06

University of Sri Jayewardenepura

Faculty of Humanities and Social Sciences

Bachelor Degree of Arts Fourth Year First Semester Examination- Aug./Sep., 2019

Economics

ECON 4160. 03– Applied Econometrics

Part I is **compulsory**. Attempt any **three (3)** questions from **Part II**.

Time: Three (03) hours
Commence each question on a new page. Write the question number on the front cover of the examination booklet.
Calculators are allowed.

PART I

01: Questions **i- xx;** choose the correct answer and **WRITE the LETTER** in the sheet provided

i). The statistical significance of a parameter in a regression model refers to:

a). testing the null hypothesis that the parameter is equal to zero, against the alternative that it is non-zero.

b). testing the null hypothesis that the probability that the OLS estimate of this parameter is equal to zero.

c). the interpretation of the sign (positive or negative) of this parameter.

e). testing null hypothesis that the parameter is not equal to zero, against the alternative that it is non-zero.

ii). What is the meaning of the term "heteroscedasticity"?

a) The variance of the errors is not constant

b) The variance of the dependent variable is not constant

c) The errors are not linearly independent of one another

d) The errors have non-zero mean

iii). Negative residual (error) autocorrelation is indicated by which one of the following?

a) A cyclical pattern in the residuals

b) An alternating pattern in the residuals

c) A complete randomness in the residuals

d) Residuals that are all close to zero

iv). Which of the following could be used as a test for autocorrelation up to third order?

a) The Durbin Watson test
b) White's test
c) The RESET test
d) The Breusch-Godfrey test

v). If a Durbin Watson statistic takes a value close to zero, what will be the value of the first order autocorrelation coefficient?

a) Close to zero
b) Close to plus one
c) Close to minus one
d) Close to either minus one or plus one

vi). Near multicollinearity occurs when

a) Two or more explanatory variables are perfectly correlated with one another
b) The explanatory variables are highly correlated with the error term
c) The explanatory variables are highly correlated with the dependent variable
d) Two or more explanatory variables are highly correlated with one another

vii). Consider the following regression line : $Y = 19 - 57X_1 - 95X_2$. You are told that the t-statistic on the slope coefficient X_1 is -3. What is the standard error of the slope coefficient?

a). 19
b). -95
c). 1.96
d). You do not have enough information to answer this question.

viii). The OLS estimator is derived by

a) ensuring that the standard error of the regression equals the standard error of the slope estimator.
b) minimizing the sum of absolute residuals.
c) minimizing the sum of squared residuals.
d) connecting as many data points as possible, except for the outliers

ix). Finding a small value of the p - value (e.g. less than 5%)

a) indicates evidence in favor of the null hypothesis (accept).
b) implies that the z-statistic is less than 1.96.
c) indicates evidence against the null hypothesis (reject).
d) will only happen roughly one in twenty samples.

x). You are interested in estimating a regression relating earnings to years of schooling. Imagine that you had collected data on earnings for different individuals and that all these individuals had completed university education (16 years of education) and have no further education. What OLS coefficient do you expect to find?

a) A positive and significant coefficient.
b) A negative insignificant coefficient.
c) The OLS slope estimator would not be defined.
d) Information on the actual university attended would be required.

xi). Choose which of the following statements are TRUE and FALSE:

1. An influential observation always has a large residual.
2. The OLS residual plots and histogram are valid instruments to detect outliers.
3. Heteroscedasticity and autocorrelation are frequent problems when modeling cross-section and time series data, respectively.
4. Perfect multicollinearity has no effect of regression coefficients

a) True: 2, 3, 4. False: 1
b) True: 1, 4 False: 2 and 3
c) True: 2, 3 False: 1 and 4
a) True: 1, 3 False: 2, 4

xii). In a simple linear regression model: $Y = \beta_0 + \beta_1 X + \varepsilon$ the slope coefficient measures

a) the elasticity of Y with respect to X
b) the change in Y which the model predicts for a unit change in X
c) the change in X which the model predicts for a unit change in Y
d) the ratio Y/X for any given value of X

xii). One sample t test can be used to test the mean difference between a given sample and

a) Hypothetical value
b) Given value
c) Common value
d) Al the above

xiv). A fitted regression equation is given by $\hat{Y} = 20 + 0.75X$. What is the value of the residual at the point X=100, Y=90?

