RMIT University
Faculty of Business
School of Marketing

COURSE:	**Graduate Diploma in Property**
SYLLABUS NUMBER:	**PR670**
SUBJECT NAME:	Economic Studies For Real Estate
DURATION:	Second Semester
CLASS CONTACT HOURS:	Part time - 1 x 2 Hr class Tuesday 5.30 – 7.30 pm
SUBJECT CO-ORDINATOR:	John Flaherty Telephone: 9660 5546 E-mail: john.flaherty@rmit.edu.au

WWW ADDRESS: **http://www.bf.rmit.edu.au/Property/subjects/pr670/pr670.htm**

Use of the Internet

All students are encouraged to become familiar with using the Internet and recognise the long term benefits of mastering this skill.

Email will be used as much as possible to communicate outside class. If you do not have an email account it is suggested that you use one of the free email facilities such as **hotmail**.

Your lecturer will assist you to set up an email account if required.

The username and password to access the subject homepage is:

Downloading Excel files: it is recommended that you use **Internet Explorer**

PRESCRIBED TEXT

Waxman, Peter, ***Business Mathematics and Statistics***, Fourth Edition, Prentice Hall, 1998.

REFERENCES

Berk, K.N., & Carey, P., 1998, ***Data Analysis with Microsoft Excel***, Duxbury Press. Chapters 2 and 3.

Flaherty, J., Lombardo, R., Morgan, & deSilva B., Wilson, D., 1999, ***A Spreadsheet Approach to Business Quantitative Methods***. **Contains a chapter on Excel.**

Hanke, J.E. and Reitsch, A.G., 1994, ***Understanding Business Statistics***, 2nd edition, Richard D. Irwin.

Lee, C.F., 1993, ***Statistics For Business and Financial Economics***, D.C. Heath and Company Lexington, Massachusetts.

Lehman, M. & Zeitz, P., 1998, ***Statistical Explorations with Microsoft Excel***, Duxbury Press.

Levine, D.M., Berenson, M.L. & Stephan, D., 1997, ***Statistics for Managers Using Microsoft Excel***, Prentice -Hall, Inc. **Contains a chapter on Excel.**

Lusht, K.M, 1997, ***Real Estate Valuation, Principles and Applications***, Richard D. Irwin.

Middleton, M.R., 1997, ***Data Analysis Using Microsoft Excel***, Duxbury Press.

Neufeld, John. L., ***Learning Business Statistics with Microsoft Excel***, Prentice Hall, 1997

O'Brien, D.T., ***Mathematics for Business and Economics***, Harcourt Brace Jovanovich, 1989

Recommended Access to a spreadsheet such as Microsoft Excel is essential.

A non-programmable calculator with financial and statistical capabilities (suggested HP-10B) will be useful for simple calculations but spreadsheets will be used for most of the material covered.

ASSESSMENT

One Assignment	30%
End of year examination	70%

Assumed knowledge: A familiarity with Microsoft Windows and a working knowledge of Microsoft Excel.

Aim of the subject

To familiarise students with basic mathematical concepts and provide a formal introduction to the analysis of business data. Students will be introduced to the use of equations and graphical analysis to interpret the salient features of quantitative information. The understanding and use of descriptive and inferential statistics is a key feature of this subject.

Objectives

By the completion of the course students should be able to

- structure information in the form of algebraic relationships
- solve linear simultaneous equations
- develop and employ commonly used equations for financial mathematics
- calculate and interpret summary statistical measures
- understand the fundamental laws of probability
- recognise and use common probability distributions
- use simple linear regression as an analytical tool

- understand and apply the concept of hypothesis testing
- use simple time series forecasting models
- use Excel to organise, analyse and present data.

Computer Access

Students are required to obtain a **USER NAME** and **Password** to access the Business Faculty Student server within the first three weeks of semester. This is available from the Help Desk, Level 4 of Building 108.

When you obtain your USER NAME and Password, check that your login works on at least three separate occasions. Your login details must be **EXACT**, ensure that you take it down correctly and store it in a secure place. At various times during the semester lab sessions will be held, these are subject to the availability of computer labs.

Topics and reading guide for second semester

	Readings
1. Review of Algebra	**Readings**
• Powers, Roots & Reciprocals	Waxman, Chapter 1
• Polynomials	Chapter 8 and pp. 795 - 799
Practice exercises: Waxman pp.20-21	**Q's 9 - 18**
2. Linear and Non-Linear Relationships	
• Equations	Waxman, Chapter 7
• Slope and the equation of a line	Flaherty, pp. 21 - 20.
• Line graphs	Levine Chapter 1
• Solving simultaneous equations	O'Brien, Chapter 5
• Break-even analysis	
• Exponential and logarithmic functions	
Practice exercises: Waxman pp. 192-193	**Q's 3 - 10, 14 - 16, 18 - 20.**
3. Financial Mathematics	
• Simple and Compound Interest	Waxman, Chapters 3, 4 & 5
• Annuities	Flaherty, pp. 21 - 28
	O'Brien, Chapters 3 & 4
Practice exercises: Waxman pp. 99-101	**Q's 1 - 5, 12, 19**
Waxman pp. 114-116	**Q's 1 - 4, 12 - 15 & 20.**
Waxman pp. 139-139	**Q's 1, 5, 8, 12, 14, 19 & 20**
4. Foundations of Statistics	
• **Statistical Analysis Using Excel**	Neufeld, Chapter 1
	Levine Chapter 2
	Pelosi, Chapters 2 & 3
• **Introduction to Statistics**	Waxman, Chapter 8
	Flaherty, Section 4.1
Practice exercises: Waxman p. 224-225	**Q's 1 - 8.**
• **Data Collection**	Waxman, Chapter 8
Practice exercises: Waxman pp. 224-225	**Q's 9 - 15 & 20.**

