ECON 180

Introduction to Principles of Microeconomics and Financial Project Evaluation

Lecture 20: Measuring Inflation

October 22, 2021

Version 1

Required Reading and Viewing

- *Engineering Economics*, (Required Textbook) Chapter 9, Sections 9.1-9.2, Appendix 9A
- Statistics Canada. (2014, August 22). An Overview of Canada's Consumer Price Index (CPI) [Video File]. https://youtu.be/qfKmJe3CK6E
- Statistics Canada. (2014, August 22). An Overview of Canada's Consumer Price Index (CPI) [Video File]. https://youtu.be/qfKmJe3CK6E
- Mjmfoodie. (2009, September 29). (Macro) Episode 16: Inflation & Price Indexes [Video File]. https://www.youtube.com/watch?v=SmOMp8gycMA
- Province of BC. (2015, March 12). BC indexes minimum wage to CPI [Video File]. https://www.youtube.com/watch?v=KBKuxk2DhMs

Optional Readings Part 1: Solved Problems

- California Department of Finance. (n.d.) *How to use CPI Data*. Retrieved from http://www.dof.ca.gov/Forecasting/Economics/Documents/How_to_Use_CPI_Data.pdf
- Thompson, G. (2009). *How to adjust for inflation*. Retrieved from https://*old.parliament.uk/briefing-papers/SN04962.pdf*
- Perrins, G. & Nilsen, D. (n.d.). *Math calculations to better utilize CPI data*. Retrieved from http://www.bls.gov/cpi/cpimathfs.pdf
- Zugarramurdi, A. & Parin, M. A. (1995). Inflation in Profitability Calculation. In *Economic Engineering Applied to the Fishery Industry* [FAO Fisheries Technical Paper 351]. Retrieved from http://www.fao.org/3/v8490e/V8490e09.htm#7.9.%20Inflation%20in%20Profitability%20Calculation
- International Labour Office. (2004). *Consumer price manual: Theory and practice*. Geneva: ILO/IMF/OECD/UNECE/Eurostat/The World Bank. Retrieved from https://www.ilo.org/public/english/bureau/stat/download/cpi/cpi_manual_en.pdf
- **ADVANCED mathematical details of price index calculation. Overkill for this course, but presented for the curious.**

Optional Readings Part 2: Canada's CPI

- Statistics Canada. (1996). , Your Guide to the Consumer Price Index [Catalogue No. 62-557-XPB]. Canada: Statistics Canada, Prices Division.Retrieved from http://www5.statcan.gc.ca/olc-cel/olc.action?objId=62-557-X&objType=2&lang=en&limit=1
- **A non-technical introduction to the CPI**.
- Canadian CPI Basket of Goods and Services [Web Page]. (n.d.). Retrieved from http://inflationcalculator.ca/cpi-basket/
- **Shows what's in the basket, and how basket weights have changed over time**.
- Rossiter, J. (2005). Measurement Bias in the Canadian Consumer Price Index [Bank of Canada Working Paper 2005-39]. Retrieved from http://www.bankofcanada.ca/wp-content/uploads/2010/02/wp05-39.pdf
- **Problems with the CPI, and how to deal with them**.
- Chiru, R. et al. (2015). Calculation of the Consumer Price Index. In *The Consumer Price Index Reference Paper* [Statistics Canada Item 62-553-X]. Retrieved from https://www150.statcan.gc.ca/n1/pub/62-553-x/2015001/chap/chap-6-eng.htm
- **Official details on Canada's CPI Calculation.**

Optional Readings Part 3: Engineering Uses

- Zhishuo, L., Ma, J., Wei, X. , Wang, J. & Li, H. (2015). A Steel Price Index Model and Its Empirical Research. *IEEE 12th International Conference on e-Business Engineering.* Retrieved from https://ieeexplore-ieee-org.ezproxy.library.uvic.ca/document/7349969
- **Calculates a Laspeyres index for Chinese rebar**.
- Ye, Z. & Cai, J. (2010). Effects Comparison of Peak-Load Price under Price Cap Regulation. *2010 International Conference on E-Product E-Service and E-Entertainment*. Retrieved from https://ieeexplore-ieee-org.ezproxy.library.uvic.ca/document/5661621
- **Uses a Laspeyres index to quantify the impact of peak load price regulations in an electricity market**.

Learning Objectives

- Understand, at a basic level, inflation and the consequences of expected and unexpected inflation (and deflation).
- Be aware of common measures of the price level and inflation, such as the CPI and PPI.
- Know how a price index is created, the limitations of the same, and how to calculate inflation from a price index.
- Be able to calculate a Laspeyres price index from price and quantity data.
- Be able to convert between prices in different years (e.g. be able to put everything 'in 1995 dollars').

Relevant Solved Problems (Measuring Inflation)

- From Engineering Economics, Chapter 9
- Price Index: 9.16
- CPI: Example 9.1, 9.23, 9.24
- Laspeyres Price Index: Example 9A.1, Example 9A.2

- From Stand-Up Economics, Chapter 17 (solutions at end of the chapter)
- Stand-Up Microeconomics: http://standupeconomist.com/stand-upeconomics-the-micro-textbook/ (Choose the version with calculus.)
- Year X dollars: 17.7

Notation Dictionary

(Not provided on quiz/final formula sheet)

- C = Nominal dollar value (from textbook's 'Current')
- f = Inflation Rate
- i = Nominal Interest Rate
- N = Time Index (usually, years from present)
- P = Present Value
- r = Real Interest Rate
- R = Real dollar value
- t = general time index

$f(x)$

New Equations

- Notation: The orange symbol on a slide indicates a formula sheet formula is introduced there.
- (These will be provided on quizzes and the final.)
- $\frac{C_X}{C_Y} = \frac{CPI_X}{CPI_Y}$
- $s_{tj} = \frac{p_{tj}q_{tj}}{\sum_{i=1}^{n} p_{ti}q_{ti}}$
- $L_t = \left(\sum_{i=1}^{n} \frac{p_{ti}}{p_{0i}} s_{0i}\right) \times 100$
- $\frac{C_X}{C_Y} = \frac{CPI_X}{CPI_Y}$
- Current Dollars (Textbook) = Nominal Dollars (Economics)

ESSENTIALS (19 slides)

What is a price index?