a) 5
b) -5
c) 0
d) 15

xv). What is the number of degrees of freedom for a simple bivariate linear regression with 20 observations?

a) 20
b) 22
c) 18
d) 4

xvi). R squared measures

a) the amount of variation in Y
b) the explained sum of squares as a proportion of the Total Sum of Squares
c) the covariance between X and Y
d) the residual sum of squares as a proportion of the Total Sum of Squares

Answer: a

xvii). If the multiple regression model: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$ and the sample size is 40. Which of the following probability statement will allow us to correctly deduce a 90% confidence interval for β_3?

a) $P[\beta_3 - t(0.95,36) \times se(\beta_3) \leq \beta_3 \leq \beta_3 + t(0.95,36) \times se(\beta_3)] = 0.90$

b) $P[\beta_3 - t(0.95,36) \times se(\beta_3) \leq \beta_3 \leq \beta_3 + t(0.95,36) \times se(\beta_3)] = 0.10$

c) $P[\beta_3 - t(0.025,36) \times se(\beta_3) \leq \beta_3 \leq \beta_3 + t(0.975,36) \times se(\beta_3)] = 0.90$

d) $P[\beta_3 - t(0.025,36) \times se(\beta_3) \leq \beta_3 \leq \beta_3 + t(0.975,36) \times se(\beta_3)] = 0.10$

xviii). The ANOVA procedure is a statistical approach for determining whether or not

a. the means of two samples are equal

b. the means of two or more samples are equal

c. the means of more than two samples are equal

d. the means of two or more populations are equal

xix). If the regression equation is $Y = \beta_1 + \beta_2 X_1 + \beta_3 X_2 + \beta_4 X_3$, the null hypothesis for the standard F-test would be……..

a) $\beta_2 = 0$ and $\beta_3 = 0$ and $\beta_4 = 0$

b) $\beta_2 = 0$ or $\beta_3 = 0$ or $\beta_4 = 0$

c) $\beta_1 = 0$ and $\beta_2 = 0$ and $\beta_3 = 0$ and $\beta_4 = 0$

d) $\beta_1 = 0$ or $\beta_2 = 0$ or $\beta_3 = 0$ or $\beta_4 = 0$

xx. Which one of the following is examined by looking at a goodness of fit statistic?

a) How well the population regression function fits the data

b) How well the sample regression function fits the population regression function

c) How well the sample regression function fits the data

d) How well the population regression function fits the sample regression function.

(20 marks)

02: What is the most suitable statistical term to fill the blanks in the following questions? Write in the **SHEET PROVIDED**

i. Both Independent Samples t Test and Dependent Samples t Test check the ………………………………………………

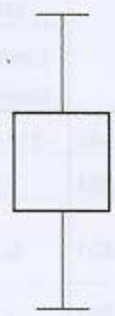
ii. A possible main reason behind choosing Sign test, instead of using One Sample t Test is ………………………………………………

iii. If VIF value of a Multiple Regression is greater than 10, it concludes that there is………………………………………………

iv. when dependent variable is qualitative, mean comparison among three groups can be done by using ………………………………………………

v. If Kolmogorov Smirnov statistic is significant, the variable tested is said to be………………………………………………

vi. A box plot created for the error term of a regression is shown below.



This implies that the assumption of ....is satisfied.

vii. A non-parametric counterpart of the Independent samples t Test is ....

viii. An essential condition that should be satisfied to use t test for a small sample is ....

ix. If you need to compare the strong ness of regression coefficients or most important contributors among independent variables, you should look at ....of the output.

x. If the dependent variable is categorical, where values 1, 0, appropriate regression model would be ....

xi. If $t_{n-k,\propto/2} > t^{*}$, regression coefficient will be statistically.......................................

xii. H₀: $\beta_1 = \beta_2 = \beta_3 = 0$ is the null hypothesis to check .... a regression model.