- **Data Presentation**

Waxman, Chapter 9
Levine Chapter 3, Sections 3.1 to 3.3
Pelosi, Chapters 4 & 5
Flaherty, Section 4.2

Practice exercises: Waxman pp. 272-277 | Q's 1, 7- 11, 15, 18

- **Measures of Central Tendency**

Waxman, Chapter 17
Levine Chapter 3, Section 3.4
Flaherty, Section 4.3

Practice exercises: Waxman pp. 393-6 | Q's 1-4, 6 - 12

- **Measures of Dispersion**

Waxman, Chapters 10 & 11
Levine Chapter 3, Section 3.4
Pelosi, Chapter 6
Flaherty, Sections 4.4 & 4.5

Practice exercises: Waxman pp. 310-318 | Q's 1 - 4, 10, 15, 17 & 20
Waxman pp. 358-367 | Q's 1, 2, 5, 6, 11, 14 & 19

- **Skewness & Kurtosis**

Flaherty, Section 4.6
Waxman, Appendix 11A

Practice exercises: Flaherty pp. 149-150 | Q's 8 & 10 (attached)

5. Probability

- Probability Laws
- Conditional Probability
- Discrete Random Variables
- Probability Distributions
- Applications of the Normal Distribution

Waxman, Chapters 13 & 14
Flaherty Ch. 5 Sections 5.3 & 5.4
Neufeld, Chapters 3 & 5
Levine Chapter 4

Practice exercises: Waxman pp. 424-428 | Q's 1, 3, 7, 11, 14, 15 & 20
Waxman pp. 457-460 | Q's 1, 2, 5, 12, 13, 18 & 21
Flaherty pp. 196-197 | Q's 17, 18, 19 & 20. (attached)

6. Regression Analysis

- Correlation
- The Regression Equation
- Evaluating the Equation
- Hypothesis testing

Waxman, Chapter 15
Flaherty Chapter 10
Levine Chapters 11 & 12
Pelosi, Chapter 14

Practice exercises: Waxman pp. 504-511 | Q's 1 - 12, 19 & 21.
Flaherty pp. 381-385 | Q's 6 - 11. (attached)

7. Time Series Analysis

- The need for Forecasting
- Time Series Decomposition
- Moving Averages & Exponential Smoothing
- Error Statistics
- Confidence Intervals

Waxman, Chapter 17
Flaherty Chapter 13, Sections 13.1 to 13.5
Neufeld, Chapter 14
Pelosi, Chapter 14
Levine Chapter 13

Practice exercises: Waxman pp. 614-618 | Q's 1 - 7, 19, 21 & 22.
Flaherty p. 476-467 | Q's 5 - 10. (attached)

Flaherty et al. — Chapter 4 Introduction to Statistics

Skewness & Kurtosis

8. Property managers of a property portfolio comprising 49 buildings, have collected the data, given below, on maintenance expenditure over the past year.

   (i) Arrange the data in the above table as an ascending data array (using Excel).

   (ii) Using ungrouped formulae, calculate and interpret the following measures of central tendency and location:
   - arithmetic mean, median and mode
   - 1st and 3rd quartile
   - 10th and 90th percentile

   (iii) Using ungrouped formulae calculate and interpret the following measures of dispersion:
   - the range
   - the inter quartile range
   - the quartile deviation
   - the mean absolute deviation
   - the variance and standard deviation
   - the coefficient of variation

   (iv) Using ungrouped formulae calculate and interpret the following measures of skew:
   - Pearson's 1st and 2nd coefficient of skew.
   - the quartile measure of skew
   - the moment coefficient of skew
   - Excel's measure of skewness

   (v) Using ungrouped formulae calculate and interpret the coefficient of kurtosis.

Maintenance Expenditure (measured in $'000s)						
2.71	3.41	4.14	3.70	2.17	4.79	2.09
2.46	1.16	3.55	2.85	4.57	0.51	4.85
0.37	2.85	6.20	1.24	3.58	2.27	3.27
5.05	0.64	3.62	2.62	6.61	3.83	5.72
1.00	4.01	4.26	4.31	0.96	7.34	1.58
5.17	1.57	3.07	1.93	4.60	5.40	2.32
2.40	3.99	5.58	4.45	3.30	1.64	3.95

10. In 1993, the owner of a very large car park in Manhattan, New York obtained the following information regarding the distribution of weekly revenue over 50 operating weeks:

Mean	$44800
Median	$46360
Mode	$52500
Standard Deviation	$15430
Pearson's Coefficient of Skew	-0.499

At the beginning of 1994 the parking tariff was increased. The distribution of weekly revenue for 1994 is reproduced below:

Weekly Dollar Revenue for 1994 (expressed in constant dollars of the previous year)	Number of Weeks
10000 - < 20000	2
20000 - < 30000	5
30000 - < 40000	14
40000 - < 50000	11
50000 - < 60000	9
60000 - < 70000	6
70000 - < 80000	2
80000 - < 90000	1

(i) For the above distribution of weekly dollar revenue, use grouped formulae to calculate the mean, median, mode and standard deviation. Also compute Pearson's 1st coefficient of skew based on values extracted from grouped formulae for the mean, mode and standard deviation.

(ii) Write a non-technical report to the manager summarising the major revenue impacts of the increased parking tariffs.

