

## **Measuring the Cost of Living**

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## The cost of living



#### •Measures of inflation are crucial

- Determine monetary policy
- Index benefits and taxes
- Set wages in private and public sector contracts
- Inflate/deflate historical series of economic data

•But there are different measures (e.g. in the UK: RPI, CPI, CPIH, RPIJ, GDP deflator..)

•Which measure you use can make a lot of difference



#### Source: IFS Green Budget, 2014 Note: Incomes equivalised using the OECD scale

Median real HH incomes (CPI and RPI)

Institute for

"The cost of living crisis": 2014 Labour poster





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# Measuring the cost of living (this presentation)



- 1. How are changes in the cost of living measured?
- 2. What are different measures used for?
- 3. Why are there differences across measures?
- 4. What can we say about which of these gives the "right" answer?

## Inflation measures in the UK



#### "A man with one watch knows what time it is. A man with two watches is never sure." – Segal's law

	СРІ	СРІН	RPI	RPIJ
Budget data	National accounts	National accounts	Living Costs and Food Survey	Living Costs and Food Survey
Population	All consumer spending in UK	All consumer spending in UK	Excludes top earners and some pensioners	Excludes top earners and some pensioners
Owner occupied housing	×	$\checkmark$	$\checkmark$	$\checkmark$
'Elementary' formulae	Jevons and Dutot	Jevons and Dutot	Carli and Dutot	Jevons and Dutot
National Statistic	$\checkmark$	×	×	$\checkmark$







Source: Office for National Statistics

## Uses ('Inflation Shopping')



#### •CPI

•Indexation of benefits (notionally) and pensions

- •Indexation of tax thresholds
- •Monetary policy
- •Public sector pensions

#### •RPI

- Excise duties
- •Inflation indexed gilts
- •Interest rates on student loans

## **Indexation changes timeline**



2015

•RPI/Rossi indices used for increase benefits and tax thresholds •Government announces changes in benefit indexation rules

- •Government switches to CPI for working age benefits (projected to save +£6bn in 2014-15)
- Public sector pensions to be indexed by the CPI
   State pension to rise by highest of earnings, RPI and 2.5% (triple lock)
- State pension to rise by highest of earnings, CPI and 2.5%
  Direct tax thresholds to rise by CPI (projected extra revenue +£780m in 2017-18)

•Welfare Benefits Up-rating Bill: Benefits to rise by 1% regardless of inflation for April 2013-2015 (projected to save +£2.3bn in 2015-16)

•July: Government announces most working-age benefits to be held constant in cash terms until March 2020 (projected to save £+4bn in 2019-20)

•RPI declassified as a national statistic •New RPIJ index published



•The RPI has gradually been replaced by the CPI for a variety of official purposes

## •In addition in 2013, the UK Statistics Authority declared that the RPI should no longer be treated as national statistic

•Office for National Statistics (ONS) started to publish a new index - the RPIJ

•Decided not to replace the RPI (an option which they had been considering)

## **Decision moved markets!**





#### Source: Johnson Review (data from Debt Management Office)



•The reason for the decision was that the RPI makes use of the *Carli* index in its construction

•This is not used in the CPI

•In the RPIJ the *Carli* index is replaced with the *Jevons* index as in the CPI

•These are indices used at the 'elementary level' of the index

## Aggregation





The elementary level



•Define price relative for good *i* 

•At most levels of aggregation, the price index is a weighted average of price relatives made up of indices from the previous level

•E.g to get the group level index for "alcohol" we take a weighted average of the indices for "beer" and "wine"

 $\sum_{i} W_{i,r} \left( \frac{p_{i1}}{p_{i0}} \right)$ 

 $p_{i1}$ 

 $p_{i0}$ 





•Budget share information is take from the National Accounts for the CPI and from the Living Costs and Food Survey

## •At the elementary level we use price quotes take for very specific products

•E.g. different brands of 800g loaves of white bread sold in certain types of store in the South East of England

•Budget share information at this level is difficult to obtain (though suitable datasets are becoming available for some goods)

