



Bristol Business School

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School of: Economics

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1. Introduction

The general aims of this module are to provide students with an appreciation of the use of econometrics as a tool for studying economics, to make them familiar with the main tools of econometrics at an advanced level and to introduce students to computer based methods of econometric investigation.

The module is taught by Paul Dunne

Website: Details of the course including datasets will be posted on the course website on Blackboard and at: <http://carecon.org.uk/UWEmasters/Econometrics>

2. Learning Outcomes

By the end of the module student should have a knowledge and understanding of econometric analysis to an advanced level, have a knowledge and understanding of the value and limitations of econometric techniques, develop a critical perspective on the use of econometric analysis, be proficient in using an advanced econometric package (Microfit) and be able to independently replicate econometric analyses of economic data.

3. Organisation of the Module

Lectures and workshops will complement each other. Workshops will be computer based exercises on Microfit 4.1 and will allow students to work through the topics covered in the lectures.

3.1. Teaching and Learning Methods

The basic framework is one of lecture and seminar (one hour of each per week). As a general rule, the lecture session will be one of exposition and the workshops will be computer based and give the opportunity for questions, discussion and practise. However, there will be departures from this framework depending upon the part of the syllabus being covered.

3.2. Student responsibilities

Lectures

You should be aware that lectures are designed to provide a framework for discussion and analysis. Your responsibility therefore is to attend these lectures on a regular basis. Failure to do so may seriously affect your ability to keep abreast of the course and hence impact on your final grade.

Seminars

A seminar is designed to enable students to investigate an issue or theme in greater detail. The onus is on you to keep up to date with the reading on a weekly basis. **Seminars work well if everyone has done some preparatory reading, have thought about interesting questions to ask and come along prepared to discuss the theme in question.** Do not leave it to others to do the work. As you can see the reading lists for seminars are extensive. The

purpose is two fold: to give an idea of what is available in our library; and to introduce various opinions expressed by a number of authors. This does not mean that just because a book is not listed here that it may not be relevant to the course. **We would encourage you from the outset to explore the wide variety of material contained in our library, which can be equally useful when preparing for a seminar or writing an essay.** Equally important, you are strongly encouraged to use journal articles, which publish the latest research. Articles are extremely useful because they concentrate on a specific issue or debate. They get to the heart of a debate and therefore provide insight into complex issues. So get into the habit of using the journals for all facets of your work.

Library

A final point concerns the library system. You are expected to use the full potential of the UWE library system. As a multi-campus institution, resources are scattered. Books and periodicals may be housed on only one site. So be prepared, especially when preparing essays, to use the inter-site loan system or (better still) travel to the other sites to obtain relevant material. UWE is well equipped with electronic media. Increasingly it is necessary for libraries to take journals in electronic form, and UWE does this well. Please take advantage of the resources available through the Library catalogue as well as internet-based research aids. Please be familiar with the University's inter-library loan (ILL) system: remember that ILLs always take a number of days to arrive, so you must plan ahead.

Computers

Most of the exercises are computer based and it is important that students work independently outside of the workshops on the exercises. Students should also frequently visit the course website on Blackboard and/or:

<http://www.carecon.org.uk/UWEMasters/Econometrics/>

Finally, **remember that this is a postgraduate course.** You are expected to be able to cover a lot of ground at a high level in a short space of time. Notice that the course is divided into modules which are just one semester long. This means that they last for approximately 12 weeks. This in turn makes it very difficult to recover lost time. You must be prepared to start the course promptly and to stay with it week by week.

3.3. Staff Responsibilities

Staff will endeavour to produce useful and clear lectures, which cover the material students are expected to master. In the workshops staff will provide guidance and support, including dealing with individual problems.

3.4. Facilities and Resources

There is a course webpage on Blackboard and at <http://carecon.org.uk/UWEMasters/Econometrics/>

This is a valuable resource, providing updates of the course, reading lists, lecture notes and other resources. It also operates as a means of communication between lecturers and students and it is important that students check it out regularly.

4. Module Programme and lecture details

Lect. no.	UWE week	w/c date	Title	Reading
1	9	01.10.07	Maths and Stats revision	
2	10	08.10.07	Introduction to Econometrics: Research and Econometric Methodology	
3	11	15.10.07	The Simple Regression Model: Assumptions of the classical linear model	
4	12	22.10.07	Multiple Regression: Goodness of Fit; Interpretation;	
5	13	29.10.07	Statistical Inference and Hypothesis Testing	
6	14	05.11.07	Violation of the Assumptions of the Classical Regression Model	
7	15	12.11.07	Autocorrelation and Dynamic Models	
8	16	19.11.07	Time Series Analysis	
9	17	26.11.07	Heteroskedasticity and Limited Dependent Variable Models	
10	18	03.12.07	Multicollinearity, Prediction and Structural Stability	
11	19	10.12.07	Developments in Time Series Analysis	
12	20	17.12.07	Developments in Time Series Analysis II	

5. Workshops

Wk 2:

Introduction to Microfit. MM Ch 1 – 3, 8 - 9. Microfit Exercise 1.

Wk3:

Microfit exercises. MM Ch 1 – 4, 10.

Wk4:

Microfit exercises. MM Ch 10.

Wk5:

Microfit exercises. MM Ch 10.

Wk6:

Microfit exercises. MM Ch 10.

Wk7:

Microfit exercises. MM Ch 11.

Wk8:

Microfit exercises. MM Ch 11.

Wk9:

Microfit exercises. MM Ch 14.

Wk10:

Microfit exercises. MM Ch 14.

Wk11:

Microfit exercises. MM Ch 17

Wk12:

: Microfit exercises. MM Ch 15 – 16.

Applied Exercises:

Introduction

These exercises introduce you to Microfit 4.1, a very powerful interactive econometrics package that is also relatively easy to use. It has a clear structure of screen editors and windows facilities for data processing, file management, graphic display, estimation, hypothesis testing and forecasting windows. It is driven by icons and written commands.