Flaherty et al. — Chapter 5 Probability

17. Use the data given below to obtain the measures requested.

(i) Calculate the mean, variance and standard deviation for building area and number of rooms for each suburb.

(ii) Point out any differences between the suburbs revealed by your calculations.

(iii) Calculate and interpret the meaning of the covariance and correlation for:

$COV(BA_F, BA_{NC})$, $COV(NR_F, NR_{NC})$, $CORR(BA_F,BA_{NC})$ and $CORR(NR_F,NR_{NC})$

Flemington		North Carlton	
Building Area BA_F	No. of Rooms NR_F	Building Area BA_{NC}	No. of Rooms NR_{NC}
92.90	4	67.82	4
102.19	6	74.32	5
92.90	5	102.19	5
130.06	6	92.90	5
88.26	5	123.55	5
102.19	4	148.64	6
83.64	4	92.90	5
92.90	5	148.65	6
92.90	4	120.77	6
111.48	6	83.61	4
74.35	4	111.48	6
92.90	4	92.90	4
148.64	5	148.64	7
111.48	4	92.90	5
74.35	4	139.35	5
83.61	5	65.03	4
92.90	5	89.19	5

18. Simulate the toss of a die 500 times using the RAND() function. Obtain the relative frequencies and chart them. Use a lookup table to obtain the values on the die face. What conclusions may be drawn from this analysis?

19. An investor wishes to invest in three listed securities. Research based on historical returns for these securities indicates that returns are normally distributed with means and standard deviations of:

	Mean return	Standard Deviation
Security 1	11%	6.5%
Security 2	9.6%	4.2%
Security 3	5.5%	1.5%

Use Excel's Random Number Generator to generate 200 returns for each security. If the three securities are combined, so that each represents one-third of the total investment, to form a portfolio, what is the portfolio expected return and risk?

20. As an investment analyst you are required to advise a client in constructing a portfolio. The portfolio consists of three assets; commercial property, industrial stocks, and corporate bonds. The return on each asset is **independent** of every other asset and depends on the state of the economy. The following table gives the required information on returns for each asset depending on the different states of the economy.

Real Estate		**Stocks**		**Bonds**	
X	p(x)	Y	p(y)	Z	p(z)
160	0.4	180	0.5	220	0.2
110	0.3	140	0.3	130	0.5
80	0.3	90	0.2	60	0.3

(i) Determine the expected return and risk (variance) for each asset.

(ii) Given that 60% of the investor's funds are placed in real estate and the remaining 40% placed in stocks what is the expected return and risk for the portfolio ?

(iii) Using your results illustrate the benefits of diversification.

(iv) Assume now that the proportion of funds invested in each asset is: 50% in real estate and 25% in each of stocks and corporate bonds, what is the expected return and risk for the portfolio ?

(v) Are the benefits of diversification greater with the addition of the third asset to the portfolio ?

Flaherty et al — Regression Analysis

6. Consider the problem of predicting profit Y (in thousands of dollars) for supermarkets in a large metropolitan area. As independent variables we use the total sales (in tens of thousands of dollars) X_1 of foods and X_2 of non-foods. One reason for splitting sales into food and non-food categories is that stores will differ significantly from each other in their offerings of non-food items. The variable X_3 for store size, is included to improve profit prediction.

S'market Number	Food Sales \$10,000 X_1	Non-food Sales \$10,000 X_2	Store Size sq. ft. 1000 X_3	Profit \$1,000 Y
1	305	35	35	20
2	130	98	22	15
3	189	83	27	17
4	175	76	16	9
5	101	93	28	16
6	269	77	46	27
7	421	44	26	35
8	195	57	12	7
9	282	31	40	22
10	203	92	32	23

(i) Estimate the models: $\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3$

$\hat{Y} = b_0 + b_1X_1 + b_2X_2$ $\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_1X_2$

$\hat{Y} = b_0X_1^{b_1}X_2^{b_2}X_3^{b_3}$ and $\hat{Y} = b_0X_1^{b_1}X_2^{b_2}$

(ii) For each equation calculate S_e, R^2, Adj. R^2, F and t-ratios and test the hypothesis that the regression coefficients are not significant at the 1% level.

(iii) What do you conclude about the addition of the interaction term, X_1X_2, and X_3 to the equation and the functional form of the equation?

(iv) How should the choice of functional form be made? What is the preferred choice of model using the model selection criteria in Table 10.2?

7. Use the Residential Units data set to carry out the analysis (available at text Web site)

(i) Estimate the regression model that best fits the data.

(ii) Discuss the features of the data from a theoretical and statistical perspective. Use the model selection criteria available in the text, Table 11.4, to assist in the process of model selection.

8. RENT BREAKDOWN: We are attempting to set rentals in a project consisting of small warehouse and unserviced office units. Rentals for a very similar development, and the respective office and warehouse areas, measured in square feet, are provided below.

(i) Fit the models:

$Y = f(X_1, X_2)$, $Y = f(X_1, X_2, X_3)$, $Y = f(X_1, X_2, X_1X_2)$,

$Y = f(X_1, X_2, X_1^2, X_2^2)$, $Y = f(X_1, X_2, X_1^2, X_2^2, X_1X_2)$

Which model is preferred, use the model selection criteria in Table 11.4.

(ii) Repeat the estimation for the models in part (i) using ln(Y) as the dependent variable. Does transforming Y represent an improvement in capturing the underlying relationship between the variables?

