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FACULTY OF ECONOMICS & ADMINISTRATIVE SCIENCES

MATHEMATICS FOR BUSINESS
LECTURE NOTES-10

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Index numbers

- Economic data often take the form of a ***time series;*** values of economic indicators are available on an annual, quarterly or monthly basis, and we are interested in analysing the rise and fall of these numbers over time.
- ***Index numbers*** enable us to identify trends and relationships in the data.
- The following example shows you how to calculate index numbers and how to interpret them.

Example 1

- Table 3.1 shows the values of household spending (in billions of dollars) during a 5-year period.
- Calculate the index numbers when 2000 is taken as the base year and give a brief interpretation.

Table 3.1

	Year				
	1999	2000	2001	2002	2003
Household spending	686.9	697.2	723.7	716.6	734.5

Solution 1

- When finding index numbers, a base year is chosen and the value of 100 is allocated to that year.
- So, in this example, the index number of 2000 is 100.
- To find the index number of the year 2001 we work out the scale factor associated with the change in household spending from the base year, 2000 to 2001, and then multiply the answer by 100.

$$\text{index number} = \text{scale factor from base year} \times 100$$

- In this case, we get $\frac{723.7}{697.2} \times 100 = 103.8$
- This shows that the value of household spending in 2001 was 103.8% of its value in 2000. In other words, household spending increased by 3.8% during 2001.

Solution 1

for the year 1999 :

$\frac{689.9}{697.2} \times 100 = 98.5$ (value of household spending in 1999 was 98.5% of its value in 2000)

for the year 2002:

$\frac{716.6}{697.2} \times 100 = 102.8$ (value of household spending in 2002 was 102.8% of its value in 2000)

for the year 2003:

$\frac{734.5}{697.2} \times 100 = 105.3$ (value of household spending in 2003 was 105.3% of its value in 2000)

Table 3.2

	Year				
	1999	2000	2001	2002	2003
Household spending	686.9	697.2	723.7	716.6	734.5
Index number	98.5	100	103.8	102.8	105.3

- Index numbers themselves have no units. They merely express the value of some quantity as a percentage of a base number.
- This is particularly useful, since it enables us to compare how values of quantities, of varying magnitudes, change in relation to each other.
- The following example shows the rise and fall of two share prices during an 8-month period.
- The prices (in dollars) listed for each share are taken on the last day of each month.
- Share A is exceptionally cheap. Investors often include this type of share in their portfolio, since they can occasionally make spectacular gains. This was the case with many dot.com shares at the end of the 1990s.
- The second share is more expensive and corresponds to a larger, more established firm.

Practice 1 (for students)

- Find the index numbers of each share price shown in Table 3.3, taking April as the base month.

Table 3.3

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Share A	0.31	0.28	0.31	0.34	0.40	0.39	0.45	0.52
Share B	6.34	6.40	6.45	6.52	6.57	6.43	6.65	7.00

Inflation

- Over a period of time, the prices of many goods and services usually increase.
- The ***annual rate of inflation*** is the average percentage change in a given selection of these goods and services, over the previous year.
- Seasonal variations are taken into account, and the particular basket of goods and services is changed periodically to reflect changing patterns of household expenditure.
- The presence of inflation is particularly irritating when trying to interpret a time series that involves a monetary value. It is inevitable that this will be influenced by inflation during any year, and what is of interest is the fluctuation of a time series 'over and above' inflation.

Inflation

- Economists deal with this by distinguishing between nominal and real data.
- ***Nominal data*** are the original, raw data such as those listed in tables in the previous sub-section. These are based on the prices that prevailed at the time.
- ***Real data*** are the values that have been adjusted to take inflation into account.
- The standard way of doing this is to pick a year and then convert the values for all other years to the level that they would have had in this base year.
- This may sound rather complicated, but the idea and calculations involved are really quite simple as the following example demonstrates.

Example 2

- Table below shows the price (in thousands of pounds) of an average house in a certain town during a 5-year period. The price quoted is the value of the house at the end of each year. Use the annual rates of inflation given in table below to adjust the prices to those prevailing at the end of 1991. Compare the rise in both the nominal and real values of house prices during this period.

	Year				
	1990	**1991**	**1992**	**1993**	**1994**
Average house price	72	89	93	100	106
Annual rate of inflation	-	10.7%	7.1%	3.5%	2.3%

Solution 2

The base year is 1991.

