University of the West of England

MOCK EXAMINATION PAPER

2002-3

MA International Business Economics

Econometric Theory and Methods

Time allowed:	3 HOURS
Total number of questions:	Eight
Instructions to candidates:	Answer four questions
Materials provided:	Statistical tables are attached to the exam paper
Equipment permitted:	Non-programmable calculators
Total number of pages:	15

No books, paper or electronic devices are permitted in the examination room other than those specified above

Candidates are warned that illegible scripts will not be marked.

Question 1

The following general model was postulated to explain annual fluctuations in the rate of inflation in the United Kingdom during the period 1971-95:

$$\dot{P}_t = a + b(1/U_{t-x}) + cEER_{t-x} + d(\dot{M} - \dot{Q})_{t-x} + e\dot{P}_{t-x} + u_t \qquad (1)$$

where
- $\dot{P}$ is the annual percentage change in the retail price index;
- U is the percentage of the working population unemployed at mid-year;
- EER is the average effective exchange rate for sterling (1985 = 100);
- $\dot{M}$ is the annual percentage change in M4;
- $\dot{Q}$ is the annual percentage change in real GDP at factor cost (1990 prices);
- u is a random disturbance term;
- x is a time lag in years.

The parameters of equation (1) were estimated by OLS, using annual data for the period 1969-95. Since the precise length of the lag for each explanatory variable was unclear *a priori*, lags of one and two years were tried. The regression yielding the largest t values for the individual variables, along with a number of plots and further analyses using *Microfit*, is shown in Tables 1 to 3 below.

Required:

(a) Provide a brief rationale for the inclusion of the various explanatory variables in equation (1) above. What signs should one expect on theoretical grounds for the parameters b, c, d and e? Why have time lags been included in each case? (8 marks)

(b) Comment on the regression results in Tables 1 and 2, referring particularly to the signs, statistical significance and interpretation of the estimated coefficients, the goodness of fit of the regression and any evidence of serial correlation or multicollinearity. ***(Note:** when considering the unemployment variable, you should provide an interpretation of the effect of a change in unemployment rather than its reciprocal).* (12 marks)

(c) The estimated model was used to forecast inflation for the period 1996-98. A comparison of the actual and forecast results along with some summary statistics and a plot is provided in Table 3 on page 5. Provide a brief comment on the forecasting performance and explain the difference between a static and a dynamic forecast. (5 marks)

Table 1

Ordinary Least Squares Estimation

Dependent variable is PDOT
25 observations used for estimation from 1971 to 1995

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
K	7.4840	4.0706	1.8385[.081]
RU1	41.5883	9.2142	4.5135[.000]
EER(-2)	-.10140	.043117	-2.3518[.029]
EGM(-2)	.20247	.13139	1.5410[.139]
PDOT(-1)	.28093	.14141	1.9866[.061]

R-Squared	.80567	R-Bar-Squared	.76680
S.E. of Regression	2.8206	F-stat. F(4, 20)	20.7290[.000]
Mean of Dependent Variable	8.6720	S.D. of Dependent Variable	5.8409
Residual Sum of Squares	159.1181	Equation Log-likelihood	-58.6081
Akaike Info. Criterion	-63.6081	Schwarz Bayesian Criterion	-66.6553
DW-statistic	1.8011	Durbin's h-statistic	.70306[.482]

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(1)= .26376[.608]	F(1, 19)= .20260[.658]
B:Functional Form	CHSQ(1)= 1.2512[.263]	F(1, 19)= 1.0010[.330]
C:Normality	CHSQ(2)= 2.0054[.367]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .011903[.913]	F(1, 23)= .010956[.918]