Unit Number	Office Area X_1	Warehouse Area X_2	Office & W'house X_3	Annual Rent Y	Log of rent ln(Y)
1	1815	2310	4125	1200	7.0901
2	360	2235	2595	5900	8.6827
3	420	2700	3120	7200	8.8818
4	350	2050	2400	5700	8.6482
5	350	1850	2200	5400	8.5942
6	1097	1103	2200	6750	8.8173
7	280	1320	1600	3600	8.1887
8	280	1320	1600	3750	8.2295
9	280	1160	1440	3400	8.1315
10	880	560	1440	4560	8.4251
11	350	1250	1600	3900	8.2687
12	450	150	600	4120	8.3236
13	274	4318	4592	5450	8.6034
14	250	1190	1440	3360	8.1197
15	302	1426	1728	4200	8.3428
16	676	1340	2016	5420	8.5979
17	690	750	1440	4250	8.3547
18	264	1896	2160	4800	8.4764
19	274	2606	2880	6450	8.7718
20	260	1180	1440	3450	8.1461

Source: Gene Dilmore, 1981, ***Quantitative Techniques in Real-Estate Counselling***, Lexington Books, D.C. heath and Company.

9. LAND VALUATION USING CENSUS DATA: The following regression uses as independent variables (1) population; (2) retail sales, city; (3) apparel sales, metro; (4) women's, girls' clothing sales, metro; and (5) bank deposits, county. The dependent variable is the estimated 100% downtown land value for the city. The purpose was to provide a method for a rough estimate of 100% land values for economic analyses, based solely on available census data. The raw data are given below.

(i) Estimate: $\hat{Y} = b_0 + b_1X_1$, $\hat{Y} = b_0 + b_1X_1 + b_2X_2$

$\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3$

$\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4$

$\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$

(ii) If your objective was estimating land value only, how many variables would you use?

(iii) If you were concerned mainly with the contributory factors for land value, and wanted to retain variables significant at the 95% level, which regression would you use?

(iv) Considering S_e, R^2, Adj.R^2, F and the t-ratios for each equation what conclusions may be drawn? Are these models really informative?

City	X_1 1,000	X_2 \$1,000,000	X_3 \$1,000,000	X_4 \$1,000,000	X_5 \$1,000,000	Y
1	30.1	153.685	11.716	10.002	137.6	6.0
2	299.2	1266.227	142.161	128.661	1154.6	45.0
3	36.7	132.108	18.403	13.067	86.1	6.0
4	54.7	187.107	13.640	12.660	114.3	6.4
5	147.2	472.996	38.586	43.309	172.2	15.0
6	140.1	526.567	47.924	47.099	347.1	27.5
7	69.5	211.349	19.893	12.893	111.1	16.0
8	147.6	680.510	42.166	64.002	545.1	22.5
9	129.0	447.311	36.161	40.482	216.1	16.0
10	117.1	404.361	39.237	35.518	315.8	25.0
11	23.1	197.960	12.202	15.541	193.6	12.0
12	454.7	1349.097	94.661	128.505	1348.2	75.0
13	490.9	2219.170	232.341	396.496	2536.7	150.0
14	356.5	1478.200	287.285	324.921	2825.2	100.0
15	64.6	253.014	25.696	32.332	179.9	7.5
16	303.9	1498.284	165.335	227.127	878.2	45.0
17	587.2	1551.132	187.546	201.401	1775.6	150.0
18	44.9	356.576	28.207	23.421	332.0	8.0
19	55.6	387.796	33.359	40.191	268.7	12.0
20	121.7	440.033	41.389	51.179	338.6	15.0
21	43.3	206.141	17.836	12.262	181.5	10.0
22	174.8	689.917	37.758	64.485	726.8	30.0
23	193.7	588.481	55.155	56.824	518.4	35.0

Source: Gene Dilmore, 1981, ***Quantitative Techniques in Real-Estate Counselling***, Lexington Books, D.C. heath and Company.

10. The owner of an apartment building in Minneapolis believed that her 1990 property tax bill was too high due to an over assessment of the property's value by the city tax assessor. The owner hired an independent real estate appraiser to investigate the appropriateness of the city's assessment. The appraiser used regression analysis to explore the relationship between the sale prices of apartments sold in Minneapolis during 1990 and various characteristics of the properties. Twenty-five apartment buildings were randomly sampled from all apartment buildings that were sold during 1990. The table below lists the data collected by the appraiser. The real estate appraiser hypothesised that the sale price (i.e., market value) of an apartment building is related to the other variables in the table according to the following model:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

(i) Fit the real estate appraiser's model to the data in the table. Report the least squares prediction equation.

(ii) Find the standard deviation of the regression model and interpret its value in the context of this problem.

(iii) Do the data provide sufficient evidence to conclude that value increases with the number of units in an apartment building? Report the observed significance level, and reach a conclusion using $\alpha = .05$.

(iv) Interpret the value of β_1 in terms of these data. Remember that your interpretation must recognise the presence, of the other variables in the model.

(v) Construct a scatter gram of sale price versus age. What does your scatter gram suggest about the relationship between these variables?

(vi) Test $H_0: \beta_2 = 0$ against $H_1: \beta_2 < 0$ using $\alpha = .01$. Interpret the result in the context of the problem. Does the result agree with your observation in part (v) ? Why is it reasonable to conduct a one-tailed rather than a two-tailed test of this null hypothesis?

(vii) What is the observed significance level of the hypothesis test of part (vi) ?