The value of the house at the end of 1991 is obviously £89 000, since no adjustment need to be made.

At the end of 1992, it is worth £93 000. However, during that year inflation year was 7.1%. To adjust this price to '1991 prices' we simply divide by the scale factor.1.071 $(=1+\frac{7.1}{100})$

$$\frac{93000}{1.071}=86835$$(we divide it, since we are going backwards in time)

To adjust the price of the house in 1993 we first need to divide by 1.035$(=1+\frac{3.5}{100})$ to backtrack totheyear 1992,and then divide again by 1.071 to reach 1991.

$$\frac{100000}{1.035\times1.071}=90213$$

Solution 2

Similarly, for the 1994 year, the adjusted value is:

$$\frac{106000}{1.023\times1.035\times1.071}=93476$$

And for 1990, the adjusted value is,

72000x1.107=79704 (going forward in time so multiply)

	Year				
	1990	**1991**	**1992**	**1993**	**1994**
Nominal house price	72	89	93	100	106
1991 house price	80	89	87	90	93

- Table above presents the nominal and the 'constant 1991' values of the house (rounded to the nearest thousands) for comparison. As can be seen from the table, apart from the gain during 1991, the increase in value has, in fact, been quite modest.

Practice 2 (for students)

- Table 3.10 shows the average annual salary (in thousands of dollars) of employees in a small firm, together with the annual rate of inflation for that year. Adjust these salaries to the prices prevailing at the end of 1991 and so give the real values of the employees' salaries at constant '1991 prices'.

Table 3.10

	Year				
	1990	1991	1992	1993	1994
Salary	17.3	18.1	19.8	23.5	26.0
Inflation		4.9	4.3	4.0	3.5

Exercises

10.

- Table 3.10 gives the annual rate of inflation during a 5-year period.

Table 3.10

	2000	2001	2002	2003	2004
Annual rate of inflation	1.8%	2.1%	2.9%	2.4%	2.7%

- If a nominal house price at the end of 2000 was $10.8 million, find the real house price adjusted to prices prevailing at the end of the year 2003.

11.

- Table 3.11 shows the index numbers associated with transport costs during a 20-year period. The public transport costs reflect changes to bus and train fares, whereas private transport costs include purchase, service, petrol, tax and insurance costs of cars.

Table 3.11

	Year				
	1985	1990	1995	2000	2005
Public transport	100	130	198	224	245
Private transport	100	125	180	199	221

(1) Which year is chosen as the base year?

(2) Find the percentage increases in the cost of public transport from

a) 1985 to 1990 b) 1990 to 1995 c) 1995 to 2000 d) 2000 to 2005

(3) Repeat part (2) for private transport.

12.

- Table 3.12 shows the number of items (in thousands) produced from a factory production line during the course of a year. Taking the second quarter as the base quarter, calculate the associated index numbers.

Table 3.12

	Quarter			
	Q1	Q2	Q3	Q4
Output	13.5	1.4	2.5	10.5

13.

- Table 3.13 shows the prices of a good for each year between 1999 and 2004.

Table 3.13

Year	1999	2000	2001	2002	2003	2004
Price ($)	40	48	44	56	60	71

(a) Work out the index numbers, correct to 1 decimal place, taking 2000 as the base year.

(b) If the index number for 2005 is 135, calculate the corresponding price. You may assume the base year is still 2000.

(c) If the index number in 2001 is approximately 73, find the year that is used as the base year.

14. For students

- Table 3.5 shows the index numbers of the output of a particular firm for the years 2004 and 2005.

Table 3.5

	Output							
	04Q1	04Q2	04Q3	04Q4	05Q1	05Q2	05Q3	05Q4
Index	89.3	98.1	105.0	99.3	100	106.3	110.2	105.7

- Calculate the percentage change in output:

a) from 05Q1 to 05Q3

b) from 04Q2 to 05Q2

c) from 04Q3 to 05Q1

15.

- The prices of a good at the end of each year between 2003 and 2008 are listed in the table 3.16, which also shows the annual rate of inflation.

Table 3.16

Year	2003	2004	2005	2006	2007	2008
Price	230	242	251	257	270	284
Inflation		4%	3%	2,5%	2%	2%

- Find the values of the prices adjusted to the end of year 2004, correct to 2 decimal places. Hence, calculate the index numbers of the real data with 2004 as the base year. Give your answers correct to 1 decimal place.

Thank you for attention!