Is There a Measurement bias from quality adjustment in Austria and Italy?

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Rome

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Introduction
Introduction

• Price Index demands constant quality => adjustment for quality when products change
• Fully missing quality adjustment (QA) would lead to a biased index
• What about a bias if QA is done in an „incorrect way“? What is „correct“ quality adjustment?
• No common sense on how to evaluate quality => Better: define corridor for meaningful quality adjustment
• Bias: QA result outside the corridor
• Presentation elaborates this idea and presents results for Austria and Italy based on microdata
Quality adjustment in theory and practice
Quality adjustment methodology

Quality adjustment methods

Implicit methods
- General assumptions on price and quality changes
  - Direct price comparison
  - Link-to-show-no-price change/(simple) overlap
  - Bridged overlap (class/overall/targeted mean imputation)
    - Easy to apply
    - Possible bias

Explicit methods
- Accounting for individual product characteristics
  - Hedonic quality adjustment
  - Option pricing
  - Supported judgemental quality adjustment
    - Individual results for product items
    - Large investments, not undisputed results

Different Methods = Different Results
Quality adjustment bias

- Boskin commission (1996) established framework for CPI measurement bias including a "quality adjustment bias"
- Bias as difference between benchmark and actual quality adjustment
- However, no undisputed benchmark for quality adjustment
  "...solutions to quality change and new good bias problems must be the fruit at the top of the tree…"
- But what about a corridor of meaningful results for QA?
- Corridor proposed recently on the level of single price quotations by Eurostat (2021)
Eurostat’s quality adjustment corridor (1)

- Eurostat (2021): HICP recommendation on bridged overlap
- Central assumption: quality adjusted price should lie in the corridor between two critical values, the extreme cases of quality adjustment:
  - Link-to-show-no price change (LNP): total nominal price change equals quality difference $\Rightarrow \Delta p = 0$
  - Direct price comparison (DPC): assumption of no quality difference $\Rightarrow \Delta p = p_{n^*}^t - p_{n}^{t-1}$
- Quality adjustment calculation framework – relation of prices and quality:
  $$p_{n, qa}^t \equiv \frac{p_{n^*}^t}{\hat{\alpha}_n} = p_{n}^{t-1} \cdot r_n^t$$

$\hat{\alpha}_n$ Quality adjustment factor of product $n$; $r_n^t$ “bridge“/real price change factor;
$n^*$ Replacement product
Eurostat’s quality adjustment corridor (2)

- Upper boundary: DPC
- Lower boundary: LNP

⇒ Plausibility check for quality adjustment in replacement situations

Can this be used for estimating index bias?

Source: Eurostat (2021). Formulae adapted to the notations in this paper.
Logical boundaries to quality-adjusted price indices

Single price quotation: logical boundary DPC and LNP

Price index: logical boundary DPC index and LNP index

\[\begin{align*}
  \text{if } \forall i \in n: p_{i}^{t-1} < p_{i}^*: I_{n}^{DPC,t} &\geq I_{n}^{QA,t} \geq I_{n}^{LNP,t} \\
  \text{if } \forall i \in n: p_{i}^{t-1} > p_{i}^*: I_{n}^{DPC,t} &\leq I_{n}^{QA,t} \leq I_{n}^{LNP,t}
\end{align*}\]

- Index outside boundaries => bias is difference of average annual change rate to next boundary
- Main assumption: relationship holds for **ALL** replacement situations
### Quality adjustment practice in Austria and Italy

<table>
<thead>
<tr>
<th>Austria</th>
<th>Italy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Focus on explicit quality adjustment</strong></td>
<td><strong>Implicit quality adjustment</strong></td>
</tr>
<tr>
<td>Direct price comparison</td>
<td>Direct price comparison</td>
</tr>
<tr>
<td>Price/quality split 25/50/75%</td>
<td>Bridged overlap (class/ overall/targeted mean imputation)</td>
</tr>
<tr>
<td>Link-to-show-no price change</td>
<td>Link-to-show-no price change („overlap“)</td>
</tr>
<tr>
<td>Individual pricing of quality dependent on characteristics (all explicit methods including hedonics)</td>
<td></td>
</tr>
</tbody>
</table>
Methodology for assessing a possible measurement bias related to QA
Assessing a possible quality adjustment bias

• Recalculation of inflation rates based on microdata for a number of selected products

• Calculation of three different indices:
  – LNP index: use of LNP in all replacement situations
  – QA index: use of actual quality adjustment practice in all replacement situations
  – DPC index: use of DPC in all replacement situations

• QA index should move inside the DPC-LNP corridor, otherwise bias cannot be ruled out