It is important that you follow the steps exactly the first time you use the package. You will soon get used to moving through the screens to find the task you want. When typing in commands always use the "return" / "enter" key at the end.

Documentation: There is a Microfit manual available in the library, but you will not need to reference it at this stage, as the applied exercises are fairly straightforward and there is a very good help facility in the programme. MFIT is menu driven you do not need a manual to run the programme.

Important: Becoming familiar with Microfit is an essential part of this course. It will require considerable amounts of practice outside of the timetabled sessions.

EXERCISE 1

1. Getting Started

Logon to the network and access Microfit

2. Data Input:

- Click on File and choose the New option
- Choose Annual as the data frequency
- Give 1977 as the Start year and 1987 as the End year
- Give 2 as the number of variables
- Click on OK

In the next window overwrite X1 and X2 with RC and RPDI respectively and insert descriptions of the variables, RC is real consumption, RPDI is real personal disposable income.

Click on Go

Now input the following data in the relevant cells

	RC	RPDI
1977	176.0	195.6
1978	186.0	209.9
1979	193.8	221.7
1980	193.8	224.9
1981	193.8	222.2
1982	195.6	221.7
1983	204.3	227.9
1984	207.9	232.4
1985	215.3	237.8
1986	226.8	244.8
1987	238.5	252.2

When you have finished you can check and edit if necessary and when you are ready click on Go.

There are a number of icons above the data window with Variables, Data, Process etc on them:

- Click on Variables to check the information you have input, then click on Close
- Click on Data to check the inputted data (same window)
- Click on Process to get to the data processing screen.

3. Data Processing

You are now in the main screen and can undertake various tasks. For now:

a. Check the data:

- Type LIST RC RPDI
- Click on Close

b. Compute variables:

- Compute the savings ratio type: $S=(RPDI-RC)/RPDI$
Then click Go
- Compute a constant type: $C=1$
Then click Go
- Take logs of variables type: LRPDI=LOG(RPDI);
 LRC=LOG(RC);
 LS=LOG(S);

Then click Go.

The ; allows you to run more than one command at a time.

You can also compute other transformations in the same way. For example first differences for DC would require $DRC=RC-RC(-1)$.

c. Plot variables over time: Type:

PLOT RPDI
PLOT RC
PLOT S
PLOT RPDI RC

Click on Go after each of these and on Close in the graphics Window

d. Plot variables against each other: Type

XPLOT RPDI RC

Click on Go
Click on Close

e. Get simple descriptive statistics and correlations: Type

COR RPDI RC

Click on Go

(You should get correlation coefficient of 0.9676)

Click on Close

After you have done all of these type click on the Single icon, which will give you the Linear regression - Ordinary Least Squares screen.

4. Running a Regression

Click on the empty window and type in the dependent variable a constant and the independent variable as follows:

RC C RPDI

and then click on the Start icon.

This will give you regression results and various statistics. They should be equivalent to:

$$RC = \begin{matrix} -52.21 & + & 1.13 & RPDI \\ (-2.4) & & (11.5) & \end{matrix}$$

$$R^2 = 0.94 \qquad DW = 0.596$$

You can print this out or save to

Further possible statistics are offered when you click on the Close icon. For the moment choose no. 3 (List/plot/save residuals and fitted values) and then click on OK.

5. Analysing the Residuals

Choose the option no. 3 Plot residuals and click on Ok
You will now see a plot of the residuals

It should be clear that there are problems with this regression!

You can print this graph out or save to a file using icons at the top left.

- Click on Close to return to the menu
- Accept option 0, Return to the Post Regression Menu
- Choose option 0, Return to Backtracking Menu
- Choose option 1, Return to Single Equation Estimation Window

6. Saving Data and Variables

- Click on File menu
- Choose Save As option
- Give the filename MAEG1.FIT
- Specify a directory and drive or floppy disk
- Accept the first and last observations offered by clicking on OK

- Exit from Microfit:

Either go to the File menu and choose Exit.

Or click on the X in the top right hand corner. Click on OK when you receive the warning about data being lost as you have already saved it.

7. Using saved FIT files

- Start Microfit again.
- Click on the File menu and choose Open
- Give the filename MAEG1.FIT

Note that you may have to specify a drive or directory, depending on where you saved the file.

You are now back with your data and all of the variables you created above are still there.

Check that this is the case by using the icons and then rerun the regression

You can now either exit or move on to exercise three, by clicking on the File menu and choosing the option Open

EXERCISE 2

The steps below only provide instructions. You will need to go through the same procedures as in Exercise 1 to complete the tasks.

1. Enter Microfit
2. Click on the File menu and choose the Open option. Give the filename as MAEG2.FIT with the directory/disk details. This file contains data for 1959-87 on consumption and income
3. Using OLS, estimate the linear model: $RC = a + b \text{RPDI}$
4. Estimate a log-linear model: $LRC = a + b \text{LRPDI}$
where $LRC = \text{LOG}(RC)$ and $\text{LRPDI} = \text{LOG}(\text{RPDI})$
5. Estimate an extended model introducing inflation: $LRC = a + b \text{LRPDI} + c \text{DLPC}$
Where the inflation term DLPC is constructed using:
 $\text{LPC} = \text{LOG}(\text{PC})$
 $\text{DLPC} = \text{LPC} - \text{LPC}(-1)$
6. Consider the results for each of these regressions and why each one improves on the previous one.
7. To consider how to interpret multiple regression.
 - Make a note of the results of the extended model (parameter estimates/ t ratios/ DW/ Rsq)
 - Estimate $LRC = a_1 + b_1 \text{DLPC}$
 - Save the residuals. Give them the name RES1
 - Estimate $\text{LRPDI} = a_2 + b_2 \text{DLPC}$
 - Save the residuals as RES2
 - Estimate $\text{RES1} = a_3 + b_3 \text{RES2}$

You will see that b_3 is the same as b (the estimate in the extended model). Consider what this tells you about the interpretation of parameter estimates in multiple regression analysis.