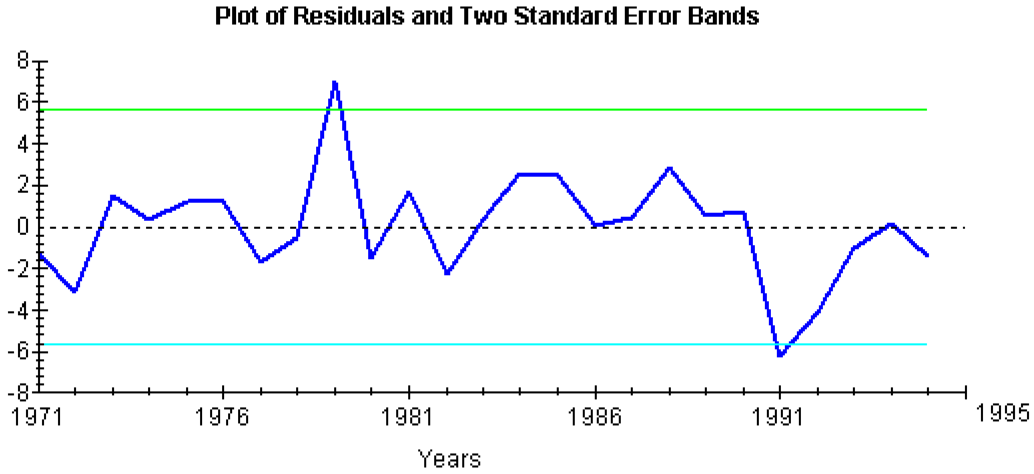
A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

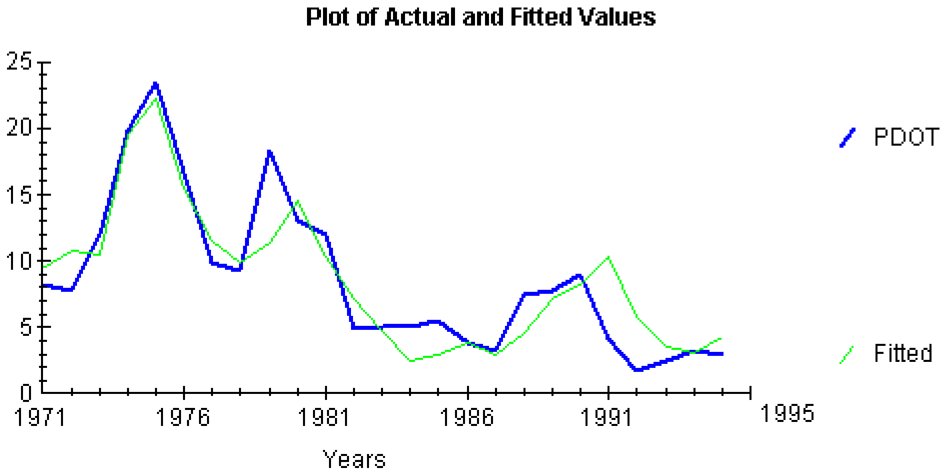
Sample period :1971 to 1995

Estimated Correlation Matrix of Variables

	PDOT	RU1	EER2	EGM2	PDOT1
PDOT	1.0000	.79882	.47769	.35294	.75008
RU1	.79882	1.0000	.80211	.20739	.62393
EER2	.47769	.80211	1.0000	.25163	.38891
EGM2	.35294	.20739	.25163	1.0000	.35603
PDOT1	.75008	.62393	.38891	.35603	1.0000

Table 2





List of Variables and their Descriptions

EER	:	sterling exchange rate index (1990=100)
EER2	:	eer(-2)
EGM	:	mdot-qdot
EGM2	:	egm(-2)
K	:	intercept
MDOT	:	% annual change in M4
PDOT	:	annual % change in RPI (to mid-Jan)
PDOT1	:	pdot(-1)
QDOT	:	% annual change in real GDP
RU1	:	1/u(-1)
U	:	unemployment (% of workforce)

Table 3

Single Equation Dynamic Forecasts

Based on OLS regression of PDOT on:

K	RU1	EER(-2)	EGM(-2)	PDOT(-1)