Code No	Sale Price Y ($)	No. of Apartment Units X_1	Age of Structure X_2 (Years)	Lot Size X_3 (sq. ft.)	No. on-site Parking Spaces X_4	Gross Building Area X_5	Condition of Apartment Building
0229	90,300	4	82	4,635	0	4,266	F
0094	384,000	20	13	17,798	0	14,391	G
0043	157,500	5	66	5,913	0	6,615	G
0079	676,200	26	64	7,750	6	34,144	E
0134	165,000	5	55	5,150	0	6,120	G
0179	300,000	10	65	12,506	0	14,552	G
0087	108,750	4	82	7,160	0	3,040	G
0120	276,538	11	23	5,120	0	7,881	G
0246	420,000	20	18	11,745	20	12,600	G
0025	950,000	62	71	21,000	3	39,448	G
0015	560,000	26	74	11,221	0	30,000	G
0131	268,000	13	56	7,818	13	8,088	F
0172	290,000	9	76	4,900	0	11,315	E
0095	173,200	6	21	5,424	6	4,461	G
0121	323,650	11	24	11,834	8	9,000	G
0077	162,500	5	19	5,246	5	3,828	G
0060	353,500	20	62	1 1,223	2	13,680	F
0174	134,400	4	70	5,834	0	4,680	E
0084	187,000	8	19	9,075	0	7,392	G
0031	155,700	4	57	5,280	0	6,030	E
0019	93,600	4	82	6,864	0	3,840	F
0074	110,000	4	50	4,510	0	3,092	G
0057	573,200	14	10	11,192	0	23,704	E
0104	79,300	4	82	7,425	0	3,876	F
0024	272,000	5	82	7,500	0	9,542	E

Source: J.T. McClave and P.G. Benson, 1991, ***Statistics for Business and Economics***, Fifth edition, MacMillan Publishing Company, page 636.

11. Using the data from question 10:

(i) Fit a first-order model to the data. (You may already have done this for question 10.)

(ii) Do the data provide sufficient evidence to conclude that the model of part (i) is useful for predicting sale price ? Test using a = .05.

(iii) Drop X_3 and X_4 from the model of part (i) and refit the model to the data.

(iv) Do the data provide sufficient evidence to conclude that the model of part (iii) is useful for predicting sale price ? Test using $\alpha = .05$.

Flaherty et al — Forecasting

5. For the following industries/markets which variables are the most important to monitor and forecast?
   - Construction
   - Merchant Banking
   - Motor Vehicles
   - Prime Movers
   - Residential real estate sales
   - Home mortgage rates
   - Timber
   - International Container Trade

6. What advantages does time series forecasting have in comparison to other forecasting methods? What cautions are necessary in using time series forecasting?

7. What are the advantages in using the following techniques for forecasting:
   - a simple moving average ?
   - a triple moving average ?
   - a linear trend ?
   - a non-linear trend ?

8. Are exponential smoothing models better than decomposition methods for forecasting? Discuss the merits of each.

9. Complete the following table for container demand (TEU - twenty feet equivalent units).

YEAR	CONTAINER DEMAND	5-YEAR MOVING AVERAGE	3-YEAR MOVING AVERAGE	EXPONENTIAL SMOOTHING (α = 0.9)	EXPONENTIAL SMOOTHING (α = 0.3)
1985	800				
1986	925				
1987	900				
1988	1025				
1989	1150				
1990	1160				
1991	1200				
1992	1150				
1993	1270				
1994	1290				
1995	-				

(i) Calculate Sum of Squared Errors (SSE) for each column.

(ii) Calculate Mean Squared Error (MSE).

(iii) Which forecast would you use for 1996? Why?

(iv) Fit a least squares trend line to the data. Let t = 1 for 1985, t = 2 for 1986, etc.

10. Assume that monthly sales, Y_t, for a particular region may be forecast with the aid of the model:

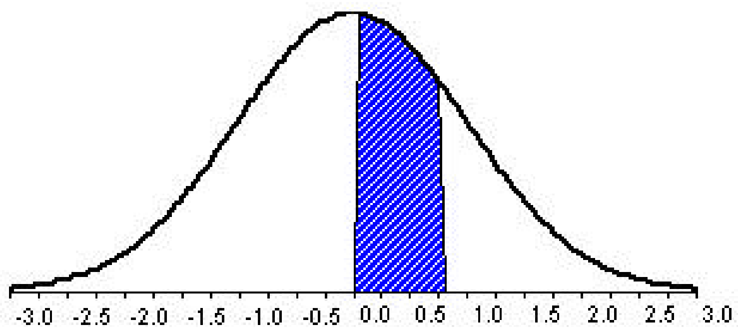
$$Y_t = 340 + 0.75Y_{t-1} - 0.15Y_{t-2} + e_t$$

where e_t is a normally distributed random error with zero mean and constant variance.

(i) The values for the last 3 periods are: $Y_7 = 430$, $Y_6 = 470$, $Y_5 = 380$. Forecast sales for the region for the next 3 periods.

(ii) Suppose the errors from this model were examined and found to be non-random, what are the implications for the model and the forecasts generated by the model?