(12 marks)

PART II

03. Consider the following outputs.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.577[a]	.333	.288	39.31954	1.781

a. Predictors: (Constant), Father_eduYrs, TV habit, School satisfaction, Pvt Tuition expenditure, Father_job, Teacher quality, Household_income, Mother_eduYrs

b. Dependent Variable: Maths and Science marks

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	91825.144	8	11478.143	7.424	.000[b]
	Residual	183977.074	119	1546.026		
	Total	275802.219	127			

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-3.981	55.80		-.071	.943	-114.48	106.52		
	Mothet_eduYrs	6.639	2.24	.264	2.952	.004	2.18	11.09	.70	1.42
	School satisfaction	.489	3.55	.011	.137	.891	-6.55	7.52	.85	1.16
	Teacher quality	6.823	3.74	.151	1.820	.011	-.59	14.24	.81	1.23
	Pvt Tuition expenditure	.010	.001	.200	2.444	.016	.00	.01	.83	1.19
	TV habit	-2.693	3.92	-.054	-.687	.494	-10.46	5.07	.92	1.08
	Household income	-3.368	6.004	-.050	-.561	.576	-15.25	8.52	.71	1.41
	Father_job	2.481	4.59	.043	.540	.590	-6.618	11.58	.88	1.14
	Father_eduYrs	5.867	1.678	.319	3.496	.001	2.543	9.190	.674	1.485

Coefficients[a]

a. Dependent Variable: Maths and Science marks

I. Write the regression equation (2 marks)

II. Check Statistical validity of the regression coefficients (2 marks)

III. Evaluate overall significance and model fit (4 marks)

IV. Do you identify any 2nd order problems in the model? Comment (2 marks)

V. Report the results (6 marks)

04. A teacher conducted a series of interactive student centered mathematics lessons and obtained the following outputs.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	marks_before	63.5500	40	16.70552	2.64137
	marks_after	70.0500	40	15.54967	2.45862

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	marks_before & marks_after	40	.924	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	Upper			
Pair 1	marks_before - marks_after	-6.50	6.38106	1.00893	-8.54076	-4.45924	-6.44	39	.000

Group Statistics

	gender	N	Mean	Std. Deviation	Std. Error Mean
marks_after	male	21	71.3333	15.42509	3.36603
	female	19	68.6316	15.98336	3.66683

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
marks_after	Equal variances assumed	.000	.987	.544	38	.590	2.70175	4.96846	-7.35637	12.75988
	Equal variances not assumed			.543	37.288	.591	2.70175	4.97753	-7.38106	12.78457

I. Explain the research situation of the two tests used. (4 marks)

II. What are the main assumptions of the above tests? (4 marks)

III. Interpret each of the outputs given. (8 marks)

04. Suppose you are assigned to construct a women empowerment index. By considering the multidimensionality of the concept, how would you construct your questionnaire? Briefly explain with possible dimensions. (4 marks)

I. What type of statistical technique do you use to construct the above said index? What are the basic requirements? (4 marks)

II. The SPSS outputs given below explore some of the dimensions of children's subjective wellbeing. Interpret each of the outputs and asses the model. (8 marks)

Correlation Matrix[a]

		SFC1	SFC2	SFC3	SFC4	SFC5	PCOM1	PCOM2	PCOM3	PCOM4	HMsup1	HMsup2	HMsup3
Correlation	SFC1	1.000	-.063	.471	.173	.200	-.028	-.030	.076	.099	-.085	-.014	-.333
	SFC2	-.063	1.000	.077	.204	.210	.164	.106	.231	.063	.148	.117	.065
	SFC3	.471	.077	1.000	.272	.279	-.012	-.017	.094	.025	-.089	.024	-.353
	SFC4	.173	.204	.272	1.000	.482	.086	.048	.109	.064	.005	.096	-.124
	SFC5	.200	.210	.279	.482	1.000	.093	.051	.161	.118	-.063	.007	-.163
	PCOM1	-.028	.164	-.012	.086	.093	1.000	.585	.406	.295	.195	.163	-.006
	PCOM2	-.030	.106	-.017	.048	.051	.585	1.000	.290	.278	.233	.113	-.043
	PCOM3	.076	.231	.094	.109	.161	.406	.290	1.000	.371	.168	.100	.012
	PCOM4	.099	.063	.025	.064	.118	.295	.278	.371	1.000	.118	.190	-.100
	HMsup1	-.085	.148	-.089	.005	-.063	.195	.233	.168	.118	1.000	.423	.019
	HMsup2	-.014	.117	.024	.096	.007	.163	.113	.100	.190	.423	1.000	-.126
	HMsup3	-.333	.065	-.353	-.124	-.163	-.006	-.043	.012	-.100	.019	-.126	1.000