- Tracks the price of a basket of goods over time.
- (e.g. 1 can of pop + 1 cookie, or 1 bottle of cookie pop)
- Everything is compared to a base year.
- Let C_t = cost of the basket in year t
- C_{base} = cost of the basket in the base year
- Index = C_t/C_{base} x 100
- This shows how prices have changed since the base year.
- e.g. Index of 115 means prices are 115% of base year prices
- The CPI is a measure of the price level.
- Inflation measures the change in the price level.

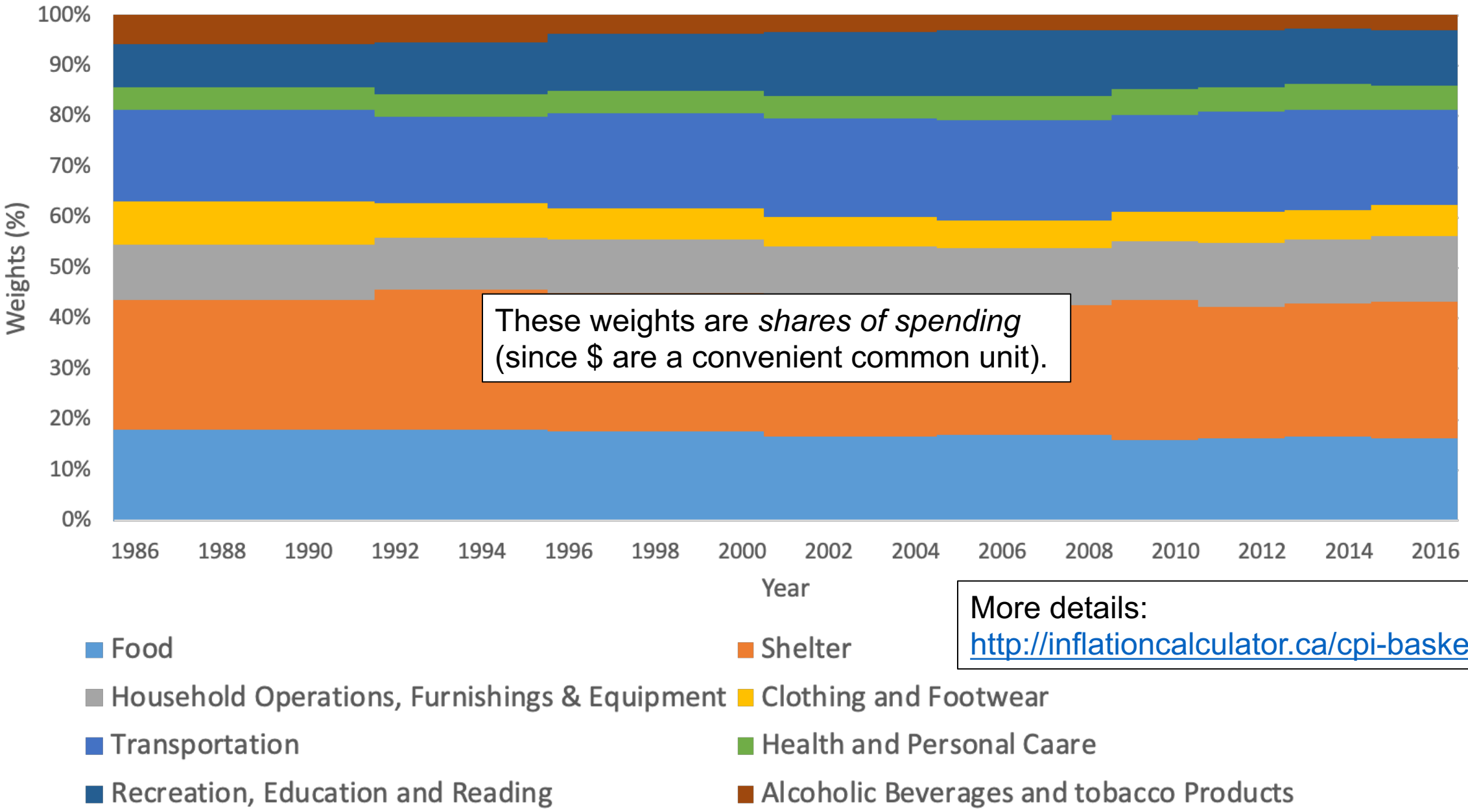
Using an index to calculate yearly inflation, f

- Let P_t = Price index for year t
- Inflation, f = the % increase in P from one year to the next
- The rate of inflation in 2016 (say) would then be $(P_{2016} – P_{2015})/P_{2015}$
- $f_{2016 =} (P_{2016} – P_{2015})/P_{2015}$

Some Common Indices

- Consumer price index (CPI): goods bought by a representative household
- Producer price index (PPI): goods bought by a representative producer
- GDP Deflator: all goods and services produced within Canada in a given year.

Evolution of Canadian CPI Basket Weights (Broad Classes)



More details:
http://inflationcalculator.ca/cpi-basket/

How do these weights figure in?

