MONASH University

Information Technology

FIT1006 Business Information Analysis

Lecture 13
Index Numbers

Topics covered:

- Simple indices – a problem with these
- Aggregate indices – Laspeyres, Paasche and Fisher
- Changing the base of an index
- Chaining indices
- The Consumer Price Index (CPI)

Motivating Problem

- Petrol cost, on ave[illegible]30 cents per litre in Melbourne in 2007.
- What should the average price of petrol be now to maintain parity with the 2007 price?

Costs Over Time

- We are often interested in monitoring the changes in costs over time. For example, the cost of day-to-day living, or how various costs have changed relative to each other.
- It is usual to express the costs over time relative to those in a base year, and create a price index.
- We are often interested in the overall change in a group of items, such as those that contribute to everyday family spending. For this purpose we use an aggregate index, the Consumer Price Index.

Housing aff

- Source: The Sunday Age, April 18 20

Source: https://www.9news.com.au/national/australia-house-prices-2020-national-average-hits-record-high-as-lockdowns-ease

9NEWS

News / National

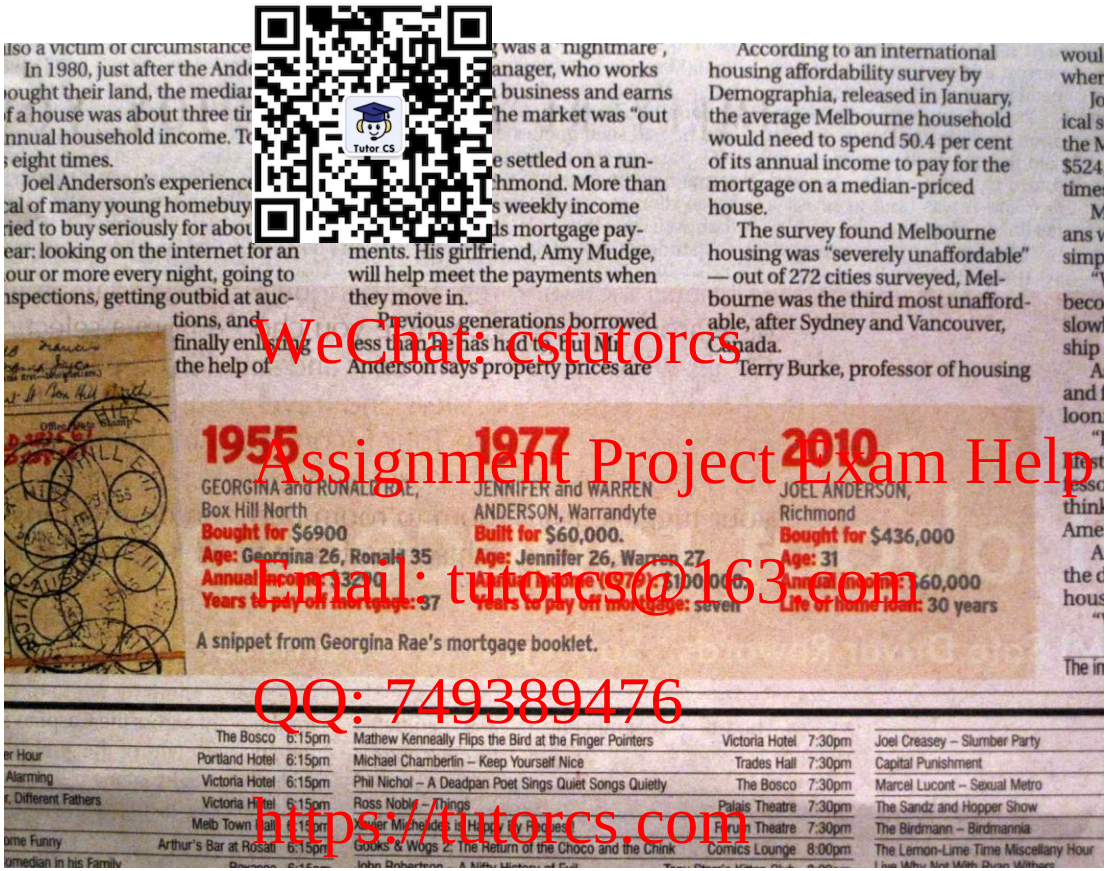
Australia's average house price hits record high as buyers flood market post-COVID

· Senior Producer | 5:03pm Jan 28, 2021

Domain House Price Report: December Quarter 2020

Capital city:	Average house price:	Year-on-year growth:
Sydney	$1,211,488	+ 6.7 per cent
Melbourne	$936,073	+ 3.9 per cent
Brisbane	$616,387	+ 5.6 per cent
Adelaide	$574,264	+ 6.1 per cent
Canberra	$855,530	+ 9.1 per cent
Perth	$563,214	+ 6.3 per cent
Hobart	$564,091	+ 12.4 per cent
Darwin	$533,845	+ 3.6 per cent
National	**$852,940**	**+ 5.8 per cent**

Prices/Wages over time...