•As a result we take *unweighted* averages

## **Elementary indices**



$$Carli = \frac{1}{N} \sum_{i=1}^{N} \frac{p_{1}^{i}}{p_{0}^{i}}$$

$$Jevons = \sqrt[N]{\prod_{i=1}^{N} \frac{p_1^i}{p_0^i}}$$

•The Carli index is a simple (arithmetic) mean of price relatives

•The Jevons is a *geometric* mean

•Mathematical fact: The Jevons is always less than or equal to the Carli index

### **Carli vs Jevons**



Gian Rinaldo Carli (1720-1795)





William Stanley Jevons (1835-1882)

#### •Why doesn't the ONS like the Carli index?

•To answer this we need to look at some theory...

VS

## **Theory of index numbers**



"The theory and measurement of economic index numbers presents side by side some of the most difficult and abstruse theory with the most immediately practical issues of everyday measurement."- Angus Deaton



•Inflation is defined as an increase in the *general* level of prices

- •ONS price survey collects the prices of over 120,000 items each month
- •Fundamental problem: How to aggregate all of this into a single inflation number to get inflation from one month to the next?

•To solve this we need an *index* 

$$P(p_0, p_1, q_0, q_1)$$



•There are different approaches to selecting an appropriate index

- •Economic approach: does the index approximate the change in the cost of living
- •Test approach: does the price index *P()* satisfy appropriate (common-sense) axioms
- •Statistical approach: is the price index a good statistical predictor of the average price change?
- •Not going to discuss this one (sorry)

The Economic approach



•Economists make use of a cost function  $c(u_t, p_t)$ 

•This tells us the cost (level of expenditure) need to attain a given utility when the consumer faces prices p<sub>t</sub>

•A cost of living index gives the ratio of cost functions in two periods

$$C = \frac{c(u_0, p_1)}{c(u_0, p_0)}$$

•This tells us how much money we need to give consumer to compensate them for the price change

The Economic approach: Laspeyres



•There are a potentially infinite number of cost of living indices depending on the nature of consumers preferences

•One option: a Laspeyres index for two periods

$$L = \frac{\sum_{i=1}^{i=1} q^{i_0} p^{i_1}}{\sum_{i=1}^{i=1} q^{i_0} p^{i_0}} = \sum_{i=1}^{i=1} w_0^{i_1} \frac{p^{i_1}}{p^{i_0}}$$

•This assumes *Leontief* preferences over different goods

$$u_0 = \max(q_0^{-1}, q_0^{-2}, q_0^{-3}, q_0^{-4}...)$$

#### •Assumes no substitution across products as relative prices change

•Using this measure can lead to a substitution bias











$$L = \sum_{i=1}^{i} w_0^i \frac{p_1^i}{p_0^i} \ge \frac{c(u_0, p_1)}{c(u_0, p0)}$$

## •In general, substitution bias means that a Laspeyres index gives an inflation rate that is too high

The Economic approach: Geometric Laspeyres

•Some other formulae may be exact for certain preferences

•If preferences are Cobb-Douglas, ratio of cost functions is given by

$$\frac{c(u_0, p_1)}{c(u_0, p_0)} = \frac{\sqrt[N]{\prod_{i=1}^{N} (p_1^i)^{w^i}}}{\sqrt[N]{\prod_{i=1}^{N} (p_0^i)^{w^i}}} = \sqrt[N]{\prod_{i=1}^{N} (\frac{p_1^i}{p_0^i})^{w^i}}$$

#### •This incorporates substitution of a particular kind

•A 10% increase in price results in a 10% reduction in quantity i.e. an own price elasticity of -1

•Budget shares of different goods remain constant as prices change

## The Economic approach: Carli vs Jevons



•Leontief preferences: Cost function is share weighted average of price relatives

•Cobb-Douglas Preferences: Cost function is share weighted geometric average of price relatives

•Which of these looks more realistic?

•You decide!

•The first of these resembles the Carli and the second the Jevons index

## The Economic approach: Carli vs Jevons



•Can we say that the Carli suffers from substitution bias?

- •Does the Jevons assume a certain amount of substitution?
- •Can we decide which is better on this basis?