a. Determinant = .113

SFC = self-confidence; PCOM = parental communication; HMsup = home supervision

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.678
Bartlett's Test of Sphericity	Approx. Chi-Square	523.752
	df	66
	Sig.	.000

Communalities

	Initial	Extraction
SFC1	1.000	.636
SFC2	1.000	.714
SFC3	1.000	.596
SFC4	1.000	.656
SFC5	1.000	.628
PCOM1	1.000	.715
PCOM2	1.000	.632
PCOM3	1.000	.583
PCOM4	1.000	.442
HMsup1	1.000	.698
HMsup2	1.000	.750
HMsup3	1.000	.565

Extraction Method: Principal Component Analysis.

Anti-image Matrices

		SFC41	SFC2	SFC3	SFC4	SFC5	PCOM1	PCOM2	PCOM3	PCOM4	HMsup1	HMsup2	HMsup3
Anti-image Correlation	SFC1	.680[a]	.111	-.371	-.040	-.051	.027	.033	-.053	-.083	.016	.044	.187
	SFC2	.111	.712[a]	-.078	-.106	-.134	-.048	.004	-.151	.040	-.090	-.051	-.090
	SFC3	-.371	-.078	.686[a]	-.126	-.097	.029	.004	-.075	.074	.069	-.022	.230
	SFC5	-.040	-.106	-.126	.675[a]	-.412	-.026	-.003	.009	.020	.005	-.084	-.006
	PCOM1	.027	-.048	.029	-.026	-.021	.676[a]	-.508	-.249	-.070	.003	-.080	-.015
	PCOM2	.033	.004	.004	-.003	.008	-.508	.659[a]	-.026	-.121	-.150	.067	.058
	PCOM3	-.053	-.151	-.075	.009	-.065	-.249	-.026	.734[a]	-.277	-.091	.044	-.084
	PCOM4	-.083	.040	.074	.020	-.063	-.070	-.121	-.277	.737[a]	.028	-.143	.067
	HMsup1	.016	-.090	.069	.005	.071	.003	-.150	-.091	.028	.628[a]	-.400	-.024
	HMsup2	.044	-.051	-.022	-.084	.050	-.080	.067	.044	-.143	-.400	.574[a]	.132
	HMsup3	.187	-.090	.230	-.006	.073	-.015	.058	-.084	.067	-.024	.132	.698[a]

a. Measures of Sampling Adequacy(MSA)

Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.586	21.548	21.548	2.145	17.871	17.871
2	2.087	17.391	38.939	1.881	15.674	33.546
3	1.280	10.669	49.608	1.679	13.993	47.539
4	1.219	10.159	59.767	1.467	12.228	59.767
5	.853	7.111	66.878			
6	.816	6.799	73.676			
7	.688	5.731	79.407			
8	.567	4.728	84.136			
9	.554	4.613	88.748			
10	.492	4.100	92.849			
11	.482	4.020	96.868			
12	.376	3.132	100.000			

Extraction Method: Principal Component Analysis.

5) A researcher who wanted to examine the factors behind the parental willingness of taking private supplementary tuition for their children, obtained the following results. Interpret each of the outputs and discuss the results. (16 marks)

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	242	62.2
	Missing Cases	147	37.8
	Total	389	100.0
Unselected Cases		0	.0
Total		389	100.0

a. If weight is in effect, see classification table for the total number of cases.