- (Details are in Appendix 9A of the textbook.)
- Canada (and many other countries) use a *Laspeyres* price index, which is a bit more complicated than our basic cookies & pop index.
- We need three components:
  - A price for each class j in year t, p_{tj} (following textbook's notation)
  - A base year price for each class, p_{0j} (the text uses year 0 as the base year)
  - A weight/share of base year spending by class, s_{0j} (if the weights never change)
  - Canada uses a modified Laspeyres index called a *Lowe* index, in which the shares are calculated using data from different years: quantities are from some *weight reference year* for which we have good quantity data, while prices are from the base year (*price reference year*). For details, see sections 6.23 to 6.35 on https://www150.statcan.gc.ca/n1/pub/62-553-x/2015001/chap/chap-6-eng.htm
  - This information is FYI only. You don't need to be able to calculate a Lowe index for ECON 180.

How do you calculate shares of spending?

$f(x)$

- The share of spending of Class j in year t is the % of the value of the basket that year that was spent on Class j.
- Let q_{tj} be the quantity of Class j goods bought in Year t.
- Then total spending on Class j in Year t is $p_{tj}q_{tj}$ (Price x Quantity)
- If there are n categories, total spending on ALL basket goods in year t is $\sum_{i=1}^{n} p_{ti}q_{ti}$.
- The share of spending of Class j in year t is therefore

$$s_{tj} = \frac{p_{tj}q_{tj}}{\sum_{i=1}^{n} p_{ti}q_{ti}}$$

- (Divide the amount spent on Class j, by the amount spent on all classes, in Year t.)

$f(x)$

Assembling the Laspeyres Price Index

- Suppose we are keeping our weights constant at base year (Year 0) levels.
- If there are n classes, then the Laspeyres price index for year t, L_t, is

$$L_t = \left(\sum_{i=1}^{n} \frac{p_{ti}}{p_{0i}} s_{0i} \right) \times 100$$

- Keep in mind this is simpler than the CPI calculation actually used by Statistics Canada. For details, see https://www150.statcan.gc.ca/n1/pub/62-553-x/2015001/chap/chap-6-eng.htm

Example: Apples and Oranges

	Year 0 Price	Year 1 Price	Year 0 Quantity	Year 1 Quantity
Apples	$1	$2	10	9
Oranges	$3	$4	8	7

- Using Year 0 as the base year, let's calculate a Year 1 price index.
- For our Laspeyres Index, we only need Year 0 shares.
- Year 0 spending on apples: 1 $/apple x 10 apples = $10
- Year 0 spending on oranges: 3 $/orange x 8 oranges = $24
- Total Year 0 spending: $10 + $24 = $34
- $s_{0apples}$ = $10/$34 = 29%, $s_{0oranges}$ = $24/$34 = 71%

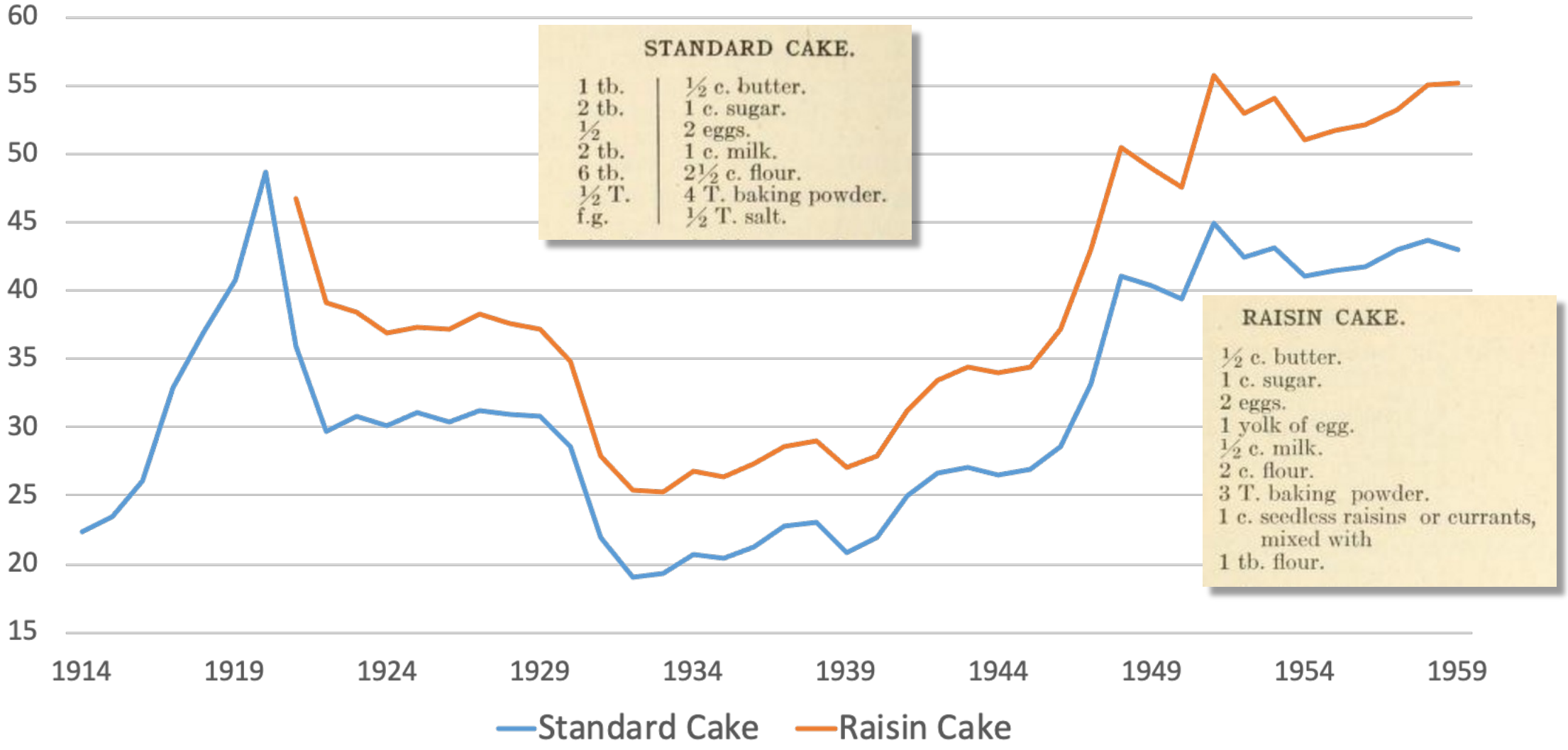
Moving on…

$$L_1 = \left(\frac{p_{1apples}}{p_{0apples}} s_{0apples} + \frac{p_{1oranges}}{p_{0oranges}} s_{0oranges} \right) \times 100$$

$$L_1 = \left(\frac{\$2}{\$1} \times 29\% + \frac{\$4}{\$3} \times 71\% \right) \times 100 = 152.9 \text{ (rounded)}$$

