how you would reformulate (1) in order to take into account the fact that firms need to make additional investments in order to change the use of electricity.

c) Explain how your chosen reformulation of (1) can be used to estimate and distinguish between the short run and long run elasticity of the price elasticity of electricity.

d) A commentator representing the manufacturing industry claims that the firms in the industry are unable to change the use of electricity. Explain how you can test this claim within your chosen model formulation in question b).

Question 3.

Table 3 shows estimated coefficients in different estimated versions of a log-log formulation of an underlying Cobb-Douglas production function based on data from 1000 chemical firms in China. ly is the logarithm of production, ll is the logarithm of employment and lc is the logarithm of capital.

a) A commentator argues that management quality and technological changes have an important impact on firm production. Use the results in Table 3 and explain **i)** which of the estimated equations can account for permanent differences in management quality between firms and **ii)** which of the estimated equations can account for *both* permanent differences in management quality between firms, *and* technological progress common for all Chinese firms over time.

b) Explain what restrictions (if any) are imposed on the coefficients across firms and over time in the models estimated in Table 3.

c) What is the elasticity of production with respect to employment and capital in the models estimated in Table 3 and which of these models would you prefer? Explain your choice. Construct 95% confidence intervals around the elasticities of production with respect to capital and employment.

d) Use the results in Table 3 to test the hypothesis of constant returns to scale. What is your interpretation of this hypothesis?

e) A commentator argues that differences in ownership affect production in addition to the other inputs. Suppose you have access to a variable PRIVATE that takes the value 1 if the firm is privately owned and 0 otherwise. Ownership is unchanged during the estimation period. Formulate a model that includes the effect of ownership in addition to the other variables which are already included in Table 3 and discuss to what extent the effect of ownership can be estimated using the methods used in Table 3.

f) A second commentator suggests extending the models in Table 3 with an interaction term between lc and PRIVATE. Comment on this suggestion and explain how you would interpret coefficients in this extended version.

g) A third commentator is concerned with the fact that Chinese firms depends very much on what is happening on world markets and that this should be represented in econometric models. Discuss briefly to what extent his arguments are accounted for in the specifications estimated in Table 3.

Tabell 3.Estimation results. Estimation method: OLS. Estimated standard errors in parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variables	ly	ly-ll	ly	ly-ll	ly	ly-ll	ly	ly-ll	ly	ly-ll
ll	0.351	-0.311	0.395	-0.285	0.399	-0.284	0.269	-0.615	0.271	-0.655
	(0.0382)	(0.0225)	(0.0225)	(0.0136)	(0.0224)	(0.0136)	(0.0307)	(0.0347)	(0.0291)	(0.0331)
lc	0.337		0.320		0.316		0.116		0.0735	
	(0.0265)		(0.0153)		(0.0153)		(0.0195)		(0.0188)	
lc-ll		0.337		0.320		0.316		0.116		0.0735
		(0.0265)		(0.0153)		(0.0153)		(0.0195)		(0.0188)
Constant	5.478	5.478	5.541	5.541	5.442	5.442	7.946	7.946	8.184	8.184
	(0.139)	(0.139)	(0.0828)	(0.0828)	(0.0849)	(0.0849)	(0.214)	(0.214)	(0.204)	(0.204)
year dummies	No	No	No	No	Yes	Yes	No	No	Yes	Yes
Firm dummies	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Period (years)	2004	2004	2004-2006	2004-2006	2004-2006	2004-2006	2004-2006	2004-2006	2004-2006	2004-2006
Observations	1,000	1,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
R-squared	0.568	0.227	0.558	0.195	0.562	0.203	0.946	0.902	0.952	0.912