Categorical Variables Codings

		Frequency	Parameter coding
			(1)
St_Gender	.0	157	1.000
	1.0	85	.000

Block 0: Beginning Block

Classification Table[a,b]

	Observed		Predicted		
			YES=1 NO =0		Percentage Correct
			.00	1.00	
Step 0	YES=1 NO =0	.00	0	21	.0
		1.00	0	221	100.0
	Overall Percentage				91.3

a. Constant is included in the model.

b. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	2.354	.228	106.237	1	.000	10.524

Block 1: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	62.178	6	.000
	Block	62.178	6	.000
	Model	62.178	6	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	80.610[a]	.227	.308

a. Estimation terminated at iteration number 9 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	36.354	8	.000

Classification Table[a]

	Observed		Predicted		
			YES=1 NO =0		Percentage Correct
			.00	1.00	
Step 1	YES=1 NO =0	.00	8	13	38.1
		1.00	4	217	98.2
	Overall Percentage				99.0

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Student_Age	.235	.199	1.383	1	.240	1.264
	Father_edu_level	.227	.109	4.357	1	.037	1.254
	Mothers_Education	.185	.109	2.297	1	.006	1.203
	Parent_teacher_relation	.477	.183	2.834	1	.012	1.611
	Family_income	.001	.000	16.994	1	.000	1.001
	St_Gender(1)	.775	.601	1.664	1	.197	2.171
	Constant	-5.328	3.015	3.122	1	.077	.005

Please **ATTACH** this sheet to your answer booklet

Question 1

	Answer
i	
ii	
iii	
iv	
v	
vi	
vii	
viii	
ix	
x	
xi	
xii	
xiii	
xiv	
xv	
xvi	
xvii	
xviii	
xix	
xx	

Question 2

Answer
i
ii
iii
iv
v
vi
vii
viii
ix
x
xi
xii

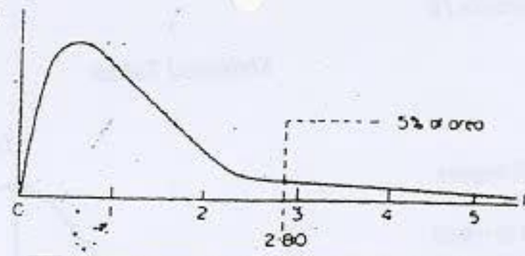


Table 4A. Values of $F_{0\cdot 05}, \nu_1, \nu_2$

Example
For $\nu_1 = 9$, $\nu_2 = 12$ degrees of freedom
$P(F > 2\cdot80) = 0\cdot05$