- Note that, by definition, the index is 100 in the base year.
- The choice of the base year depends on the application – your text uses the project's 'Year 0', because that's a very convenient choice for engineering economics applications.
- We could have just as easily used Year 1: in CPI indices, etc., the base year can be any year for which complete data is available.
- For example... Cake ingredients as a basket, 1925 as the base year:

Cost of Ingredients (Canadian cents)
(Sources: DBS, The Canadian Cookbook 1925 & 1953)

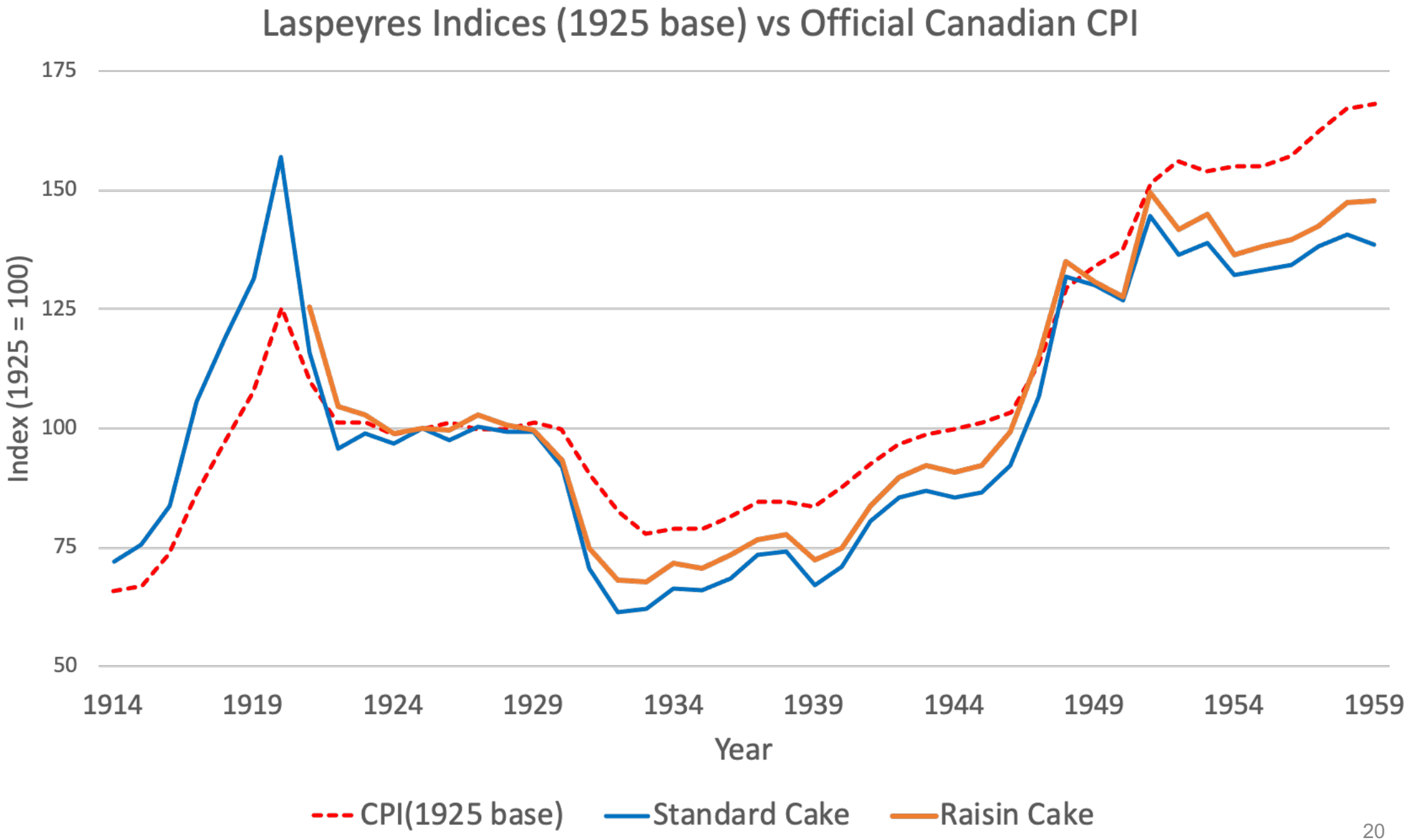


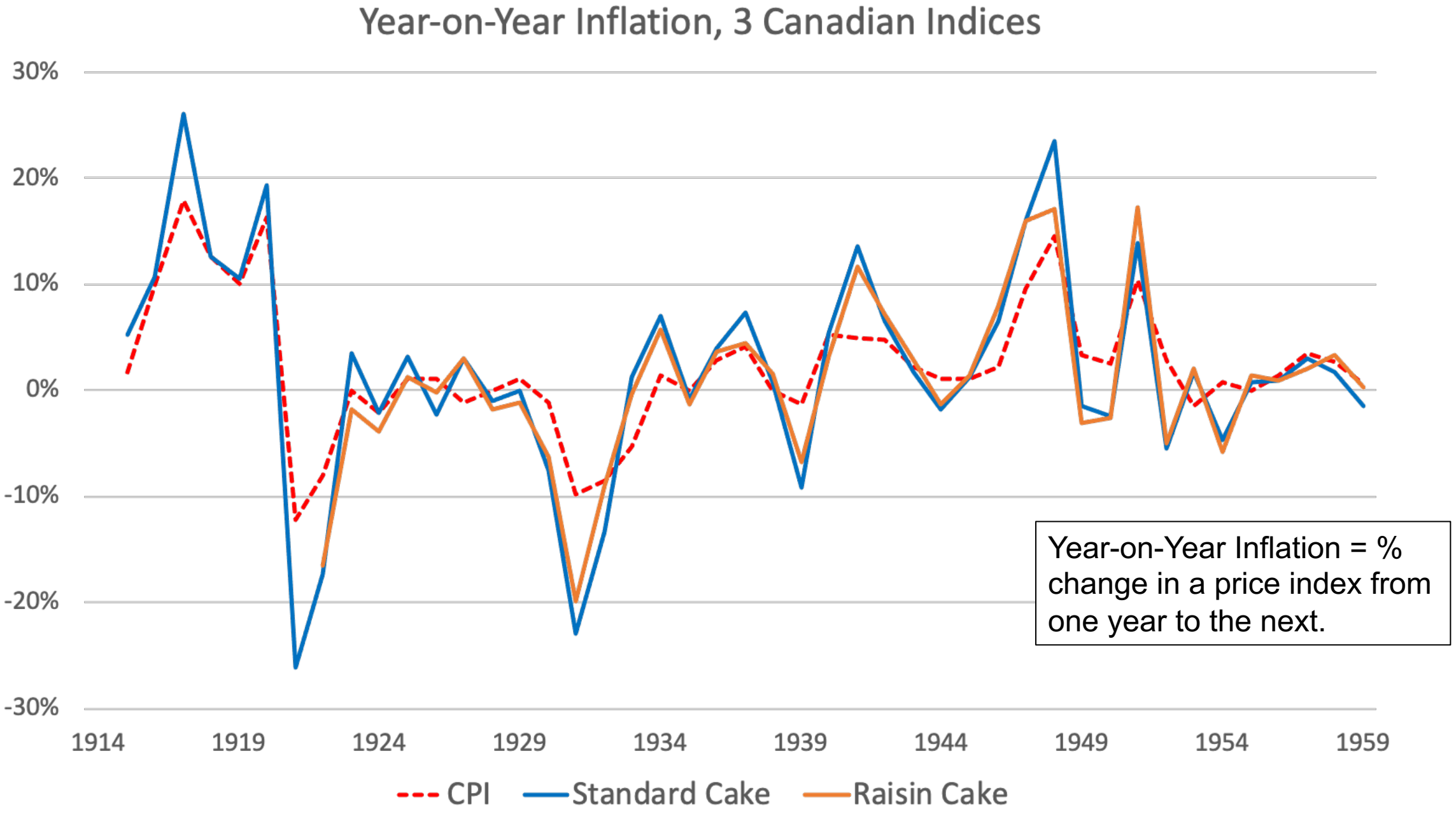
STANDARD CAKE.

1 tb.	½ c. butter.
2 tb.	1 c. sugar.
½	2 eggs.
2 tb.	1 c. milk.
6 tb.	2½ c. flour.
½ T.	4 T. baking powder.
f.g.	½ T. salt.

RAISIN CAKE.

½ c. butter.
1 c. sugar.
2 eggs.
1 yolk of egg.
½ c. milk.
2 c. flour.
3 T. baking powder.
1 c. seedless raisins or currants, mixed with
1 tb. flour.


Laspeyres Indices (1925 base) vs Official Canadian CPI
175
150
125
100
75
50
Index (1925 = 100)
1914
1919
1924
1929
1934
1939
1944
1949
1954
1959
Year
CPI(1925 base)
Standard Cake
Raisin Cake


Year-on-Year Inflation, 3 Canadian Indices
30%
20%
10%
0%
-10%
-20%
-30%
1914
1919
1924
1929
1934
1939
1944
1949
1954
1959
CPI
Standard Cake
Raisin Cake
Year-on-Year Inflation = % change in a price index from one year to the next.

Problems with indices