...lso a victim of circumstance
In 1980, just after the And
bought their land, the media
f a house was about three ti
nnual household income. T
eight times.
Joel Anderson's experienc
al of many young homebuy
ied to buy seriously for abo
ear: looking on the internet for an
our or more every night, going to
spections, getting outbid at auc-
tions, and
finally enlisting
the help of

was a "nightmare",
anager, who works
business and earns
he market was "out

e settled on a run-
hmond. More than
s weekly income
ls mortgage pay-
ments. His girlfriend, Amy Mudge,
will help meet the payments when
they move in.
Previous generations borrowed
less than he has had to. But Mr
Anderson says property prices are

According to an international housing affordability survey by Demographia, released in January, the average Melbourne household would need to spend 50.4 per cent of its annual income to pay for the mortgage on a median-priced house.
The survey found Melbourne housing was "severely unaffordable" — out of 272 cities surveyed, Melbourne was the third most unaffordable, after Sydney and Vancouver, Canada.
Terry Burke, professor of housing

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1955
GEORGINA and RONALD RAE, Box Hill North
Bought for $6900
Age: Georgina 26, Ronald 35
Annual income: $3200
Years to pay off mortgage: 37

1977
JENNIFER and WARREN ANDERSON, Warrandyte
Built for $60,000.
Age: Jennifer 26, Warren 27
Years to pay off mortgage: seven

2010
JOEL ANDERSON, Richmond
Bought for $436,000
Age: 31
Life of home loan: 30 years

A snippet from Georgina Rae's mortgage booklet.

	The Bosco 6:15pm	Mathew Kenneally Flips the Bird at the Finger Pointers	Victoria Hotel 7:30pm	Joel Creasey – Slumber Party
er Hour	Portland Hotel 6:15pm	Michael Chamberlin – Keep Yourself Nice	Trades Hall 7:30pm	Capital Punishment
Alarming	Victoria Hotel 6:15pm	Phil Nichol – A Deadpan Poet Sings Quiet Songs Quietly	The Bosco 7:30pm	Marcel Lucont – Sexual Metro
. Different Fathers	Victoria Hotel 6:15pm	Ross Noble – Things	Palais Theatre 7:30pm	The Sandz and Hopper Show
	Melb Town Hall 6:15pm		Forum Theatre 7:30pm	The Birdmann – Birdmannia
me Funny	Arthur's Bar at Rosati 6:15pm	Gooks & Wogs 2: The Return of the Choco and the Chink	Comics Lounge 8:00pm	The Lemon-Lime Time Miscellany Hour
omedian in his Family				

- Source: The Sunday Age, April 18 2010, Page 8

40 years of change: 1975 to 2015

mccrindle

About Work Services Outcomes Insights

Earning more, cost

Australians are also earning a lot ere back then; the average full time earnings in 1975 was $7,600 per ye average earnings exceed $72,000 per annum.

And while we are earning more, costs are a lot more today than they were back then. The cost of a loaf of bread today is more than 10 times the price it was in 1975, while a litre of milk today is 3 times the cost it was 4 decades ago.

	1975	2015
Full time earnings	$7,618	$72,000
Everyday costs	**1975**	**2015**
Loaf of bread	$0.24	$2.84
1 litre of milk	$0.30	$1.45
Newspaper	$0.12	$2.50
Petrol	$0.57 / litre	$1.20 / litre

Four decades ago Sydney had the highest house cost, averaging $28,000 while today it exceeds $850,000. So while earnings have gone up, by almost tenfold, house prices have gone up by more than thirtyfold in that same period of time.

Source: https://mccrindle.com.au/insights/blog/40-years-of-change-1975-to-today/

https://flux.qa (Feed code: SJ6KGV)

Question 1

What should a h[illegible]er costing $3.00 in Year 0 cost in Year 5?

A. $3.00

B. $3.50

✓ C. $4.50

D. $5.00

inflate

3.00 x 150 (Current)
100 (Base)

Year	Index
0	100
1	110
2	120
3	130
4	140
5	150
6	160
7	170
8	180
9	190
10	200

A Simple Price Index

- Consider the cost of a hamburger over time.