25 observations used for estimation from 1971 to 1995

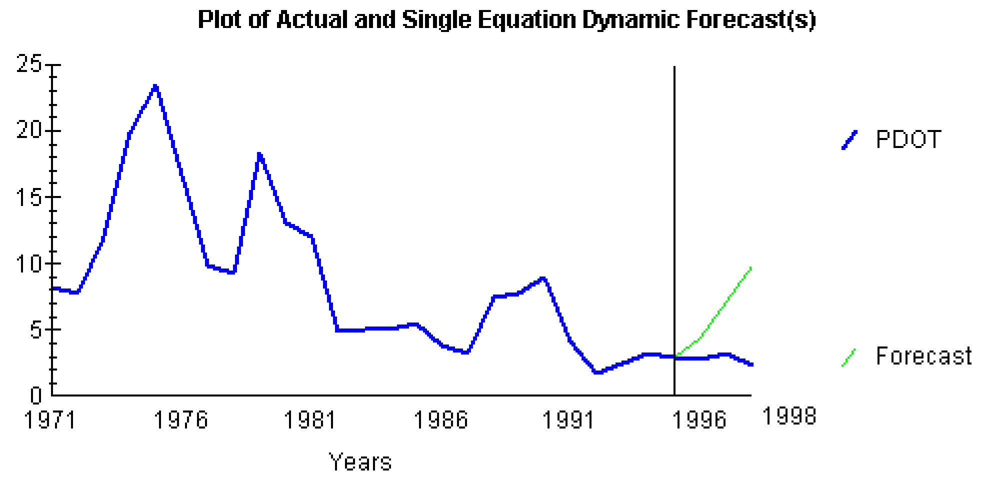
Observation	Actual	Prediction	Error	S.D. of Error
1996	2.8000	4.4925	-1.6925	3.2524
1997	3.3000	7.2046	-3.9046	3.4141
1998	2.4000	9.8554	-7.4554	3.5358

Summary statistics for single equation dynamic forecasts

Based on 3 observations from 1996 to 1998

Mean Prediction Errors	-4.3509	Mean Sum Abs Pred Errors	4.3509
Sum Squares Pred Errors	24.5646	Root Mean Sumsq Pred Errors	4.9563

Predictive failure test F(3, 20)= 1.3791[.278]



Question 2

A student specified the following linear function as a first attempt at modelling the fluctuations in the consumption of lamb in Great Britain:

$$QB_t = \alpha_0 + \alpha_1 PB_t + \alpha_2 PP_t + \alpha_3 PL_t + \alpha_4 Y_t + \alpha_5 TIME + \alpha_6 B_{96} + v_t \qquad (1)$$

where QB is consumption of beef by British households, in grams per person per week;

PB, PP and PL are the respective prices of beef, pork and lamb, in pence per kilogram, deflated by the retail price index for all food (1985 = 100);

Y is real personal disposable income per head (1995 prices);

TIME is a linear trend such that 1966 = 1, 1967 = 2, etc.;

B_{96} is a binary variable equal to unity in 1996 and to zero in all other years;

v is a disturbance term.

The student used OLS and annual data for the period 1966–99 to obtain estimates of the parameters of the above demand function. However, because she was unsure whether the true functional form was linear or non-linear, she also ran the model in exponential and multiplicative forms. Her findings are presented in Table 4 on the next page. (*For simplicity, the intercepts are not presented. ln denotes logarithm to base e.*)

Required:

(a) Discuss the extent to which you feel each of the three functional forms considered by this student is appropriate to the modelling of demand for a food product. Illustrate your answer with appropriate sketches. **Note:** Accurate diagrams are not required. (8 marks)

(b) For each of the three regressions in Table 4, obtain an estimate of the elasticity of QB with respect to PB in 1999. Interpret your results and comment on the degree of similarity or otherwise of the estimates. Why do the models not produce identical estimates of elasticities?

Note: The observed values of QB and PB in 1999 were 110.0 and 490.8, respectively. The linear regression gave a fitted value for QB in 1999 of 114.813. After taking antilogs, the exponential and multiplicative models yielded fitted values of 116.270 and 121.903, respectively. (8 marks)

(c) Assess the evidence supporting the inclusion of B_{96} in the models? (4 marks)

(d) Which one of the three models would *you* choose? Explain your reasoning. (5 marks)

Table 4. Alternative Forms of the Demand Function for Beef in Great Britain 1966–99

	Dependent variable		
	QB	ln QB	ln QB
PB_t	-0.407 (-2.76)	–0.001 (–1.48)	-
ln PB_t	-	-	–0.217 (–0.57)
PP_t	–0.179 (–0.80)	–0.001 (–0.74)	-
ln PP_t	-	-	–0.890 (–2.04)
PL_t	0.066 (0.32)	-0.358E-3 (-0.29)	-
ln PL_t	-	-	-0.694 (-1.72)
Y_t	-0.033 (-2.72)	-0.234E-3 (-3.17)	-
ln Y_t	-	-	0.182 (0.24)
TIME	–0.117 (–0.05)	0.008 (0.57)	–0.038 (–1.78)
B_{96}	-22.039 (-1.40)	-0.190 (-1.99)	-0.114 (-0.97)
R^2	0.934	0.933	0.902
D.W.	1.162	0.888	0.828
$\hat{s}$	12.457	14.371	17.569