EXERCISE 3: Capital Asset Pricing Model

This exercise is based upon those at the end of Chapter 2 in Berndt. The data is the same except that it has been collected in a Microfit file.

1. Start Microfit
2. Read in the file CHAP2.FIT, which contains monthly share return data.
3. Have a look at the descriptions of the variables.
4. Plot MARKET from Jan 78 to Dec 87 and then IBM over the same period.
5. What do the plots tell you?
6. Construct the risk premium measures $r_p - r_f$ and $r_m - r_f$, using:
RIBM = IBM - RKFREE
RMARKET = MARKET - RKFREE
Plot these and look at what happened October 1987.
7. Get the sample means using:
COR IBM MARKET RKFREE RIBM RMARKET
Work out the values you would expect for β if you estimated
 $(r_j - r_f) = \alpha_j + \beta_j (r_m - r_f) + e_j$
8. Estimate β for IBM using $RIBM = \alpha_j + \beta_j RMARKET + e_j$
9. Are the results what you would expect?. Look at the residuals and consider any outliers.
10. Choose two companies, a highly risky one and a relatively safe one and estimate their values of β . Are they what you would expect?
11. Look at the plots over time and the plots of the residuals. Are there any outliers? How would you interpret them?
12. Test the null hypothesis that $\alpha = 0$ and the hypothesis that $\beta = 1$. What are the implications of these results?
13. If you wish follow the rest of the Exercises in Berndt Chapter 2.

EXERCISE 4

This exercise will extend the previous two, both in terms of the data coverage and the techniques used.

Part 1

A Microfit file named CONS95.FIT contains the data.

Run Microfit and access this file.

The data consist of:

CE: Consumers Expenditure in current prices

RCE: Consumers Expenditure in 1995 prices

RDE: Expenditure on Durables in 1995 prices

PDI: Personal Disposable Income in current prices

RPDI: Real Personal Disposable Income in 1995 prices

C: A variable with the value one for each observation

When you have read in the data, check the data definitions using TITLE.

Then:

Explain what RPDI measures and how it differs from personal income.

Plot RCE and RPDI and comment on the main features

Generate:

$S = \log((PDI - CE) / PDI)$

$RS = \log((RPDI - RCE) / RPDI)$

Plot these two series and comment on their meaning and the difference between them.

Generate:

$LC = \log(RCE - RDE)$

$GC = LC - LC(-1)$

$LY = \log(RPDI)$

$GY = LY - LY(-1)$

$LP = \log(CE / RCE)$

$GP = LP - LP(-1)$

$Z = LC - LY$

What do these series measure?

Use the following commands and explain the output you get:

PLOT LC LY

PLOT GC GY

COR LC

COR LC LY GC GY

LIST C LC LY GC GY

XPLOT LC LY

Run a regression with RCE as the dependent variable and C and RPDI as the independent variables, **using sample 1950 to 1980**. Note and interpret the regression results.

Save your dataset in a special Microfit file with a different name to the original (eg consnew.fit). Use this file from now on.

Part 2

Run the following regressions using OLS, on **sample 1950 1980**, the first variable is the dependent variable, the rest the independent ones. In each case interpret and comment on the main features of the regression results, diagnostic tests A to D, the plot of actual and predicted values and the plot of the residuals.

1. LC C LY

Test whether the coefficient of LY is significantly different from zero and then from one, at the 5% level.

2. GC C GY

After estimating the equation go to the hypothesis testing menu and conduct a variable addition test to see whether LC(-1) and LY(-1) are jointly significant using the F statistic and individually significant using the t statistics

3. GC C GY GP

Repeat as for 2 and comment on the significance of the lagged values.

4. LC C LY LY(-1) LC(-1)

5. GC C GY LY(-1) LC(-1)

Compare the results for 4 and 5 in terms of coefficients, standard errors, log-likelihoods, and the sum of squared residuals. What is the relationship between them.

6. GC C GY LY LY(-1) LC(-1)

Explain what happens when LY is added to 5

7. GC C GY LY(-1) GP LP(-1) LC(-1)

Calculate the long run elasticities of consumption with respect to the price level and income. What does economic theory predict about the coefficient of LP(-1). Test this prediction.

8. GC C GY GP Z(-1)

Test 8 against 7. Is this a well specified equation. Explain the economic interpretation of 8. What is the long run elasticity of consumption with respect to prices and incomes in this model.

9. GC C

Interpret this model and carry out a variable addition test for the significance of LY(-1) and GY(-1). Interpret the result.

Part 3

Run equation 8 for the samples 1950 to 1965 and 1966 to 1980. Test whether the variances are equal in the two periods and whether the coefficients are equal.

Use the equation to forecast 1980 to 1985. Interpret your results.
Estimate equation 8 for 1980 to 1985. Note the results.

Construct dummy variables for 1986, 1987, 1988 and 1989 using the following commands:

```
SAMPLE 1948 1989
```

```
D86=0
```

```
D87=0
```

```
D88=0
```

```
D89=0
```

```
SAMPLE 1986 1986
```

```
D86=1
```

```
SAMPLE 1987 1987
```

```
D87=1
```

```
SAMPLE 1988 1988
```

```
D88=1
```

```
SAMPLE 1989 1989
```

D89=1
SAMPLE 1948 1989

Run the following regression for 1950 to 1989:
GC C GY GP Z(-1) D86 D87 D88 D89

Compare the results from this equation with the ones obtained when equation 8 was run over 1950 to 1985. Interpret the coefficients and standard errors of the dummy variables.

Part 4

Reestimate equation 1 assuming AR(1) disturbances, test this against 3, using a likelihood ratio test.

What problems arise in testing 4 against 8?
Which of the models you have estimated are restricted versions of 7?
What are the restrictions in each case?

Construct a tree showing the relationship between this family of models and the test statistics.

Re-estimate equation 8 using the instrumental variable estimator, using as instruments:
C LY(-1) LC(-1) LP(-1) LY(-2) LC(-2) LP(-2)

Part 5

Using the whole data set 1948 1998:

Use the general to specific methodology to find the best parsimonious consumption function.