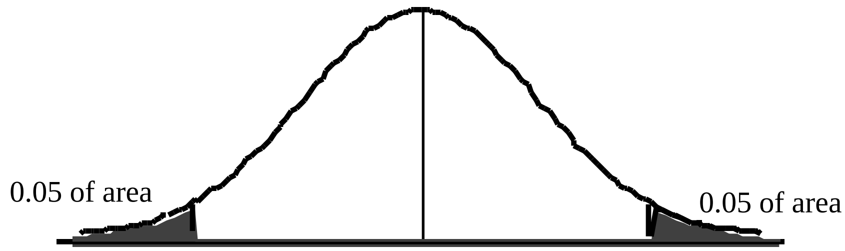
Table 1: Areas under the Standard Normal Probability Distribution



=NORMDIST(Z)

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

Table 2: Areas in both tails combined for the **Student's t Distribution**



=TINV(probability, df)

Degrees of freedom	**0.10**	**0.05**	**0.02**	**0.01**
1	6.3137	12.7062	31.8210	63.6559
2	2.9200	4.3027	6.9645	9.9250
3	2.3534	3.1824	4.5407	5.8408
4	2.1318	2.7765	3.7469	4.6041
5	2.0150	2.5706	3.3649	4.0321
6	1.9432	2.4469	3.1427	3.7074
7	1.8946	2.3646	2.9979	3.4995
8	1.8595	2.3060	2.8965	3.3554
9	1.8331	2.2622	2.8214	3.2498
10	1.8125	2.2281	2.7638	3.1693
11	1.7959	2.2010	2.7181	3.1058
12	1.7823	2.1788	2.6810	3.0545
13	1.7709	2.1604	2.6503	3.0123
14	1.7613	2.1448	2.6245	2.9768
15	1.7531	2.1315	2.6025	2.9467
16	1.7459	2.1199	2.5835	2.9208
17	1.7396	2.1098	2.5669	2.8982
18	1.7341	2.1009	2.5524	2.8784
19	1.7291	2.0930	2.5395	2.8609
20	1.7247	2.0860	2.5280	2.8453
21	1.7207	2.0796	2.5176	2.8314
22	1.7171	2.0739	2.5083	2.8188
23	1.7139	2.0687	2.4999	2.8073
24	1.7109	2.0639	2.4922	2.7970
25	1.7081	2.0595	2.4851	2.7874
26	1.7056	2.0555	2.4786	2.7787
27	1.7033	2.0518	2.4727	2.7707
28	1.7011	2.0484	2.4671	2.7633
29	1.6991	2.0452	2.4620	2.7564
30	1.6973	2.0423	2.4573	2.7500
40	1.6839	2.0211	2.4233	2.7045
50	1.6759	2.0086	2.4033	2.6778
60	1.6706	2.0003	2.3901	2.6603
70	1.6669	1.9944	2.3808	2.6479
80	1.6641	1.9901	2.3739	2.6387
90	1.6620	1.9867	2.3685	2.6316
100	1.6602	1.9840	2.3642	2.6259
110	1.6588	1.9818	2.3607	2.6213
120	1.6576	1.9799	2.3578	2.6174
130	1.6567	1.9784	2.3554	2.6142
150	1.6551	1.9759	2.3515	2.6090
200	1.6525	1.9719	2.3451	2.6006
300	1.6499	1.9679	2.3388	2.5923
500	1.6479	1.9647	2.3338	2.5857
999	1.6464	1.9623	2.3301	2.5808

Mathematical Functions in Excel

=EXP(number)	Returns e raised to the power of a given number
=LN(number)	Returns the natural logarithm of a number
=MOD(number,divisor)	Returns the remainder from division
=PI()	Returns the value of Pi
=POWER(number,power)	Returns the result of a number raised to a power
=QUOTIENT(numerator,denominator)	Returns the integer portion of a division
=RAND()	Returns a number between 0 and 1
=ROMAN(number,form)	Converts an Arabic numeral to Roman, as text
=SQRT(number)	Returns a positive square root number
=SUM(B6,number2,...)	Adds its arguments
=SUMIF(B7,criteria,sum_range)	Adds the cells specified by a given criteria
=SUMPRODUCT(array1,array2,array3,...)	Returns the sum of products of corresponding array components
=SUMSQ(number1,number2,...)	Returns the sum of the squares of the arguments
=SUMX2MY2(B9,array_y)	Returns the sum of the difference of squares of corresponding values in two arrays
=SUMX2PY2(array_x,array_y)	Returns the sum of squares of corresponding values in two arrays
=SUMXMY2(array_x,array_y)	Returns the sum of squares of differences of corresponding values in two arrays
=N(value)	Returns a value converted to a number
=TRANSPOSE(array)	Returns the transpose of an array

Statistical Functions in Excel

=AVEDEV(number1,number2,...)	Returns the average of the absolute deviations from their means
=AVERAGE(number1,number2,...)	Returns the vaerage of its arguments
=CHIDIST(x,degrees_freedom)	Returns the one tailed probability of the chi_squared distribuitin
=CORREL(array1,array2)	Returns the correlation coeficient between two data sets
=COUNT(value1,value2,...)	Counts how many numbers are in the list of arguments
=COUNTA(value1,value2,...)	Counts how many values are in the list of arguments
=COVAR(array1,array2)	Returns the covariance, the average of the products of squared deviations
=DEVSQ(number1,number2,...)	Returns the sum of squares of deviations
=FDIST(x,degrees_freedom1,degrees_freedom2)	Returns the F probability distribution
=FINV(probability,degrees_freedom1,degrees_freedom2)	Returns the inverse of the F probability distribution
=FORECAST(x,known_y's,known_x's)	Returns a value along a linear trend
=FREQUENCY(data_array,bins_array)	Returns the frequency distribution as a vertical array
=FTEST(array1,array2)	Returns the result of an F test
=GEOMEAN(number1,number2,...)	Retrurns the geometric mean
=GROWTH(known_y's,known_x's,new_x's,const)	Rerturns the values along an exponential trend
=HARMEAN(number1,number2,...)	Returns the harmonic mean
=INTERCEPT(known_y's,known_x's)	Returns the intercept of the linear regression line
=KURT(number1,number2,...)	Returns the kurtosis of a data set
=LARGE(array,k)	Returns the k-th largest value in a data set
=LINEST(known_y's,known_x's,const,stats)	Returns the parameters of a linear trend
=LOGEST(known_y's,known_x's,const,stats)	Returns the parameters of a exponential trend
=LOGNORMDIST(x,mean,standard_dev)	Returns the cumulative lognormal distribution
=MAX(number1,number2,...)	Returns the maximum value in a list of arguments
=MEDIAN(number1,number2,...)	Returns the median of the given numbers
=MIN(number1,number2,...)	Returns the minimum value in a list of arguments
=MODE(number1,number2,...)	Returns the most common value in a data set
=NORMDIST(x,mean,standard_dev,cumulative)	Returns the normal cumulative distribution
=NORMINV(probability,mean,standard_dev)	Returns the inverse of the normal cumulative distribution
=NORMSDIST(z)	Returns the standard normal cumulative distribution
=NORMSINV(probability)	Returns the inverse of the standard normal cumulative distribution
=PEARSON(array1,array2)	Returns the Pearson product moment correlation coefficient
=PERCENTILE(array,k)	Returns the k-th percentile of values in a range
=PERCENTRANK(array,x,significance)	Returns the percentage rank of a value in a data set
=PERMUT(number,number_chosen)	Returns the number of permutations for a given number of objects
=QUARTILE(array,quart)	Returns the quartile od a data set