Notes: *t* ratios are given in parentheses beneath the regression coefficients. $\hat{s}$ denotes the standard error of the linear regression or its equivalent in the case of the logarithmic regressions. [To obtain comparable values for $\hat{s}$, it was necessary to take the antilogs of the fitted values of ln QB_t and compute a statistic analogous to the standard error.]

Question 3

The following model was formulated in an attempt to explain the determinants of aggregate consumption in the United Kingdom in recent years:-

$$C_t = \beta_0 + \beta_1 Y_t + \varepsilon_t \qquad (1)$$

where C_t is consumers' expenditure and Y_t is personal disposable income, both measured in £ billion in 1995 market prices;

ε_t is a stochastic error term.

OLS was employed to estimate the parameters of the model specified above, using annual data for the periods 1970-82 and 1983-98, as well as for both periods combined. The results are presented in Table 6 on the next page.

Required:

(a) With reference to the simple Keynesian consumption function specified in equation (1) above, carefully explain the rationale of Chow's test for stability of the regression coefficients. What assumptions underlie this test? To what extent do you think that these conditions have been satisfied in the present example?

(13 marks)

(b) By using the results for the first three regressions in Table 6, examine the hypothesis that the pooled sample is homogeneous. **Hint:** First calculate the residual sum of squares for each regression, using the information appended beneath the table. Comment briefly on your findings.

(12 marks)

Table 6: The Consumption Function for the U.K. in Different Periods

	1970-82	1983-98	1970-98
β_0	52.654 (7.03)	43.459 (1.95)	13.809 (1.63)
β_1	0.773 (15.6)	0.851 (16.8)	0.914 (41.19)
D.W.	0.708	0.526	0.472
R^2	0.972	0.953	0.984
$\overline{R}^2$	0.968	0.950	0.984
$\hat{s}$	2.300	12.498	10.232

Notes: *t* ratios are given in brackets beneath the regression coefficients. $\hat{s}$ is the standard error of the regression.

Question 4

Dougherty examined data for a cross-section of 34 countries *circa* 1980 in an attempt to quantify international variations in public expenditure on education.[1] The countries varied widely in terms of size of population. Dougherty's initial model was as follows:

$$EE_i = \alpha + \beta\, GDP_i + u_i \qquad (1)$$

where EE_i is public expenditure on education in country i, measured in U.S. dollars;

GDP_i is the country's gross domestic product, again measured in U.S. dollars;

u_i is the error term associated with country i.

The results of fitting equation (1) are shown in Table 7 on the next page. With a view towards reducing the impact of heteroscedasticity, Dougherty reformulated the model as

$$EE_i / GDP_i = \alpha\, (1/GDP_i) + \beta + v_i \qquad (2)$$

and obtained the results given in Table 7.

Required:

(a) What is heteroscedasticity? Why is Dougherty's initial model likely to give rise to this problem? In what form is the heteroscedasticity likely to appear? What are the implications of heteroscedasticity for the OLS estimators and their standard errors?
(8 marks)

(b) Explain the circumstances in which Dougherty's transformation of his initial model would be exactly correct. (3 marks)

(c) How can estimates of α and β in equation (1) above be derived from the results for the transformed model? Do these estimates differ from those for the initial model? If so, why? What do the results mean and how reliable do you consider them to be?
(6 marks)

(d) Why would it be invalid to attempt to discriminate between the two models on the basis of R^2? Which equation, if any, would you prefer and why? (2 marks)

(e) Describe an appropriate *F* test for the existence of heteroscedasticity in the context of Dougherty's initial model. What caveats must be borne in mind when implementing this test?
(6 marks)

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[1] C. Dougherty, *Introduction to Econometrics*, Oxford University Press, 1992.

Table 7. Alternative Forms of the Expenditure-on-Education Function

	Model 1	*Model 2*
Dependent variable	EE	EE/GDP
Intercept	-2.32 (0.91)	0.053 (0.004)
GDP	0.067 (0.002)	-
1/GDP	-	-0.066 (0.094)
R^2	0.98	0.15

Note: Unadjusted standard errors are given in parentheses beneath the regression coefficients.