Using DF and ADF tests investigate the time series properties of the series and whether they are cointegrated. If you find they are estimate the error correction model.

Use the Johansen procedure to investigate the consumption function relationship and the dynamics.

Compare the results from the different methods and discuss any differences.

Part 6

Compare the results for each of the samples used above and discuss the differences.

Undertake tests for structural stability across the subsamples.

Investigate the evolution of the coefficients using CUSUM squared procedure

Discuss the results, their implications for the study of consumption and possible ways to move forward.

Revision Exercise

Indicate whether the following are True, False or Uncertain and give a brief, at most one page, explanation or proof of your assertion.

Do not simply state your answer, explain!

1. The least squares estimator is the best linear unbiased estimator (BLUE) as long as the error terms are normally distributed.
2. We cannot use OLS methods with a lagged dependent variable as they will be neither best nor unbiased.
3. The OLS method can only be used to estimate regressions that are linear in the variables.
4. In multiple regression a high correlation in the sample among the regressor implies that the least squares estimators of the parameters are biased. The solution is to drop one of the regressors.
5. Heteroscedasticity in the errors leads to biased estimators of the regression coefficients and their standard errors.
6. Estimating a time series regression in first differences is preferable to estimating it in levels.
7. The Durbin Watson statistic tests whether the errors are autocorrelated. If it is significant we should estimate the parameters using the Cochrane-Orcutt method.
8. In a simultaneous equation system the more exogenous variables there are the better.
9. If two variables are not cointegrated then there is no long run relation between them.
10. The linear probability model is an adequate way to deal with the problem of a limited dependent variable.

6. Assessment Offences – Cheating, Collusion and Plagiarism

The university encourages the use of a wide variety of assessment methods including coursework of various kinds. Consequently, it takes a very strict view of assessment offences like plagiarism and collusion (both of which, alas, have been facilitated by recent technological developments). The penalties for infringement are draconian. Details of the rules and penalties are included in the handbook relating to this course as a whole. You should read them carefully and follow them to the letter.

Please read carefully the following definitions of cheating, collusion and plagiarism. These are serious offences and it is very important that you know how to avoid them. The University procedures for dealing with allegations of assessment offences are laid out in the **UWE Student Handbook**, and in the Academic Regulations (E12a).

6.1. Definitions

6.1.1 Cheating (in the widest sense of the word) is the use of unfair means of presenting work for assessment. It is a serious academic offence as it prevents examiners from being able to make a realistic judgement of a student's knowledge, understanding, ability and/or creativity.

6.1.2 Cheating in an examination includes:

- a) taking aids (eg notes, books, mobile phones, equipment) into an examination room which are not authorised for use in that examination
- b) copying another student's work
- c) seeking or obtaining help from another person
- d) assisting another student with an examination

6.1.3 Collusion includes:

- a) presenting work as one's own which is derived from unauthorised collaboration with others
- b) assisting another person by giving substantial help with ideas or with text which are not then acknowledged.

6.1.4 Plagiarism is a form of theft. It includes:

- a) the quotation of another person's words without quotation marks
- b) the quotation of another person's words or ideas without acknowledgement
- c) the use of another person's ideas without acknowledgement
- d) the use of another person's facts or experimental results without acknowledgment.

6.1.5 It is also an assessment offence to prevent another student from being able to be examined properly.

6.2. Avoiding Cheating in Examinations

6.2.1 Students can ensure that they do not unwittingly cheat in examinations if they

- a) take into an examination only those items which have been authorised. Particular care must be taken with programmable calculators and dictionaries which can only be used if specifically authorised.
- b) follow carefully the "Instructions to Candidates" (Examination Regulation 2) and communicate with no-one except an invigilator during an examination.

6.3. Avoiding Collusion

- 6.3.1 Most collusion is unintentional. Students are often required to work on a topic or activity in groups and then to produce individual work for assessment. They must be careful to follow the instructions regarding the assessment. Some assessments may require the group to produce joint ideas or proposals, whereas others might assign this initiative to the individual. Unless the instructions specifically require a group report, students must produce their own written work without the help of other people.
- 6.3.2. It is a normal part of the learning process for students to discuss ideas for written work with each other. However, students should be cautious about lending essays, computer files or laboratory reports to other students in order to avoid the danger of the second student producing an essay or laboratory report similar to that of the first student.
- 6.3.3. Discussion between students can be a good way of learning: however, students should be careful to ensure that they think out and write the detail of their essays/assignments by themselves.

6.4. Avoiding Assessment Offences

- 6.4.1. In order to produce good essays, assignments, etc, it is expected that students will base their ideas on several sources and will quote from them. Plagiarism is often a result of poor academic practice rather than a deliberate attempt to cheat. Good academic standards require that -
 - a) any phrase or longer text which is taken from another author must be quoted precisely using quotation marks and the bibliographical reference
 - b) where an author's text is summarised the summary must be in the student's own words. Merely changing the order of words or using synonyms does not form an acceptable summary
 - c) any facts, tables, diagrams or experimental results taken from another person must be acknowledged and referenced
 - d) any ideas or conclusions taken from another person must be duly acknowledged and referenced.

7. Assessment

7.1 Regulations

Regulations governing assessment are contained in the handbook relating to the course. You are advised to study these carefully. As far as this module is concerned, there are two elements to the assessment.

'Element A ' is an unseen exam of 2 hours. You will be required to answer four questions from a list of eight. The exam will be held during the university's assessment period in January.

'Element B ' is an individual coursework assignment using Microfit of up to 2000 words

The marks from these two elements will be combined and averaged with equal weighting.

In order to pass this module you need to obtain an overall mark of 50% or above. In addition you need to obtain at least 40% in both assessment components.

If you do not get 50% or more in the **module**, you will be referred in each **component** for which your mark is below 50%.

If you do get 50% or more in the module but one of your components is below 40% you will be referred in that component.