- **Substitution bias**: Pizza's more expensive? Switch to ramen. Problem: weights don't reflect this. (This is one reason Canada re-calculates weights.)
- **Increase in quality bias**: a phone in 2002 is not the same as a phone in 2020
- **New product bias**: things that didn't exist at the basket's creation aren't taken into account.
- **Outlet bias**: where should price be sampled? Thrifty's or CostCo?

2002

=

2020

???

=

$f(x)$

Party trick: Price in any year

- Let C_t = cost in year t

$$\frac{C_X}{C_Y} = \frac{CPI_X}{CPI_Y}$$

- When you hear ‘in 1995 dollars’ or some such, this is what they’re talking about.
- Intuition: If things are twice as expensive in Year X as in Year Y, the cost in Year X is twice the cost in Year Y.

Another way to think about it…

- If the CPI is 80 in Year X and 112 in Year Y, that means that (consumer) goods that cost $80 in Year X cost $112 in Year Y.
- It's that easy! A lot of people spend a lot of time making the CPI very user friendly.
- → Goods that cost $1 in Year X cost $112/80 = $1.40 in Year Y.
- So to get the Year Y price of a good that cost $P in Year X…
- Multiply by 1.4: $P x 1.4 = $P x 112/80 = $P x CPI_Y/CPI_X
- →Year Y price = Year X price x (CPI_Y/CPI_X)
- Which is the equation from the previous page, rearranged.

Where this might come in useful...

Originally, this example included highway construction costs...