=RANK(number,ref,order)	Returns the rank of a number in a list of numbers
=RSQ(known_y's,known_x's)	Returns the square of the Pearson product moment correlation coefficient
=SKEW(number1,number2,...)	Returns the skewness of a distribution
=SLOPE(known_y's,known_x's)	Returns the slope of the linear regression line
=SMALL(array,k)	Returns the k-th smallest value in a data set
=STANDARDIZE(x,mean,standard_dev)	Returns the normalised value
=STDEV(number1,number2,...)	Estimates the standard deviation based on the entire population
=STDEVP(number1,number2,...)	Estimates the standard deviation based on a sample
=STEYX(known_y's,known_x's)	Returns the standard error of the predicted y-value for each x in the regression
=TDIST(x,degrees_freedom,tails)	Returns the Student's t-distribution
=TINV(probability,degrees_freedom)	Returns the inverse of the Student's t-distribution
=TREND(known_y's,known_x's,new_x's,const)	Returns values along a linear trend
=TRIMMEAN(array,percent)	Returns the mean of the inetrior of a data set
=TTEST(array1,array2,tails,type)	Returns the probability associated with a Student's t-Test
=VAR(number1,number2,...)	Estiamtes variance based on a sample
=VARP(number1,number2,...)	Estiamtes variance based on the entire population
=ZTEST(array,x,sigma)	Returns the two-tailed P-value of a z-test

Financial Functions

=ACCRINT(issue,first_interest,settlement,rate,par,frequency,basis)	Returns accrued interest for a security that pays periodic interest
=ACCRINTM(issue,settlement,rate,par,basis)	Returns accrued interest for a security that pays interest at maturity
=AMORDEGRC(cost,date_purchased,first_period,salvage,period,rate,basis)	Returns the prorated linear depreciation of an asset for each accounting period
=AMORLINC(cost,date_purchased,first_period,salvage,period,rate,basis)	Returns the prorated linear depreciation of an asset for each accounting period
=COUPDAYBS(settlement,maturity,frequency,basis)	Returns the number of days from the beginning of the coupon period to the settlement date
=COUPDAYS(settlement,maturity,frequency,basis)	Returns the number of days in the coupon period that contains the settlement date
=COUPDAYSNC(settlement,maturity,frequency,basis)	Returns the number of days from the settlement date to the next coupon date
=COUPNCD(settlement,maturity,frequency,basis)	Returns the next coupon date after the settlement date
=COUPNUM(settlement,maturity,frequency,basis)	Returns the number of coupons payable between the settlement date and maturity date
=COUPPCD(settlement,maturity,frequency,basis)	Returns the previous coupon date before the settlement date
=CUMIPMT(rate,nper,pv,start_period,end_period,type)	Returns cumulative interest paid between two periods
=CUMPRINC(rate,nper,pv,start_period,end_period,type)	Returns cumulative principal paid on a loan between two periods
=DB(cost,salvage,life,period,month)	Retyurns the depreciation of an asset for a specified period using the fixed declining balance method

=DDB(cost,salvage,life,period,factor)	Returns the depreciation of an asset for a specified period using the double-declining balance method or some other method you specify
=DISC(settlement,maturity,pr,redemption,basis)	Returns the discount rate for a security
=DOLLARDE(fractional_dollar,fraction)	Converts a dollar price, expressed as a fraction, into a dollar price, expressed as a decimal number
=DOLLARFR(decimal_dollar,fraction)	Converts a dollar price, expressed as a decimal number, into a dollar price, expressed as a fraction.
=DURATION(settlement,maturity,coupon,yld,frequency,basis)	Return the annual duration of a security with periodic interest payments
=EFFECT(nominal_rate,npery)	Returns the effective annual interest rate
=FV(rate,nper,pmt,pv,type)	Returns the future value of an investment
=FVSCHEDULE(principal,schedule)	Returns the future value of an initial principal after applyinng a series of compound interest rates
=INTRATE(settlement,maturity,investment,redemption,basis)	Returns the interest rate for a fully invested security
=IPMT(rate,per,nper,pv,fv,type)	Returns the interest rate for an investmentfor a given period
=IRR(values,guess)	Returns the internal rate of return for a series of cash flows
=MIRR(values,finance_rate,reinvest_rate)	Returns the internal rate of return where positive and negative cash flows are financed at different rates
=NOMINAL(effect_rate,npery)	Returns the annual nominal interest rate
=NPER(rate,pmt,pv,fv,type)	Returns the number of periods for an investment
=NPV(rate,value1,value2,...)	Returns the net present value of an investment based on a series of period cash flows and a discount rate
=ODDFPRICE(settlement,maturity,issue,first_coupon,rate,yld,redemption,frequency,basis)	Returns the price per $100 face value of a security with an odd first period
=ODDFYIELD(settlement,maturity,issue,first_coupon,rate,pr,redemption,frequency,basis)	Returns the yield of a security with an odd first period
=ODDLPRICE(settlement,maturity,last_interest,rate,yld,redemption,frequency,basis)	Returns the price per $100 face value of a security with an odd last period
=ODDLYIELD(settlement,maturity,last_interest,rate,pr,redemption,frequency,basis)	Returns the yield of a security with an odd last period
=PMT(rate,nper,pv,fv,type)	Returns the periodic payment for an annuity
=PPMT(rate,per,nper,pv,fv,type)	Returns the payment on the principle for an investment for a given period