If the minimum mark of 40% is not achieved in both required components of assessment (and the other is passed) at the first assessment opportunity the mark for the referred component will be limited to 50%. This is described as a capped mark. The mark for the other component will not be capped nor will the overall module mark. Where a component of assessment is not passed at the second assessment opportunity and a student makes another attempt at the module, the overall module mark achieved at the second attempt will be capped at 50%.

Students who fail to meet the assessment requirements at the first attempt will be offered a second assessment opportunity during which they will be required to sit another examination and/or submit a revised project.

All students referred in a component will have to do the same referral work.

Further information about assessment may be found in the University's Student Handbook.

7.2 Guidelines

Assessment criteria for component A

The criteria for assessment include: evidence of an understanding of relevant analytical techniques and theories; the ability to apply them effectively; the ability to gather, organise, analyse and present evidence and data in a coherent and concise fashion. Students will be expected to demonstrate their knowledge of economic and econometric concepts, theories and principles at Masters level.

Assessment criteria for Component B

The criteria for assessment include: evidence of an understanding of relevant analytical techniques and theories; the ability to apply them effectively; Students will be expected to demonstrate their knowledge of economic and econometric concepts, principles and theories at Masters level. Particular emphasis will be placed on the effective use of statistical theories and techniques.

General Assessment Criteria:

The following section provides guidance on the criteria employed for assignments which receive a distinction, pass or fail award. These are generic, but can be easily interpreted in the context of econometrics.

Distinction level (75%): For component 1, work which gains a distinction will demonstrate a standard of writing and critical analysis will be considered excellent. In other modules,

excellence will be taken to mean that it could be considered for publication in that field. To be judged of distinction quality in specific assignments or in the overall performance for a module, assessed work will demonstrate all that is required for the PASS band and will also demonstrate a range of the following characteristics, as determined by the relevant subject specialists and programme team. Care must be taken to ensure that this process does not invite subject specialists to ignore or devalue these generic criteria:

- a) creativity in developing new approaches and interpretation to existing or new areas of knowledge and/or innovations in practice
- b) original critical analysis which reviews the validity of theoretical perspectives and methodologies
- c) critical understanding of an appropriate range of research methodologies as well as the ability to explore the limitations of existing research strategies
- d) creativity in exploring the limits of current knowledge and contributing to the development of theory, research and practice
- e) work supported throughout by appropriate evidence
- f) correct use of language, unambiguous expression and clear presentation

Pass (50%): To be judged as a pass in specific assignments or in the overall performance for a module, assessed work will demonstrate the following characteristics as determined by the relevant subject specialists and programme team. Care must be taken to ensure that this process does not invite subject specialists to ignore or devalue these generic criteria:

- a) a comprehensive understanding of existing areas of relevant knowledge and practice and an awareness of gaps and weaknesses of such knowledge
- b) a standard of objective critical analysis which demonstrates academic rigour using relevant concepts and knowledge
- c) a creative attempt to contribute to the ongoing development of theory, research and practice
- d) most substantive points are supported by appropriate evidence, with avoidance of unfounded generalisations
- e) an ability to structure and organise material in a broadly logical manner with a clear development of ideas
- f) clear evidence of thorough reading of core texts
- g) largely accurate and complete referencing using an appropriate citation system
- h) largely correct use of language, unambiguous expression and clear presentation

Fail: Assessed work which is judged to fail will demonstrate a significant number of the following characteristics, as determined by the subject specialists and programme team. Care must be taken to ensure that this process does not invite subject specialists to ignore or devalue these generic criteria:

- a) insufficient critical analysis of the topic
- b) limited critical review of existing areas of knowledge and/or practice
- c) disorganised structure with incorrect or inappropriate sequencing of content/ materials
- d) failure to develop a clear line of argument
- e) inadequate use of supportive evidence
- f) disproportionate reliance on unsupported generalisations
- g) evidence of insufficient appropriate reading and reflection
- h) inaccurate referencing
- i) poor use of an appropriate citation system
- j) inappropriate or poorly executed research methodologies
- k) unclear presentation

8.4 Second Assessment Opportunity (Referral)

The regulations for passing this module are expressed in section 8.1 above. All students referred in a component will have to do the same referral work. *Further information regarding assessment may be found in the University's Student Handbook.* The deadline date for the submission of referral work will be posted on the Faculty notice board when it is known.

The referral exam, component A (50%) will be in the same format as the exam in the first assessment period, with a similar balance and style of questions.

Re-assessment for the coursework, component B (50%): Resubmit an applied project according to the instructions given above.

8. Previous Exam papers

These are available from the library

9. Source material

Principal Texts

There are many textbooks, which can be used to follow the course. It is worth having a look at them and finding the one that best suits your individual requirements. Those who have done an undergraduate econometric course might consider following the topics in one of the more advanced texts.

NB Earlier editions of the books below are fine. So don't go and spend lots of money unnecessarily.

You should review basic Maths and Stats in the textbooks.

See: Thomas Ch 1 to 5, Salvatore Ch 1 to 5, Gujarati Ch 1 to 5 and Appendix A and Dougherty Ch 1 to 3. All texts are referenced below.

For those completely new to econometrics the following provide relatively straightforward expositions:

Stewart, J. (1984) 'Understanding Econometrics', Hutchinson.

This is a useful starting point with more words per equation than any other econometrics text.

Gujarati, D. N. (1999) 'Essential of Econometrics', McGraw Hill.

Another simple introduction.

Studenmund, A. H., "Using Econometrics", Pearson, 2006. An innovative approach, suitable for those completely new to econometrics and those with some experience.

R Carter Hill, William E Griffiths, George G Judge (2001) 'Undergraduate Econometrics', Second edition, John Wiley and Sons. Very good introduction and good discussion.

Salvatore (2001) 'Statistics and Econometrics', Schaum's Outlines, Second Edition, McGraw Hill. Provides lots of worked examples

Kennedy, P. (1998) 'A Guide to Econometrics', Blackwell.

Is still very useful. It lacks notation and technical detail but explains concepts well and is a useful accompaniment to a more formal text

For those with some knowledge of econometrics:

Gujarati, D. N. (2002) 'Basic Econometrics', McGraw Hill, Fourth edition.