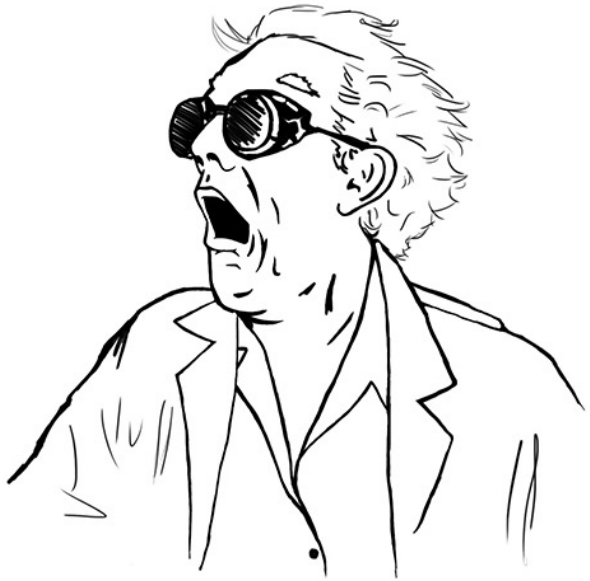
- Marty McFly uses a time machine to travel between 1955, 1985 and 2015.
- All of his destinations are in the United States.
- The US CPI was 26.8 in 1955, 107.6 in 1985 and 235.8 in 2015.
- The time machine is made out of a DeLorean DMC-12 car.
- In 1985, a DeLorean could be bought for $12,000
- In 2015, a DeLorean sold on average for for $54,000.
- Has the DeLorean become cheaper or more expensive with age?

…but where we're going with this example, we don't need roads.

What is the 1985 equivalent of $54,000 today?

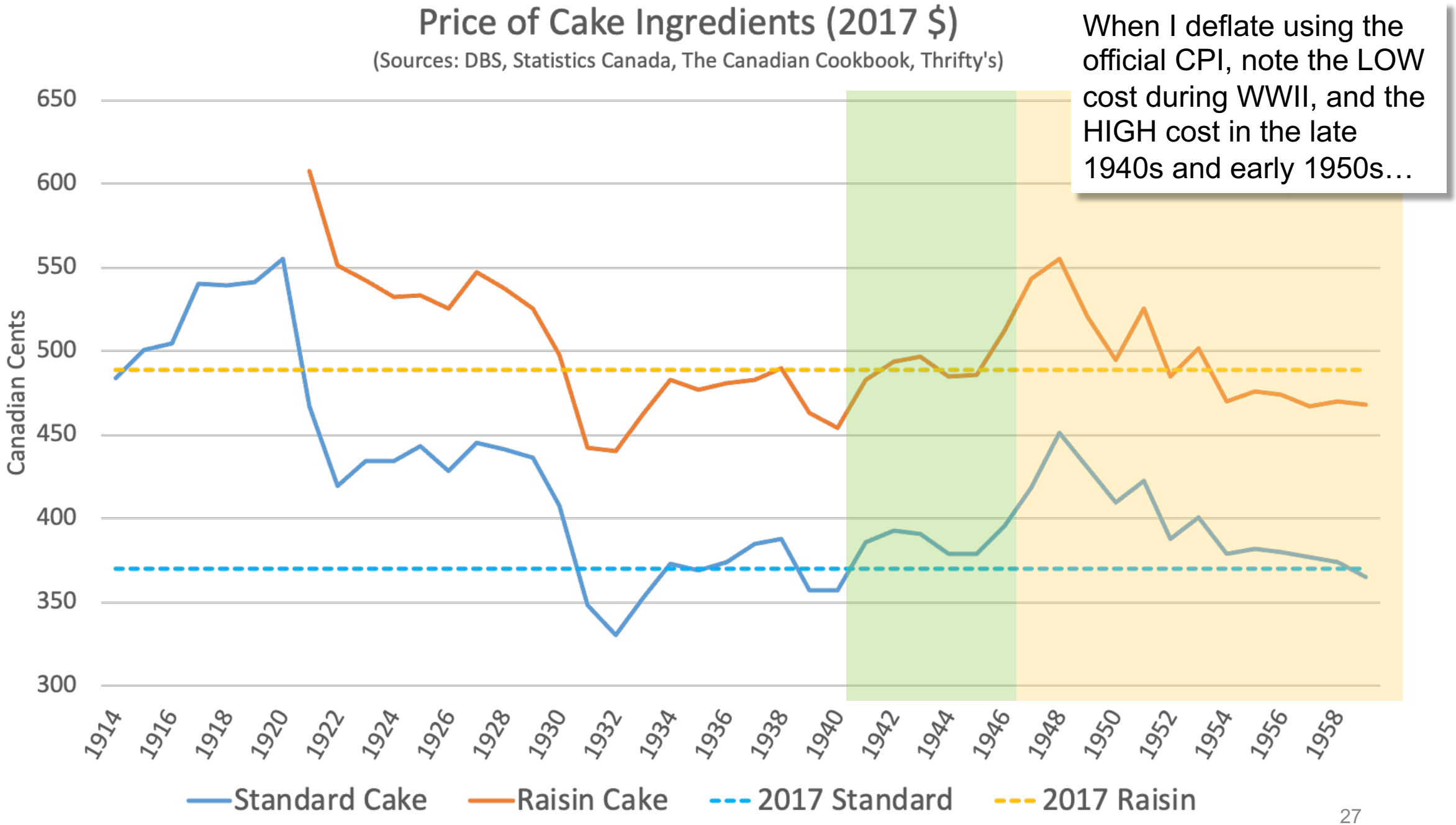
$$P_{1985} = P_{2015} \frac{CPI_{1985}}{CPI_{2015}}$$

$$P_{1985} = \$54{,}000 \frac{107.6}{235.8} = \$24{,}641.22$$



- In real terms, the DeLorean has doubled in price!
- Should Marty (and Doc) start a cross-time used car dealership?
- Sadly, over 30 years, that return only averages to about 2.5% a year…
- $\$24{,}641.22 = \$12{,}000 \times (1 + 0.24742)^{30}$
- Probably better to bring back a sports almanac…

http://www.kedificil.com/wp-content/uploads/2013/08/great-scott-doc-back-to-the-future-drawing.jpg