Year	1970	[illegible]	1980	1985	1990
Price	$0.19	[illegible]	$0.95	$1.80	$2.40

- Let p_t be the cost of hamburger at time t.

- Using $P_i = 100p_i/p_0$, we can construct a price index for hamburgers over time.

$100 \times \frac{0.35}{0.19}$

Year	1970	1975	1980	1985	1990
Price	$0.19	$0.35	$0.95	$1.80	$2.40
Index	100	184	500	947	1263

- In 1975, the price of a hamburger was 184% of the price in 1970.

https://flux.qa (Feed code: SJ6KGV)

Question 2

What should a ha[illegible]er costing $3.40 in Year 7 have cost in Year 1?

A. $1.70

✓ B. $2.20

C. $2.30

D. $2.80

Deflate

3.40 x 110 (Base)

170 (current)

Year	Index
0	100
1	110
2	120
3	130
4	140
5	150
6	160
7	170
8	180
9	190
10	200

Changing the Base of an Index

- We frequently w[illegible]e-scale an index relative to a period later than [illegible]ginal base period. We achieve this by dividing each index by that of the new base period and multiplying by 100. For example:

Year	1970	1975	1980	1985	1990
Index	100	184	500	947	1263
To set 1980 as the base period divide by 500, multiply by 100					
Index	20	36.8	100	189.4	252.6

947 X 100
500

https://flux.qa (Feed code: SJ6KGV)

Question 3

What should a ha[illegible]er costing $2.00 in Year 0 cost in Year 10?

A. $4.00

✓ B. $4.50

C. $5.00

D. $6.00

Year	Index 1	Index 2
0	100	
1	110	
2	120	
3	130	
4	140	
5	150	100
6		110
7		120
8		130
9		140
10		150

Inflate = Current / Base

Step 2:
2.00 x 225 (Current) / 100 (Base)
= 4.50

Step 1:
150 / 100 X 150 = 225

Chaining Indices

- We frequently extend indices backwards or forwards by two separate indices. For example, this is necessary when the range of components forming a composite index changes.

This process is called chaining. We obtain the chained index by multiplying the second index by the terminal value of the first index and dividing by 100.

*Eg. 102 * 132 / 100 = 134.6*

Period	Index 1	Index 2	Chained Index
1	100		100.0
2	101		101.0
3	110		110.0
4	113		113.0
5	125		125.0
6	132	100	132.0
7		102	134.6
8		109	143.9
9		110	145.2
10		124	163.7

Aggregate Indices

- In order to overcome the weaknesses simple average or relative indices (e.g. the re-reading) it is more usual to use weighted indices, where the proportion consumed or money spent on an item over a certain period of time determines its relative contribution to the index.
- We will consider three indices: the Laspeyres, the Paasche and the Fisher.

Sample Data

- Consider the follow[illegible]a:

Item	1970 Price	Quanti[illegible]		1980 Price	Quantity	Value	*Unit*
Petrol	0.20	200	40.00	0.35	230	80.50	*l*
Electricity	0.10	350	35.00	0.18	450	81.00	*KWh*
Steak	2.80	15	42.00	3.50	25	87.50	*Kg*
Potatoes	0.60	20	12.00	0.55	40	22.00	*Kg*
Milk	0.35	26	9.10	0.62	86	53.32	*l*
Newspapers	0.10	34	3.40	0.25	34	8.50	
Total			**141.50**			**332.82**	

- Over the 10 years between surveys, costs and and consumption patterns have changed.
- Total spending has increased by

  100(332.82/141.50)=235.2%.

Laspeyres Index

- The Laspeyres uses the base period values to provide weig or each product in subsequent periods.

p_i be the price per unit of item i in period t

q_i be the quantity purchased of a particular item i in some period

$$I_{0,t}^{LP} = \frac{\sum q_0 p_t}{\sum q_0 p_0} 100$$

...

- Laspeyres: use 1[illegible] *e period*) weights.