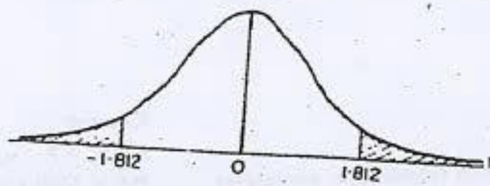
ν_1 = degrees of freedom for numerator

ν_2 = degrees of freedom for denominator

ν_2 \ ν_1	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	161	200	216	225	230	234	237	239	241	242	244	246	248	249	250	251	252	253	254
2	18·5	19·0	19·2	19·2	19·3	19·3	19·4	19·4	19·4	19·4	19·4	19·4	19·4	19·5	19·5	19·5	19·5	19·5	19·5
3	10·1	9·55	9·28	9·12	9·01	8·94	8·89	8·85	8·81	8·79	8·74	8·70	8·66	8·64	8·62	8·59	8·57	8·55	8·53
4	7·71	6·94	6·59	6·39	6·26	6·16	6·09	6·04	6·00	5·96	5·91	5·86	5·80	5·77	5·75	5·72	5·69	5·66	5·63
5	6·61	5·79	5·41	5·19	5·05	4·95	4·88	4·82	4·77	4·74	4·68	4·62	4·56	4·53	4·50	4·46	4·43	4·40	4·37
6	5·99	5·14	4·76	4·53	4·39	4·28	4·21	4·15	4·10	4·06	4·00	3·94	3·87	3·84	3·81	3·77	3·74	3·70	3·67
7	5·59	4·74	4·35	4·12	3·97	3·87	3·79	3·73	3·68	3·64	3·57	3·51	3·44	3·41	3·38	3·34	3·30	3·27	3·23
8	5·32	4·46	4·07	3·84	3·69	3·58	3·50	3·44	3·39	3·35	3·28	3·22	3·15	3·12	3·08	3·04	3·01	2·97	2·93
9	5·12	4·26	3·86	3·63	3·48	3·37	3·29	3·23	3·18	3·14	3·07	3·01	2·94	2·90	2·86	2·83	2·79	2·75	2·71
10	4·96	4·10	3·71	3·48	3·33	3·22	3·14	3·07	3·02	2·98	2·91	2·85	2·77	2·74	2·70	2·66	2·62	2·58	2·54
11	4·84	3·98	3·59	3·36	3·20	3·09	3·01	2·95	2·90	2·85	2·79	2·72	2·65	2·61	2·57	2·53	2·49	2·45	2·40
12	4·75	3·89	3·49	3·26	3·11	3·00	2·91	2·85	2·80	2·75	2·69	2·62	2·54	2·51	2·47	2·43	2·38	2·34	2·30
13	4·67	3·81	3·41	3·18	3·03	2·92	2·83	2·77	2·71	2·67	2·60	2·53	2·46	2·42	2·38	2·34	2·30	2·25	2·21
14	4·60	3·74	3·34	3·11	2·96	2·85	2·76	2·70	2·65	2·60	2·53	2·46	2·39	2·35	2·31	2·27	2·22	2·18	2·13
15	4·54	3·68	3·29	3·06	2·90	2·79	2·71	2·64	2·59	2·54	2·48	2·40	2·33	2·29	2·25	2·20	2·16	2·11	2·07
16	4·49	3·63	3·24	3·01	2·85	2·74	2·66	2·59	2·54	2·49	2·42	2·35	2·28	2·24	2·19	2·15	2·11	2·06	2·01
17	4·45	3·59	3·20	2·96	2·81	2·70	2·61	2·55	2·49	2·45	2·38	2·31	2·23	2·19	2·15	2·10	2·06	2·01	1·96
18	4·41	3·55	3·16	2·93	2·77	2·66	2·58	2·51	2·46	2·41	2·34	2·27	2·19	2·15	2·11	2·06	2·02	1·97	1·92
19	4·38	3·52	3·13	2·90	2·74	2·63	2·54	2·48	2·42	2·38	2·31	2·23	2·16	2·11	2·07	2·03	1·98	1·93	1·88
20	4·35	3·49	3·10	2·87	2·71	2·60	2·51	2·45	2·39	2·35	2·28	2·20	2·12	2·08	2·04	1·99	1·95	1·90	1·84
21	4·32	3·47	3·07	2·84	2·68	2·57	2·49	2·42	2·37	2·32	2·25	2·18	2·10	2·05	2·01	1·96	1·92	1·87	1·81
22	4·30	3·44	3·05	2·82	2·66	2·55	2·46	2·40	2·34	2·30	2·23	2·15	2·07	2·03	1·98	1·94	1·89	1·84	1·78
23	4·28	3·42	3·03	2·80	2·64	2·53	2·44	2·37	2·32	2·27	2·20	2·13	2·05	2·01	1·96	1·91	1·86	1·81	1·76
24	4·26	3·40	3·01	2·78	2·62	2·51	2·42	2·36	2·30	2·25	2·18	2·11	2·03	1·98	1·94	1·89	1·84	1·79	1·73
25	4·24	3·39	2·99	2·76	2·60	2·49	2·40	2·34	2·28	2·24	2·16	2·09	2·01	1·96	1·92	1·87	1·82	1·77	1·71
30	4·17	3·32	2·92	2·69	2·53	2·42	2·33	2·27	2·21	2·16	2·09	2·01	1·93	1·89	1·84	1·79	1·74	1·68	1·62
40	4·08	3·23	2·84	2·61	2·45	2·34	2·25	2·18	2·12	2·08	2·00	1·92	1·84	1·79	1·74	1·69	1·64	1·58	1·51
60	4·00	3·15	2·76	2·53	2·37	2·25	2·17	2·10	2·04	1·99	1·92	1·84	1·75	1·70	1·65	1·59	1·53	1·47	1·39
120	3·92	3·07	2·68	2·45	2·29	2·18	2·09	2·02	1·96	1·91	1·83	1·75	1·66	1·61	1·55	1·50	1·43	1·35	1·25
∞	3·84	3·00	2·60	2·37	2·21	2·10	2·01	1·94	1·88	1·83	1·75	1·67	1·57	1·52	1·46	1·39	1·32	1·22	1·00

Abridged from M. Merrington and C. M. Thompson, 'Tables of percentage points of the inverted beta (F) distribution', *Biometrika*, vol. 33, 1943, p. 73. By permission of the *Biometrika* trustees.