Price of Cake Ingredients (2017 $)
(Sources: DBS, Statistics Canada, The Canadian Cookbook, Thrifty's)
When I deflate using the official CPI, note the LOW cost during WWII, and the HIGH cost in the late 1940s and early 1950s…
Canadian Cents
650
600
550
500
450
400
350
300
1914
1916
1918
1920
1922
1924
1926
1928
1930
1932
1934
1936
1938
1940
1942
1944
1946
1948
1950
1952
1954
1956
1958
Standard Cake
Raisin Cake
2017 Standard
2017 Raisin

Inflation tracking for time travelers

- When going back in time from 1985 to 1955, Marty was surprised to find how cheap everything was.
- A 12-ounce bottle of Pepsi cost 10 cents in 1955, compared to 15 cents in 1985 (inferred from the cost of a 2-litre bottle).
- Let's calculate average annual inflation between 1955 and 1985 using first the CPI, and then by using the price of 12 ounces of Pepsi.
- The two values will *not* be the same! There's immediately clear reason why the price of Pepsi should track the CPI perfectly.
- Our two baskets (CPI basket, 12 ounces of Pepsi) are very different.

- Let P stand for the index used. After 30 years of inflation of f per year, something that cost \$1 in 1955 would cost \$1 x $(1+\mathrm{f})^{30}$ in 1985.
- Our index is P_{55} in 1955, and P_{85} in 1985.

$$P_{55}(1+\mathrm{f})^{30} = P_{85}$$

$$\rightarrow \mathrm{f} = \left(\frac{P_{85}}{P_{55}}\right)^{\frac{1}{30}} - 1$$

$$\mathrm{f}_{CPI} = \left(\frac{107.6}{26.8}\right)^{\frac{1}{30}} - 1 = 4.7\ \%$$

$$\mathrm{f}_{Pepsi} = \left(\frac{0.15}{0.10}\right)^{\frac{1}{30}} - 1 = 1.4\ \%$$

1985 ad for Pepsi

AFTER HOURS

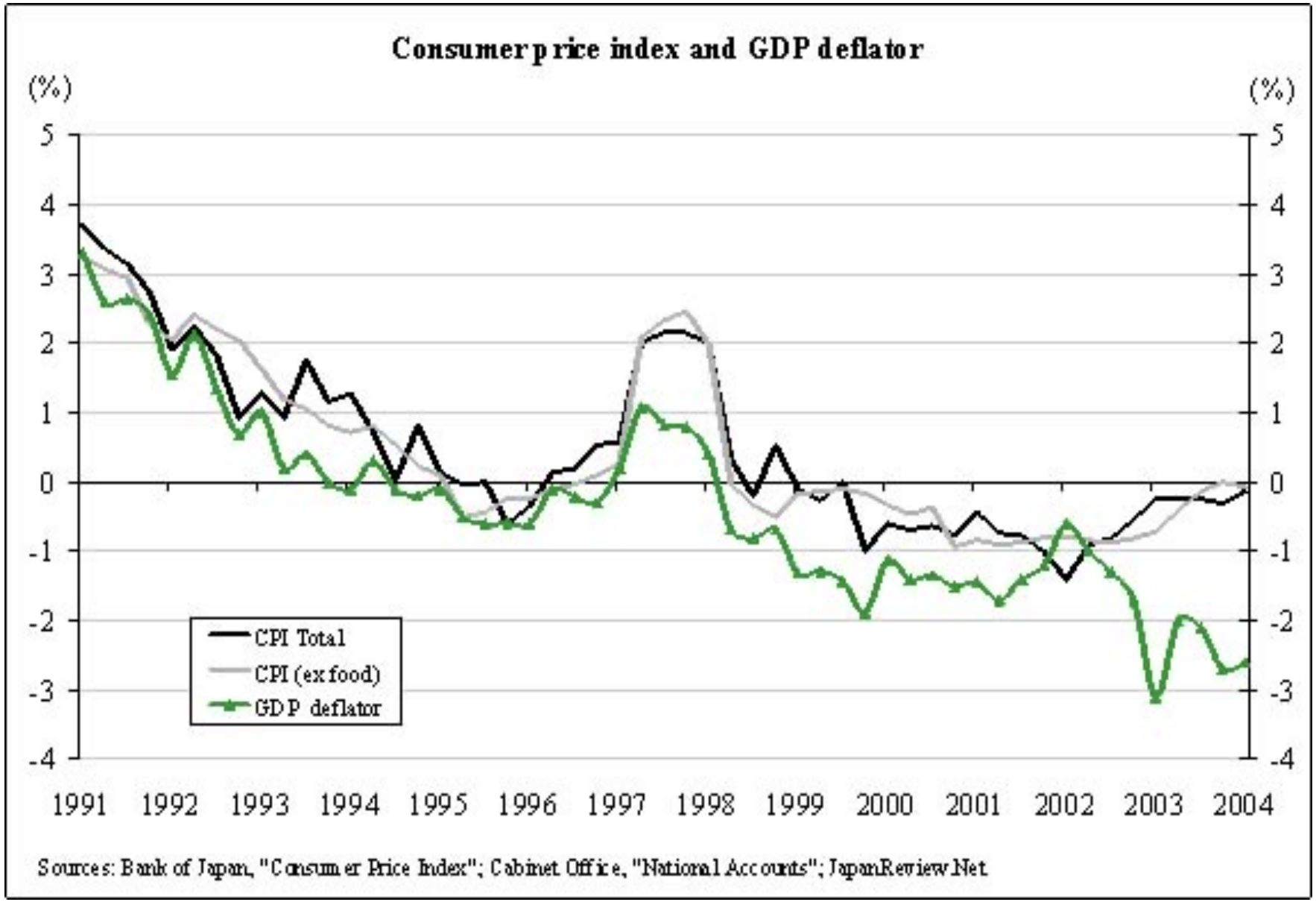
- What‘s so bad about inflation? (1 slide)
  - Deflation in Japan (3 slides)

What's so bad about inflation?