A useful introductory text with a detailed discussion.

Dougherty (2002) 'Introduction to Econometrics', Oxford University Press, Second edition.

Useful introduction.

Maddala, G. S. (2001) 'Introduction to Econometrics', Third Edition, John Wiley.

This is more up to date than most texts only uses matrix algebra in appendices don't go straight to this book if you have not done econometrics before .

Software Manuals

Pesaran, M. H. and Pesaran, B. "MICROFIT 4.0, Windows version", 1997, Oxford University Press, ISBN 0-19-268531-7. This is the manual for the MICROFIT package that you will be using and contains useful examples and exercises. It is denoted as MICROFIT MANUAL (MM) hereafter.

More advanced texts

Davidson, R. and MacKinnon, J. G. (1993), 'Estimation and Inference in Econometrics', Oxford University Press.
Very comprehensive

Greene, W. H. (1997) 'Econometric Analysis', Macmillan.
Comprehensive

Hendry, D. F. (1995), 'Dynamic Econometrics', Oxford University Press.

Intriligator M, R Bodkin, C Hsaio (1996) "Econometric Models, Techniques and Applications", Prentice Hall.

Judge, G. G., Griffiths, W. E., Hill, R. C., Lutkepohl, H., and Lee, T. C. (1985) 'The Theory and Practice of Econometrics', Second Edition, Wiley.

Maddala, G. S. (1977) 'Econometrics', McGraw Hill.
A popular reference text for researchers

Maddala, G S and Kim (1999) "Unit Roots, Cointegration and Structural Change", Cambridge University Press.

Mills T (1999) "The Econometric Modelling of Financial Time Series", Cambridge University Press.

Patterson, K (2000) "An Introduction to Applied Econometrics", Palgrave.

If you already have a textbook that is not on this list and you are happy with it then carry on and use it to follow the course. All texts follow roughly the same material.

Table E-4 Cumulative student's *t* distribution*

$$F(t) = \int_{-\infty}^t \frac{\Gamma\left(\frac{n+1}{2}\right)}{\Gamma\left(\frac{n}{2}\right)\sqrt{nn}\left(1+\frac{x^2}{n}\right)^{\frac{(n+1)}{2}}} dx$$

<i>n</i>	.75	.90	.95	.975	.99	.995	.9995
1	1.000	3.078	6.314	12.706	31.821	63.657	636.619
2	.816	1.886	2.920	4.303	6.965	9.925	31.598
3	.765	1.638	2.353	3.182	4.541	5.841	12.941
4	.741	1.533	2.132	2.776	3.747	4.604	8.610
5	.727	1.476	2.015	2.571	3.365	4.032	6.859
6	.718	1.440	1.943	2.447	3.143	3.707	5.959
7	.711	1.415	1.895	2.365	2.998	3.499	5.405
8	.706	1.397	1.860	2.306	2.896	3.355	5.041
9	.703	1.383	1.833	2.262	2.821	3.250	4.781
10	.700	1.372	1.812	2.228	2.764	3.169	4.587
11	.697	1.363	1.796	2.201	2.718	3.106	4.437
12	.695	1.356	1.782	2.179	2.681	3.055	4.318
13	.694	1.350	1.771	2.160	2.650	3.012	4.221
14	.692	1.345	1.761	2.145	2.624	2.977	4.140
15	.691	1.341	1.753	2.131	2.602	2.947	4.073
16	.690	1.337	1.746	2.120	2.583	2.921	4.015
17	.689	1.333	1.740	2.110	2.567	2.898	3.965
18	.688	1.330	1.734	2.101	2.552	2.878	3.922
19	.688	1.328	1.729	2.093	2.539	2.861	3.883
20	.687	1.325	1.725	2.086	2.528	2.845	3.850
21	.686	1.323	1.721	2.080	2.518	2.831	3.819
22	.686	1.321	1.717	2.074	2.508	2.819	3.792
23	.685	1.319	1.714	2.069	2.500	2.807	3.767
24	.685	1.318	1.711	2.064	2.492	2.797	3.745
25	.684	1.316	1.708	2.060	2.485	2.787	3.725
26	.684	1.315	1.706	2.056	2.479	2.779	3.707
27	.684	1.314	1.703	2.052	2.473	2.771	3.690
28	.683	1.313	1.701	2.048	2.467	2.763	3.674
29	.683	1.311	1.699	2.045	2.462	2.756	3.659
30	.683	1.310	1.697	2.042	2.457	2.750	3.646
40	.681	1.303	1.684	2.021	2.423	2.704	3.551
60	.679	1.296	1.671	2.000	2.390	2.660	3.460
120	.677	1.289	1.658	1.980	2.358	2.617	3.373
∞	.674	1.282	1.645	1.960	2.326	2.576	3.291

* This table is abridged from the "Statistical Tables" of R. A. Fisher and Frank Yates published by Oliver & Boyd, Ltd., Edinburgh and London, 1938. It is here published with the kind permission of the authors and their publishers.

Table E-5¹ Durbin-Watson statistic (*d*). Significance points of *d_L* and *d_U*; 5%