#### •In the end these questions did not enter the ONS's decision

•Reason 1: The Carli and Jevons are both *unweighted* and so we cannot know if they approximate the Laspeyres and Geometric Laspeyres respectively

•Reason 2: The ONS doesn't believe in the economic approach

"...neither the CPI nor the RPI is a cost of living index..." – ONS (2010)

## **Alternative criteria: The Test approach**



- •An alternative approach to the problem is the test approach
- •This asks if the index satisfies common sense properties
- •There are many (many!) such tests

Alternative criteria: The Test approach



•An example test ("identity" test)

Suppose

$$p_0 = p_1 = p$$
$$p_0^i = p_1^i \quad \forall i$$

•i.e

•Then, any reasonable price index should equal one

P(p,p)=1

•Both the Carli and the Jevons pass this test

$$Carli = \frac{1}{N} \sum_{i=1}^{N} \frac{p^{i}}{p^{i}} = 1 \qquad Jevons = \sqrt[N]{\prod_{i=1}^{N} \frac{p^{i}}{p^{i}}} = 1$$





•Most tests are satisfied by both the Carli and Jevons

- •However the Carli also fails some important properties
- •The most significant of these is "time reversal"

$$P(p_0, p_1) \times P(p_1, p_0) = 1$$

## **Time reversal example**



Prices	Period 0	Period 1	Period 2	
Shop A	1	1.25	1	
Shop B	1	0.9	1	
		Period (0,1)	Period (1,2)	Chained
Carli	•••	$\frac{1}{2} \left( \frac{1.25}{1} + \frac{0.9}{1} \right) = 1.075$	$\frac{1}{2} \left( \frac{1}{1.25} + \frac{1}{0.9} \right) = 0.93$	$1.075 \times 0.93 = 1.03$
Jevons	•••	$\sqrt{\frac{1.25}{1} \times \frac{0.9}{1}} = 1.06$	$\sqrt{\frac{1}{1.25} \times \frac{1}{0.9}} = \frac{1}{1.06}$	$1.06 \times \frac{1}{1.06} = 1$

**Time reversal example** 



•The (chained) Carli index shows a price increase over the two periods

•In fact, the Carli fails time reversal in a "biased" manner

## $Carli(p_0, p_1) \times Carli(p_1, p_0) \ge 1$

•Chaining of the index is necessary if we want to for example introduce new goods to the index

•The ONS updates the basket of goods in January of each year

## A yet more serious failure: "price bouncing"



Prices	Period 0	Period 1	Period 2	
Shop A	1	1.25	1	
Shop B	1.25	1	1.25	
		Period (0,1)	Period (1,2)	Chained
Carli	•••	$\frac{1}{2} \left( \frac{1.25}{1} + \frac{1}{1.25} \right) = 1.025$	$\frac{1}{2} \left( \frac{1}{1.25} + \frac{1.25}{1} \right) = 1.025$	1.025×1.025=1.0506
Jevons	•••	$\sqrt{\frac{1.25}{1} \times \frac{1}{1.25}} = 1$	$\sqrt{\frac{1}{1.25} \times \frac{1.25}{1}} = 1$	1×1=1

## The Carli: a flawed measure?



•The failures of the Carli (esp. with regard to Time Reversal) are what led the ONS to introduce the new RPIJ and UKSA to declassify the RPI as a national statistic

- •No other European country uses the Carli index
- •Other countries have also been switching away from it
- •Canada (1978)
- •Luxembourg (1996)
- •Australia (1998)
- •Italy (1999)
- •Switzerland (2000)

## The Carli: a flawed measure?



•However, at subsequent stage of aggregation a weighted arithmetic average is still used in both the RPI and CPI

•This is not time reversible and would not be even if all the elementary level indices were time reversible

•We can say that fixing the indices at this lower level does reduce time reversal biases in the overall index however...

## **Conclusions and future**



### •Which measure is better?

- •CPI does not include owner-occupied housing costs
- •RPI uses Carli index
- •CPIH an attempt to introduce owner occupied housing costs into the CPI
- •RPIJ an attempt to replace the Carli index with the Jevons
- •Do we need both?