- If *all* prices rise, including wages, why worry?
- First: some redistribution of income (winners and losers)
- If your income is 'sticky', you can lose out.
- (Important in many union negotiations)
- Menu costs: it costs money to send someone around with the price gun and/or print new menus
- Sometimes inflation can't be accurately predicted.
- Unexpected(ly high) inflation helps borrowers and hurts lenders.
- Your turn: why?
- Unexpectedly low inflation helps lenders and hurts borrowers.
- Deflation is sticky, and brings its own problems…

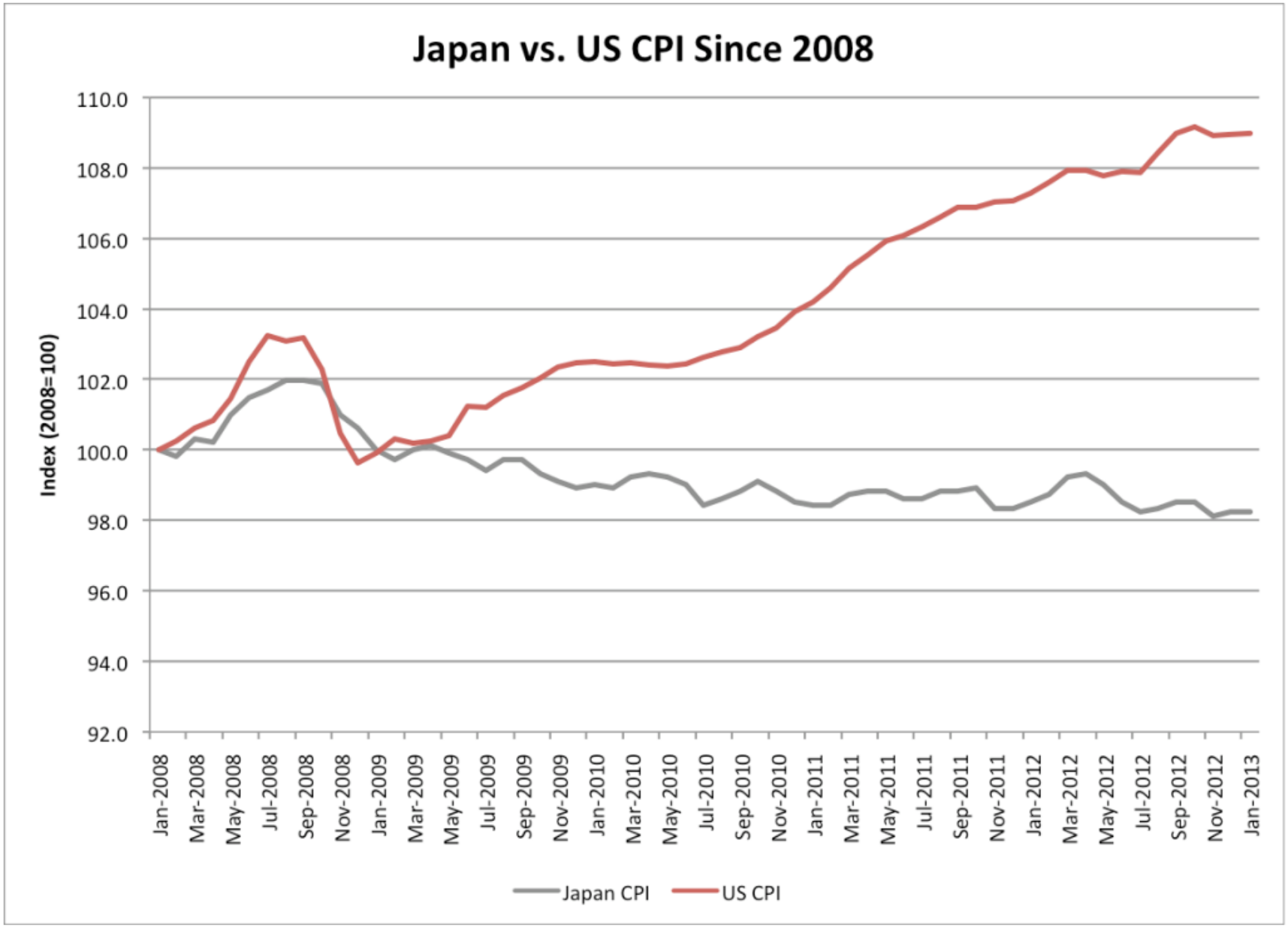
Inflation bad, deflation good? Not quite…

- In the 1990s (and after), Japan saw *falling* prices for just about everything.
- You'd think this would boost spending, since demand slopes downward.
- BUT people expected prices to fall.
- →Lower sales, which led to lower prices
- A vicious self-fulfilling cycle of expectations.
- This trap is VERY difficult to get out of.
- Stable, small, positive inflation is what most central banks aim at
- (about 2% a year is a common target)
- It's uncertain whether the Bank of Japan can create lasting inflation.
- (credibility, overcoming expectations)



(Source: http://www.japanreview.net/essays_can_the_bank_of_japan_create_inflation.htm)

Well worth reading, if a bit beyond the scope of this course.



(Source: http://avondaleam.com/us-vs-japan-cp/)