Table 2. Percentage Points of the *t* Distribution



Example

For $\nu = 10$ degrees of freedom:

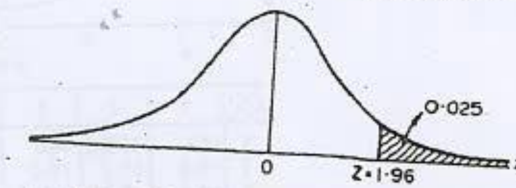
$P(t > 1{\cdot}812) = 0{\cdot}05$

$P(t < -1{\cdot}812) = 0{\cdot}05$

ν \ α	·25	·20	·15	·10	·05	·025	·01	·005	·0005
1	1·000	1·376	1·963	3·078	6·314	12·706	31·821	63·657	636·619
2	·816	1·061	1·386	1·886	2·920	4·303	6·965	9·925	31·598
3	·765	·978	1·250	1·638	2·353	3·182	4·541	5·841	12·941
4	·741	·941	1·190	1·533	2·132	2·776	3·747	4·604	8·610
5	·727	·920	1·156	1·476	2·015	2·571	3·365	4·032	6·859
6	·718	·906	1·134	1·440	1·943	2·447	3·143	3·707	5·959
7	·711	·896	1·119	1·415	1·895	2·365	2·998	3·499	5·405
8	·706	·889	1·108	1·397	1·860	2·306	2·896	3·355	5·041
9	·703	·883	1·100	1·383	1·833	2·262	2·821	3·250	4·781
10	·700	·879	1·093	1·372	1·812	2·228	2·764	3·169	4·587
11	·697	·876	1·088	1·363	1·796	2·201	2·718	3·106	4·437
12	·695	·873	1·083	1·356	1·782	2·179	2·681	3·055	4·318
13	·694	·870	1·079	1·350	1·771	2·160	2·650	3·012	4·221
14	·692	·868	1·076	1·345	1·761	2·145	2·624	2·977	4·140
15	·691	·866	1·074	1·341	1·753	2·131	2·602	2·947	4·073
16	·690	·865	1·071	1·337	1·746	2·120	2·583	2·921	4·015
17	·689	·863	1·069	1·333	1·740	2·110	2·567	2·898	3·965
18	·688	·862	1·067	1·330	1·734	2·101	2·552	2·878	3·922
19	·688	·861	1·066	1·328	1·729	2·093	2·539	2·861	3·883
20	·687	·860	1·064	1·325	1·725	2·086	2·528	2·845	3·850
21	·686	·859	1·063	1·323	1·721	2·080	2·518	2·831	3·819
22	·686	·858	1·061	1·321	1·717	2·074	2·508	2·819	3·792
23	·685	·858	1·060	1·319	1·714	2·069	2·500	2·807	3·767
24	·685	·857	1·059	1·318	1·711	2·064	2·492	2·397	3·745
25	·684	·856	1·058	1·316	1·708	2·060	2·485	2·787	3·725
26	·684	·856	1·058	1·315	1·706	2·056	2·479	2·779	3·707
27	·684	·855	1·057	1·314	1·703	2·052	2·473	2·771	3·690
28	·683	·855	1·056	1·313	1·701	2·048	2·467	2·763	3·674
29	·683	·854	1·055	1·311	1·699	2·045	2·462	2·756	3·659
30	·683	·854	1·055	1·310	1·697	2·042	2·457	2·750	3·646
40	·681	·851	1·050	1·303	1·684	2·021	2·423	2·704	3·551
60	·679	·848	1·046	1·296	1·671	2·000	2·390	2·660	3·460
120	·677	·845	1·041	1·289	1·658	1·980	2·358	2·617	3·373
∞	·674	·842	1·036	1·282	1·645	1·960	2·326	2·576	3·291

Source: This table is abridged from Table III of Fisher & Yates: *Statistical Tables for Biological, Agricultural and Medical Research* published by Oliver & Boyd Ltd., Edinburgh, and by permission of the authors and publishers.