=PRICE(settlement,maturity,rate,yld,redemption,frequency,basis)	Returns the price per $100 face value of a security that pays periodic interest
=PRICEDISC(settlement,maturity,discount,redemption,basis)	Returns the price per $100 face value of a discouinted security
=PRICEMAT(settlement,maturity,issue,rate,yld,basis)	Returns the price per $100 face value of a security that pays interest at maturity
=PV(rate,nper,pmt,fv,type)	Returns the present value of an investment
=RATE(nper,pmt,pv,fv,type,guess)	Returns the interest rate per period of an annuity
=RECEIVED(settlement,maturity,investment,discount,basis)	Returns the amount received at maturity for a fully invested security
=SLN(cost,salvage,life)	Returns the straight kline depreciation of an asset for one period
=SYD(cost,salvage,life,per)	Returns the sum-of-years' digits depreciation of an asset for a specified period
=TBILLEQ(settlement,maturity,discount)	Returns tyhe bond equivalent yield for a treasury bill
=TBILLPRICE(settlement,maturity,discount)	Returns the price per $100 face value of a treasury bill
=TBILLYIELD(settlement,maturity,pr)	Returns the yield for a treasury bill
=VDB(cost,salvage,life,start_period,end_period,factor,no_switch)	Returns the depreciation of an asset for a specified or partial period using a declining balance method
=XIRR(values,dates,guess)	Returns the internal rate of return for a shedule of cash flows
=XNPV(rate,values,dates)	Returns the net present value for a shedule of cash flows
=YIELD(settlement,maturity,rate,pr,redemption,frequency,basis)	Returns the yield on a security that pays periodic interest
YIELDDISC(settlement,maturity,pr,redemption,basis)	Returns the annual yield for a discounted security. For example, a treasury bill.
YIELDMAT(settlement,maturity,issue,rate,pr,basis)	Returns the annual yield of a security that pays interest at maturity

Information Functions

=CELL(info_type,reference)	Returns information about the format, location, or contents of a cell
=INFO(type_text)	Returns information about the current operating environment
=ISBLANK(value)	Returns TRUE if the value is blank
=ISERR(value)	Teturns TRUE if the value is any error value except #N/A
=ISERROR(value)	Returns TRUE if the value is any error value
=ISEVEN(number)	Returns TRUE if the number is even

=ISLOGICAL(value)	Returns TRUE if the value is a logical value
=ISNA(value)	Teturns TRUE if the value is the #N/A error value
=ISNONTEXT(value)	Teturns TRUE if the value is not text
=ISNUMBER(value)	Teturns TRUE if the value is a number
=ISODD(number)	Returns TRUE if the number is odd
=ISREF(value)	Returns TRUE if the value is a reference
=ISTEXT(value)	Returns TRUE if the value is text
=N(value)	Returns a value converted to a number
=NA()	Returns the error value #N/A
=TYPE(value)	Returns a number indicating the data type of a value

Text Functions

=CHAR(number)	Returns the character specified by the code number
=CLEAN(text)	Removes all nonprintable characters from the text
=CODE(text)	Returns a numeric code for the first character in a text string
=CONCATENATE(text1,text2,...)	Joins several text items into one text item
=DOLLAR(number,decimals)	Convers a number to text using currency format
=EXACT(text1,text2)	Checks to see if two text values are identical
=FIND(find_text,within_text,start_num)	Finds one text value within another (case-sensitive)
=FIXED(number,decimals,no_commas)	Formats a number as text with a fixed number of decimals
=LEFT(text,num_chars)	Returns the leftmost characters from a text string
=LEN(text)	Returns the number of characters in a text string
=LOWER(text)	Converts text to lowere case
=MID(text,start_num,num_chars)	Returns a specific number of characters from a text string
=PROPER(text)	Capitalises the first letter in each word of a text value
=REPLACE(old_text,start_num,num_chars,new_text)	Replaces characters within text
=REPT(text,number_times)	Repeats text a given number of times
=RIGHT(text,num_chars)	Returns the rightmost characters from a text string
=SEARCH(find_text,within_text,start_num)	Finds one text value within another (not case sensitive)
=SUBSTITUTE(text,old_text,new_text,instance_num)	Substitute new text for old text in a text string
=T(value)	Converts its argument to text
=TEXT(value,format_text)	Formats a number and converts it to text
=TRIM(text)	Removes spaces from text
=UPPER(text)	Converts text to upper case
=VALUE(text)	Converts a text argument to a number