<i>n</i>	<i>k</i> = 1		<i>k</i> = 2		<i>k</i> = 3		<i>k</i> = 4		<i>k</i> = 5	
	<i>d_L</i>	<i>d_U</i>	<i>d_L</i>	<i>d_U</i>	<i>d_L</i>	<i>d_U</i>	<i>d_L</i>	<i>d_U</i>	<i>d_L</i>	<i>d_U</i>
15	1.08	1.36	0.95	1.54	0.82	1.75	0.69	1.97	0.56	2.21
16	1.10	1.37	0.98	1.54	0.86	1.73	0.74	1.93	0.62	2.15
17	1.13	1.38	1.02	1.54	0.90	1.71	0.78	1.90	0.67	2.10
18	1.16	1.39	1.05	1.53	0.93	1.69	0.82	1.87	0.71	2.06
19	1.18	1.40	1.08	1.53	0.97	1.68	0.86	1.85	0.75	2.02
20	1.20	1.41	1.10	1.54	1.00	1.68	0.90	1.83	0.79	1.99
21	1.22	1.42	1.13	1.54	1.03	1.67	0.93	1.81	0.83	1.96
22	1.24	1.43	1.15	1.54	1.05	1.66	0.96	1.80	0.86	1.94
23	1.26	1.44	1.17	1.54	1.08	1.66	0.99	1.79	0.90	1.92
24	1.27	1.45	1.19	1.55	1.10	1.66	1.01	1.78	0.93	1.90
25	1.29	1.45	1.21	1.55	1.12	1.66	1.04	1.77	0.95	1.89
26	1.30	1.46	1.22	1.55	1.14	1.65	1.06	1.76	0.98	1.88
27	1.32	1.47	1.24	1.56	1.16	1.65	1.08	1.76	1.01	1.86
28	1.33	1.48	1.26	1.56	1.18	1.65	1.10	1.75	1.03	1.85
29	1.34	1.48	1.27	1.56	1.20	1.65	1.12	1.74	1.05	1.84
30	1.35	1.49	1.28	1.57	1.21	1.65	1.14	1.74	1.07	1.83
31	1.36	1.50	1.30	1.57	1.23	1.65	1.16	1.74	1.09	1.83
32	1.37	1.50	1.31	1.57	1.24	1.65	1.18	1.73	1.11	1.82
33	1.38	1.51	1.32	1.58	1.26	1.65	1.19	1.73	1.13	1.81
34	1.39	1.51	1.33	1.58	1.27	1.65	1.21	1.73	1.15	1.81
35	1.40	1.52	1.34	1.58	1.28	1.65	1.22	1.73	1.16	1.80
36	1.41	1.52	1.35	1.59	1.29	1.65	1.24	1.73	1.18	1.80
37	1.42	1.53	1.36	1.59	1.31	1.66	1.25	1.72	1.19	1.80
38	1.43	1.54	1.37	1.59	1.32	1.66	1.26	1.72	1.21	1.79
39	1.43	1.54	1.38	1.60	1.33	1.66	1.27	1.72	1.22	1.79
40	1.44	1.54	1.39	1.60	1.34	1.66	1.29	1.72	1.23	1.79
45	1.48	1.57	1.43	1.62	1.38	1.67	1.34	1.72	1.29	1.78
50	1.50	1.59	1.46	1.63	1.42	1.67	1.38	1.72	1.34	1.77
55	1.53	1.60	1.49	1.64	1.45	1.68	1.41	1.72	1.38	1.77
60	1.55	1.62	1.51	1.65	1.48	1.69	1.44	1.73	1.41	1.77
65	1.57	1.63	1.54	1.66	1.50	1.70	1.47	1.73	1.44	1.77
70	1.58	1.64	1.55	1.67	1.52	1.70	1.49	1.74	1.46	1.77
75	1.60	1.65	1.57	1.68	1.54	1.71	1.51	1.74	1.49	1.77
80	1.61	1.66	1.59	1.69	1.56	1.72	1.53	1.74	1.51	1.77
85	1.62	1.67	1.60	1.70	1.57	1.72	1.55	1.75	1.52	1.77
90	1.63	1.68	1.61	1.70	1.59	1.73	1.57	1.75	1.54	1.78
95	1.64	1.69	1.62	1.71	1.60	1.73	1.58	1.75	1.56	1.78
100	1.65	1.69	1.63	1.72	1.61	1.74	1.59	1.76	1.57	1.78

n = number of observations.
k = number of explanatory variables.

¹ This Table is reproduced from *Biometrika*, vol. 41, p. 173, 1951, with the permission of the Trustees.