Table 1. Areas under the Normal Curve



Example

$Z = \frac{X - \mu}{\sigma}$

$P(Z > 1{\cdot}96) = {\cdot}0250$

z	·00	·01	·02	·03	·04	·05	·06	·07	·08	·09
0·0	·5000	·4960	·4920	·4880	·4840	·4801	·4761	·4721	·4681	·4641
0·1	·4602	·4562	·4522	·4483	·4443	·4404	·4364	·4325	·4286	·4247
0·2	·4207	·4168	·4129	·4090	·4052	·4013	·3974	·3936	·3897	·3859
0·3	·3821	·3783	·3745	·3707	·3669	·3632	·3594	·3557	·3520	·3483
0·4	·3446	·3409	·3372	·3336	·3300	·3264	·3228	·3192	·3156	·3121
0·5	·3085	·3050	·3015	·2981	·2946	·2912	·2877	·2843	·2810	·2776
0·6	·2743	·2709	·2676	·2643	·2611	·2578	·2546	·2514	·2483	·2451
0·7	·2420	·2389	·2358	·2327	·2296	·2266	·2236	·2206	·2177	·2148
0·8	·2119	·2090	·2061	·2033	·2005	·1977	·1949	·1922	·1894	·1867
0·9	·1841	·1814	·1788	·1762	·1736	·1711	·1685	·1660	·1635	·1611
1·0	·1587	·1562	·1539	·1515	·1492	·1469	·1446	·1423	·1401	·1379
1·1	·1357	·1335	·1314	·1292	·1271	·1251	·1230	·1210	·1190	·1170
1·2	·1151	·1131	·1112	·1093	·1075	·1056	·1038	·1020	·1003	·0985
1·3	·0968	·0951	·0934	·0918	·0901	·0885	·0869	·0853	·0838	·0823
1·4	·0808	·0793	·0778	·0764	·0749	·0735	·0721	·0708	·0694	·0681
1·5	·0668	·0655	·0643	·0630	·0618	·0606	·0594	·0582	·0571	·0559
1·6	·0548	·0537	·0526	·0516	·0505	·0495	·0485	·0475	·0465	·0455
1·7	·0446	·0436	·0427	·0418	·0409	·0401	·0392	·0384	·0375	·0367
1·8	·0359	·0351	·0344	·0336	·0329	·0322	·0314	·0307	·0301	·0294
1·9	·0287	·0281	·0274	·0268	·0262	·0256	·0250	·0244	·0239	·0233
2·0	·0228	·0222	·0217	·0212	·0207	·0202	·0197	·0192	·0188	·0183
2·1	·0179	·0174	·0170	·0166	·0162	·0158	·0154	·0150	·0146	·0143
2·2	·0139	·0136	·0132	·0129	·0125	·0122	·0119	·0116	·0113	·0110
2·3	·0107	·0104	·0102	·0099	·0096	·0094	·0091	·0089	·0087	·0084
2·4	·0082	·0080	·0078	·0075	·0073	·0071	·0069	·0068	·0066	·0064
2·5	·0062	·0060	·0059	·0057	·0055	·0054	·0052	·0051	·0049	·0048
2·6	·0047	·0045	·0044	·0043	·0041	·0040	·0039	·0038	·0037	·0036
2·7	·0035	·0034	·0033	·0032	·0031	·0030	·0029	·0028	·0027	·0026
2·8	·0026	·0025	·0024	·0023	·0023	·0022	·0022	·0021	·0020	·0019
2·9	·0019	·0018	·0018	·0017	·0016	·0016	·0015	·0015	·0014	·0014
3·0	·0013	·0013	·0013	·0012	·0012	·0011	·0011	·0011	·0010	·0010