Question 5

The following simple model was formulated to explain the annual fluctuations in the volume of goods imported into the United Kingdom during the period 1970–97:

$$M_t = a + b\, G_t + c\, E_t + u_t$$

where M_t is a seasonally adjusted index of the *volume* of imported goods, measured on a balance-of-payments basis (1995 = 100);

G_t is real GDP in market prices (£ bn, 1995 prices);

E_t is the exchange rate index for sterling (1990 = 100) and u_t is an error term.

The parameters of this linear equation were estimated initially using OLS. The relationship was then reformulated as a log-linear model and re-estimated using OLS and the Cochrane–Orcutt procedure. The results are shown in Table 8 on the next page.

Required:

(a) Discuss the possible causes of both *pure* and *impure* serial correlation. What are the consequences of each? (7 marks)

(b) Explain the rationale underlying the Cochrane–Orcutt method. Why should one be cautious about the automatic use of this method whenever serial correlation is encountered? (5 marks)

(c) By referring to the results for both OLS estimations, interpret the values of the regression coefficients. Are the signs of these coefficients in accordance with your expectations? **Note:** You may ignore the intercepts. (4 marks)

(d) In the present example, which one of the three alternative approaches do you consider to be the most satisfactory? Provide a brief justification of your choice. (9 marks)

Table 8. Autocorrelation and the Imports Function for the U.K. 1970–97

	OLS Linear	**OLS Log-linear**	**Cochrane–Orcutt**
Intercept	–110.0	-11.0	–10.8
	(–12.1)	(-15.5)	(–12.3)
G_t	0.274	-	-
	(30.8)		
$\log G_t$	-	2.25	2.23
		(33.0)	(26.8)
E_t	0.175	-	-
	(4.50)		
$\log E_t$	-	0.188	0.168
		(2.94)	(2.06)
N	28	28	28
R^2	0.990	0.994	0.994
D.W.	0.907	1.438	2.003

Notes: *t* ratios are shown in parentheses beneath the regression coefficients. The Cochrane–Orcutt procedure employed a first-order autoregressive process. It converged after three iterations, yielding a figure for rho of 0.292, with an associated (asymptotic) standard error of 1.458. There was no evidence that autocorrelation persisted beyond the first year.

Question 6

Consider:

$$Y_t = BX_t^{\beta 1} X_{t-1}^{\beta 2} \; Y_t^{\beta 3}$$

(a) Show how you would transform this model to estimate it by OLS and relate it to alternative static and dynamic forms.

(b) Derive the static long run equilibrium of the equations in part a.

(c) Give an example of a dynamic model which may have both a short and a long run theoretical interpretation.

Question 7

(a) Explain the following :

i. stationarity of time series
ii. order of integration
iii. cointegration
iv. trend stationary and difference stationary

(b) Explain how you would test for the existence of a unit root and explain any statistical problems associated with the test.

(c) Discuss how you would test for cointegration of two time series.

Question 8

Consider the model

$$y_i = \alpha + \beta x_i + \delta z_i + \gamma w_i + \varepsilon_i \quad \text{where } i=1,\ldots N \text{ and } w_i = 2z_i$$

(a) Explain in detail the problems of estimating the coefficients of this relationship using OLS.

(b) Discuss at least three ways in which you could detect multicollinearity and determine whether it was a problem.

(c) Discuss dropping variables as a solution to multicollinearity.

Question 9

Consider the demand and supply model:

$$Q^d_t = \delta_0 + \delta_1 P_t + u_{1t}$$

$$Q^s_t = \gamma_0 + \gamma_1 P_t + \gamma_2 Y_t + \gamma_3 W_t + u_{2t}$$

$$Q^d_t = Q^s_t$$

where Q^d_t is the quantity demanded of a good, Q^s the quantity supplied, P the price of the good, Y income, W the weather conditions and u_{1t} and u_{2t} are white noise errors.

(a) Assess the identification of the equations with reference to the rank and order conditions.

(b) Derive the reduced form of the system and show how indirect least squares can be used to get estimates of the structural parameters.

(c) Discuss the use of two stage least squares to estimate the equation.