Item	1970 Price	[illegible]	[illegible]/alue	1980 Price	Quantity	Value	*Unit*
Petrol	0.20	[illegible]	40.00	0.35	230	80.50	*l*
Electricity	0.10	350	35.00	0.18	450	81.00	*KWh*
Steak	2.80	15	42.00	3.50	25	87.50	*Kg*
Potatoes	0.60	20	12.00	0.55	40	22.00	*Kg*
Milk	0.35	26	9.10	0.62	86	53.32	*l*
Newspapers	0.10	34	3.40	0.25	34	8.50	
Total			**141.50**			**332.82**	

$$I_{0,t}^{LP} = \frac{\sum q_0 p_t}{\sum q_0 p_0} 100$$

$$= \frac{200(0.35)+350(0.18)+15(3.50)+20(0.55)+26(0.62)+34(0.25)}{200(0.20)+350(0.10)+15(2.80)+20(0.60)+26(0.35)+34(0.10)} 100$$

$$= \frac{221.12}{141.50} 100 = 156.26$$

Paasche Index

- The paasche index uses the current time period to provide weighting for each product in the index.

p_i be the price per unit of item i in period t

q_i be the quantity purchased of a particular item i in some period

$$I_{0,t}^{PP} = \frac{\sum q_t p_t}{\sum q_t p_0} \times 100$$

...

- paasche: use 198[illegible]*eriod*) weights.

Item	1970 Price	Qu[illegible]	[illegible]ue	1980 Price	Quantity	Value	*Unit*
Petrol	0.20	[illegible]	[illegible]00	0.35	230	80.50	*l*
Electricity	0.10	350	35.00	0.18	450	81.00	*KWh*
Steak	2.80	[illegible]	[illegible]00	3.50	25	87.50	*Kg*
Potatoes	0.60	20	12.00	0.55	40	22.00	*Kg*
Milk	0.35	26	9.10	0.62	86	53.32	*l*
Newspapers	0.10	34	3.40	0.25	34	8.50	
Total			141.50			**332.82**	

$$I_{0,t}^{PP} = \frac{230(0.35)+450(0.18)+25(3.50)+40(0.55)+86(0.62)+34(0.25)}{230(0.20)+450(0.10)+25(2.80)+40(0.60)+86(0.35)+34(0.10)}100$$

$$= \frac{332.82}{218.5}100$$

$$= 152.32$$

$$I_{0,t}^{PP} = \frac{\sum q_t p_t}{\sum q_t p_0}100$$

Laspeyres *vs* Paasche

- The Laspeyres Index uses base period quantities as weights and makes no allowance for changes in consumption patterns over time. It tends to *overestimate* price rises.
- The Paasche Index uses current period quantities as weights. It tends to *underestimate* prices rises.
- The Laspeyres Index is generally preferred because it avoids the costs of surveying consumption patterns for each period of interest.
- The Laspeyres Index provides a better comparison of price movements in the intermediate periods, since all periods use the same base quantity consumption patterns.

Fisher Price Index

- As a compromise between the assumptions of the Laspeyres and the Paasche Indices, the Fisher Price Index is proposed as the geometric mean of the Laspeyres and Paasche.

$$I_{0,t}^{FP} = \sqrt{I_{0,t}^{LP} \times I_{0,t}^{PP}}$$

- For the data in the previous problem:

$$I_{0,t}^{FP} = \sqrt{152.32 \times 156.26} = 154.28$$

Class exercise

The prices of certain commodities and the quantities consumed per month are given for 1992 and 2010. Calculate the Fisher price index.

Item	Quantity 1992	Quantity 2010	Cost 1992	Cost 2010
A	3	4	4.00	5.00
B	2	1	20.00	40.00

$$I_{0,t}^{LP} = \frac{\sum q_0 p_t}{\sum q_0 p_0} 100$$

$$I_{0,t}^{PP} = \frac{\sum q_t p_t}{\sum q_t p_0} 100$$

$$I_{0,t}^{FP} = \sqrt{I_{0,t}^{LP} \times I_{0,t}^{PP}}$$

More Information ...

- Visit the Australian Bureau of Statistics web site:
  - http://www.abs.gov.au
  - Access to most ABS publications is free!
- Further Reading:
  - 6401.0 - Consumer Price Index (most recent)
  - 6440.0 - A Guide to the Consumer Price Index: 16th Series, 2011
  - 6461.0 - Consumer Price Index: Concepts, Sources and Methods, 2011
  - 6470.0 - Introduction of the 16th Series Australian Consumer Price Index

Necessary Skills

- Know how to:
  - Calculate Laspeyres, Paasche and Fisher indices;
  - Change the base of an index;
  - Chain indices;
- Have a general idea of how the CPI is constructed and used.

Reading/Questions (Selvanathan)

- Reading:
  - 7th Ed. Chapt
- Questions:
  - 7th Ed. Questions: 18.1, 18.3, 18.4, 18.9, 18.14, 18.17.