Table E-3 Cumulative chi-square distribution*

$$F(u) = \int_0^u \frac{x^{(n-2)/2} e^{-x/2} dx}{2^{n/2} \Gamma(n/2)}$$

$n \backslash F$.005	.010	.025	.050	.100	.250	.500	.750	.900	.950	.975	.990	.995
1	.00393	.0157	.0382	.0793	.158	.302	.455	1.32	2.71	3.84	5.02	6.63	7.88
2	.0100	.0201	.0506	.103	.211	.375	1.39	2.77	4.61	5.99	7.38	9.21	10.6
3	.0717	.115	.216	.352	.584	1.21	2.37	4.11	6.25	7.81	9.35	11.3	12.8
4	.207	.297	.484	.711	1.06	1.92	3.36	5.39	7.78	9.49	11.1	13.3	14.9
5	.412	.554	.831	1.15	1.61	2.67	4.35	6.63	9.24	11.1	12.8	15.1	16.7
6	.676	.872	1.24	1.64	2.20	3.45	5.35	7.84	10.6	12.6	14.4	16.8	18.5
7	.989	1.24	1.69	2.17	2.83	4.25	6.35	9.04	12.0	14.1	16.0	18.5	20.3
8	1.34	1.65	2.18	2.73	3.49	5.07	7.34	10.2	13.4	15.5	17.5	20.1	22.0
9	1.73	2.09	2.70	3.33	4.17	5.90	8.34	11.4	14.7	16.9	19.0	21.7	23.6
10	2.16	2.56	3.25	3.94	4.87	6.74	9.34	12.5	16.0	18.3	20.5	23.2	25.2
11	2.60	3.05	3.82	4.57	5.58	7.58	10.3	13.7	17.3	19.7	21.9	24.7	26.8
12	3.07	3.57	4.40	5.23	6.30	8.44	11.3	14.8	18.5	21.0	23.3	26.2	28.3
13	3.57	4.11	5.01	5.89	7.04	9.30	12.3	16.0	19.8	22.4	24.7	27.7	29.8
14	4.07	4.66	5.63	6.57	7.79	10.2	13.3	17.1	21.1	23.7	26.1	29.1	31.3
15	4.60	5.23	6.26	7.26	8.55	11.0	14.3	18.2	22.3	25.0	27.5	30.6	32.8
16	5.14	5.81	6.91	7.96	9.31	11.9	15.3	19.4	23.5	26.3	28.8	32.0	34.3
17	5.70	6.41	7.56	8.67	10.1	12.8	16.3	20.5	24.8	27.6	30.2	33.4	35.7
18	6.26	7.01	8.23	9.39	10.9	13.7	17.3	21.6	26.0	28.9	31.5	34.8	37.2
19	6.84	7.63	8.91	10.1	11.7	14.6	18.3	22.7	27.2	30.1	32.9	36.2	38.6
20	7.43	8.26	9.59	10.9	12.4	15.5	19.3	23.8	28.4	31.4	34.2	37.6	40.0
21	8.03	8.90	10.3	11.6	13.2	16.3	20.3	24.9	29.6	32.7	35.5	38.9	41.4
22	8.64	9.54	11.0	12.3	14.0	17.2	21.3	26.0	30.8	33.9	36.8	40.3	42.8
23	9.26	10.2	11.7	13.1	14.8	18.1	22.3	27.1	32.0	35.2	38.1	41.6	44.2
24	9.89	10.9	12.4	13.8	15.7	19.0	23.3	28.2	33.2	36.4	39.4	43.0	45.6
25	10.5	11.5	13.1	14.6	16.5	19.9	24.3	29.3	34.4	37.7	40.6	44.3	46.9
26	11.2	12.2	13.8	15.4	17.3	20.8	25.3	30.4	35.6	38.9	41.9	45.6	48.3
27	11.8	12.9	14.6	16.2	18.1	21.7	26.3	31.5	36.7	40.1	43.2	47.0	49.6
28	12.5	13.6	15.3	16.9	18.9	22.7	27.3	32.6	37.9	41.3	44.5	48.3	51.0
29	13.1	14.3	16.0	17.7	19.8	23.6	28.3	33.7	39.1	42.6	45.7	49.6	52.3
30	13.8	15.0	16.8	18.5	20.6	24.5	29.3	34.8	40.3	43.8	47.0	50.9	53.7

* This table is abridged from "Tables of percentage points of the incomplete beta function and of the chi-square distribution," *Biometrika*, Vol. 32 (1941). It is here published with the kind permission of its author, Catherine M. Thompson, and the editor of *Biometrika*.

Table 14.1 Critical Values for Unit Root Tests

Sample Size	K-Test		t-Test		F-Test ^a	
	1%	5%	1%	5%	1%	5%
AR (1)						
25	-11.9	-7.3	-2.66	-1.95		
50	-12.9	-7.7	-2.62	-1.95		
100	-13.3	-7.9	-2.60	-1.95		
250	-13.6	-8.0	-2.58	-1.95		
500	-13.7	-8.0	-2.58	-1.95		
∞	-13.8	-8.1	-2.58	-1.95		
AR (1) with constant						
25	-17.2	-12.5	-3.75	-3.00		
50	-18.9	-13.3	-3.58	-2.93		
100	-19.8	-13.7	-3.51	-2.89		
250	-20.3	-14.0	-3.46	-2.88		
500	-20.5	-14.0	-3.44	-2.87		
∞	-20.7	-14.1	-3.43	-2.86		
AR (1) with constant and trend						
25	-22.5	-17.9	-4.38	-3.60	7.24	10.61
50	-25.7	-19.8	-4.15	-3.50	6.73	9.31
100	-27.4	-20.7	-4.04	-3.45	6.49	8.73
250	-28.4	-21.3	-3.99	-3.43	6.34	8.43
500	-28.9	-21.5	-3.98	-3.42	6.30	8.34
∞	-29.5	-21.8	-3.96	-3.41	6.25	8.27

^a $K = T(\hat{\rho} - 1)$, $t = (\hat{\rho} - 1)/SE(\hat{\rho})$ and F -test is for $\gamma = 0$ and $\rho = 1$ in $y_t = \alpha + \gamma t + \rho y_{t-1} + u_t$.

Source: W. A. Fuller, *Introduction to Statistical Time Series* (New York: Wiley, 1976), p. 371 for the K -test and p. 373 for the t -test; D. A. Dickey and W. A. Fuller, "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root," *Econometrica*, Vol. 49, No. 4, 1981, p. 1063 for the F -test.

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Table 14.2 Critical Values (5%) for the Cointegration Tests

n	T	CRDW	DF	ADF ^a
2	50	0.78	-3.67	-3.29
	100	0.39	-3.37	-3.17
	200	0.20	-3.37	-3.25
3	50	0.99	-4.11	-3.75
	100	0.55	-3.93	-3.62
	200	0.39	-3.78	-3.78
4	50	1.10	-4.35	-3.98
	100	0.65	-4.22	-4.02
	200	0.48	-4.18	-4.13
5	50	1.28	-4.76	-4.15
	100	0.76	-4.58	-4.36
	200	0.57	-4.48	-4.43

^a $CRDW = \sum (\hat{u}_t - \hat{u}_{t-1})^2 / \sum \hat{u}_t^2$, CRDW means "cointegrating regression Durbin-Watson" statistic; DF = t -test for $\alpha = 0$ in $\Delta \hat{u}_t = \alpha \hat{u}_{t-1} + \eta_t$; ADF = t -test for $\alpha = 0$ in $\Delta \hat{u}_t = \alpha \hat{u}_{t-1} + \sum \phi_i \Delta \hat{u}_{t-i} + \eta_t$. In all these tests

\hat{u}_t is the residual from the cointegrating regression.

Source: R. F. Engle and S. Yoo, "Forecasting and Testing in Cointegrated Systems," *Journal of Econometrics*, Vol. 35, 1987.

Table E-7 *F* distribution, upper 5% points ($F_{0.95}$).¹

		Degrees of freedom for numerator																			
		1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞	
Degrees of freedom for denominator	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	19.4	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	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	5.63
	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	1.00	

Interpolation should be performed using reciprocals of the degrees of freedom.

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