

PRICE INDEX THEORY

Course lectures within Economic Statistics at Stockholm University [Second set of slides]

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- Weithting data are available on higher levels of aggregation
- Overall index is practically computed by weighting together of subindices
- Elementary aggregates are on lowest level of aggregation – weights usally not available
 - Solution Index formulas "without q" needed



 $\frac{1}{n}\sum_{i=1}^{n}p_{1,i} = \sum_{i=1}^{n}p_{1,i}$ $\frac{1}{n} \sum_{i=1}^{n} p_{0,i} = \sum_{i=1}^{n} p_{0,i}$

► Ratio of mean prices [Dutot]

 $I = \frac{1}{n} \sum_{i=1}^{n} \frac{p_{1,i}}{p_{0,i}}$

Mean of price relatives [Carli] **Beware** – bias!



Geometric mean [Jevons]
 Handles disparate price levels adequately
 Partially accounts for substitution



Weighted geometric mean Weighted by value (turnover) V_i

Jevons index combined with low-level weights

$$I_{y-1,\text{Dec};d}^{y,m} = \left(\prod_{k=1}^{n_d} p_{y,m;k} / p_{y-1,\text{Dec};k}\right)^{1/n_d}$$

$$I_{y-1,\text{Dec};g}^{y,m} = \prod_{d \in D(g)} (I_{y-1,\text{Dec};d}^{y,m})^{w_d}$$

= $\exp(\sum_{d \in D(g)} w_d \log I_{y-1,\text{Dec};d}^{y,m}), \sum_{d \in D(g)} w_d = 1$

Features of the Jevons index



- ③ Not disturbed by spread in price level
- Accounts for consumer substitution to some extent – suitable for Cost-Of-Living Index (coli)
- Index sensitive to EA level choice
- Breaks down for zero prices
 Special fix required





Index by EA size Coicop 01 – December 2001



Theoretical effects (by Dalén)

Math. expectation of GM elementary index falls below true mean μ by the amount:



Sources of errors in CPI



- > Sampling error in weights
- Uncertainty in Quality Adjustment (QA)
- > Measurement error in price observations
- Some undercoverage
- Proxies for hard-to-measure prices
- Errors by mistakes
 Urgent matter to avoid these!



Quality Assurance of work

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- Management commitment to quality
- > Staff competence
- > Knowledge of markets
- > Documentation of procedures
- > Work instructions
- Safe procedures
- Price data validation and editing
- > Output validation
- > Debriefing



Sampling error

Standard _error(I)
$$\approx \frac{\sigma\left(\frac{p_{1,i}}{p_{0,i}}\right)}{\sqrt{n}}$$
 [×(deft)]

$$\approx \frac{\sqrt{\frac{1}{N} \sum_{i=1}^{N} \left(\frac{p_{1,i}}{p_{0,i}} - \frac{1}{N} \sum_{i=1}^{N} \frac{p_{1,i}}{p_{0,i}} \right)^{2}}}{\sqrt{n}} \times (\text{deft})$$

Två sampling dimensions

Products/Services/Categories







Sampling principles

Sampling of outlets (shops etc.):

- Sampling with pps from business register (used in Swedish practice)
- Cluster sampling of regions

Sampling of products:

- Sampling with pps from product register (if available)
- Judgmental sampling of product specifications

> Judgmental sampling of models in shops

Aggregation examples (SPPI)

Architects:

Prices for 3 categories (differ between firms) 2 steps: 1) Mean price for firm 2) Index = ratio of mean prices

Technical consultants:

Prices for 5 work areas – weights available
 2 steps: 1) Sub-index for work area
 = ratio of mean prices
 2) Index = weithting of sub-indices

Survey design weights



$$I = \frac{\sum_{i} q_{0,i} p_{1,i}}{\sum_{i} q_{0,i} p_{0,i}} = \sum_{i} w_i \cdot \frac{p_{1,i}}{p_{0,i}}$$

• Estimation with design weights: $I = \sum_{i} \frac{w_i}{\pi_i} \cdot \frac{p_{1,i}}{p_{0,i}}$

where π_i = sampling probabilit y \Rightarrow For pps sampling:

$$\pi_i = n w_i$$

More problems of baskets

Problem:

- Product models vanish, new ones appear
 <u>Remedies:</u>
- Annual re-sampling of products for price observation
- *Replacement* of products in sample

Quality Adjustment at replacement
Various methods



Replacement is restricted by product specifications



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1) Tight product specifications Ex. "Biscuits brand X, 300 g" + Strong theory, simple practice - May miss price changes 2) Loose product specifications Ex. "Rye loaf 300-750 g, in slices" + Adapts to real world – Weak theory, hard practice



A basic dilemma

- Index has to follow basket sample
 Representative sample Laspeyres principle: Basket is fixed
- But also, index should reflect the current market





A firm in SPPI sample joins another by merger

<u>Solution</u> <u>– guided by Laspeyres principle</u>

- > Continue with prices from the new firm
- If both firms were in the sample, take the new firm's prices for both

Re-sampling frequency



- Pros of frequent re-sampling
 Sample reflects current market
 Adaptive to dynamic markets
 Statistically scientifically correct
- Pros of infrequent re-sampling
 Respondents get experience: easier for them + better response quality
 (Controversial linking avoided)



Some scope issues

Universes of purchase transactions

- Domestic concept purchases within the country (also by foreign visitors)
- National concept purchases by residents of the country (also those made abroad) Aggregation principles
- Plutocratic weight by expenditure (usual)
- Democratic weight by households/people
 <u>Conditional coli</u>
- Constant environment assumed heating cost raise by colder winter shall not be shown

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Sources of expenditure data for weight computation



Household Budget Survey (HBS)

- Suits Domestic concept
- Sampling errors
- Often low response rate due to respondent burden

> National Accounts

- Solution Statistics etc.
- Various complementary sources, such as industry organisation data

Price updating of weights



Price updating questioned (?)

$$I_{2005,dec}^{2007,april} = \sum_{i} W_{2005,i} \cdot \frac{P_{2007,april,i}}{P_{2006,dec;i}}$$

$$= \sum_{i} W_{2005,i} I_{2006,dec,i}^{2007,april}$$

• Lowe-index: $W_{2005,i} = \frac{U_{2005,i} I_{2005,i}^{2006,dec}}{\sum_{j} U_{2005,j} I_{2005,j}^{2006,dec}}$
• Follows a basket \Im Follows a basket \Im Conforms to HICP rules
• Young-index: $W_{2005,i} = \frac{U_{2005,i}}{\sum_{j} U_{2005,j} I_{2005,j}^{2006,dec}}$

Missing prices



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Causes:

- > Non-response (refusal etc.)
- Seasonal product
- > Model temporarily unavailable or not sold
- Model permanently unavailable: replace)
 <u>Remedies, main alternatives:</u>
- Use preceding price ('carry forward')
 ♥ May currently miss price change
 Skip observation

Solution May yield volatility in index





Methods for seasonal products – ideas

- Seasonal basket / Rothwell index
 Øut-of-season products excluded
- Counter-seasonal imputation
 Øut-of-season products represented by in-season seasonal products
- All-seasonal imputation
 Øut-of-season products represented by available products





Methods for seasonal products – properties

Seasonal basket index *and* Counterseasonal imputation index *tend to have similar outcome – under condition of similarity in price curves for seasonal products*