• Exceptions from the rule can occur in single cases => increasing robustness:
  – Observe average annual rates of change
  – Observation over long time periods: 6 years (AT)/7 years (IT)
Data
# Data

## Austria

- Dataset covers >1000 product groups
- January 2011 – December 2017
- Focus on Non-Energy Industrial Goods (highest prevalence of QA)
- Product choice: many QA cases; large weight or representativeness

<table>
<thead>
<tr>
<th>Bedroom furniture</th>
<th>Sofa set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dishwasher</td>
<td>Electrical razor</td>
</tr>
<tr>
<td>Toothbrush</td>
<td>Washing machine</td>
</tr>
<tr>
<td>Lawn mower</td>
<td>Sink</td>
</tr>
<tr>
<td>Laundry detergent</td>
<td>Notebook/tablet</td>
</tr>
<tr>
<td>PC</td>
<td>Men's jeans</td>
</tr>
</tbody>
</table>

## Italy

- Dataset covers 267 8-digit-level COICOP categories from local price collection
- >3.5 mill. price quotations
- January 2011 – December 2018
- Product choice considerations as with AT

<table>
<thead>
<tr>
<th>Bedroom furniture</th>
<th>Fridge/freezer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wash. machine/dryer/dishw.</td>
<td>Small electr. devices (razor/toothbrush)</td>
</tr>
<tr>
<td>Jewellery and clocks</td>
<td>TV</td>
</tr>
<tr>
<td>Laundry detergent</td>
<td>Appliances f. heating/AC</td>
</tr>
<tr>
<td>Women's pullovers</td>
<td>Men’s trousers</td>
</tr>
</tbody>
</table>
Results: Austria - Indices (1)

Most cases are fine…

Source: OeNB calculations with Statistik Austria data.
Results: Austria - Indices (2)

... but others problematic

Source: OeNB calculations with Statistik Austria data.
Results: Austria – Average annual change rates

- Average annual inflation rate for 2011 to 2017
- QA inflation rate on average between DPC and LNP
- Exceptions:
  - Electrical razor: +0.2 p.p.
  - Men’s jeans: +0.1 p.p.
- Size of corridor fully dependent on product
  - Dishwasher 0.2 p.p.

⇒ On average, QA in the middle of corridor; no evidence of bias

Source: OeNB calculations with Statistik Austria data.
Results: Italy - Indices (1)

Small corridors...

Source: BdI calculations with ISTAT data.
Results: Italy - Indices (2)

... with QA index at the lower bound

Source: BdI calculations with ISTAT data.
Results: Italy – Average annual change rates

- Average annual inflation rate for 2011 to 2018
- QA inflation rate outside corridor for 7 out of ten products (five cases: below lower bound)
- Largest differences:
  - Bedroom furniture: +0.061 p.p.
- QA index represents lower bound
- Different QA/sampling/replacement strategy
  ⇒ Possible bias very small

<table>
<thead>
<tr>
<th>Products</th>
<th>DPC</th>
<th>QA</th>
<th>LNP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men-pants</td>
<td>-0.016</td>
<td>-0.017</td>
<td>0.07</td>
</tr>
<tr>
<td>Womens pullovers</td>
<td>-0.22</td>
<td>-0.22</td>
<td>-0.09</td>
</tr>
<tr>
<td>Washing/dryer Machine and dish washer</td>
<td>-0.003</td>
<td>-0.013</td>
<td>-0.01</td>
</tr>
<tr>
<td>Bedroom Furniture</td>
<td>0.164</td>
<td>0.225</td>
<td>0.199</td>
</tr>
<tr>
<td>Laundry detergent</td>
<td>0.375</td>
<td>-0.067</td>
<td>-0.066</td>
</tr>
<tr>
<td>Fridge/freezer</td>
<td>-0.932</td>
<td>-1.337</td>
<td>-1.322</td>
</tr>
<tr>
<td>Appliances for heating and air conditioners</td>
<td>0.608</td>
<td>0.705</td>
<td>0.689</td>
</tr>
<tr>
<td>TV</td>
<td>-0.383</td>
<td>-0.631</td>
<td>-0.638</td>
</tr>
<tr>
<td>Small electronic appliances (razer, toothbrush)</td>
<td>-0.063</td>
<td>-0.081</td>
<td>-0.093</td>
</tr>
<tr>
<td>Jewel and clock</td>
<td>0.312</td>
<td>0.264</td>
<td>0.265</td>
</tr>
</tbody>
</table>

Source: OeNB calculations with Statistik Austria data.
Discussion and limitations

• Corridor for meaningful QA price indices may be of substantially different size
  – Different strategies for sampling, replacement, quality adjustment:
    • AT: wide product descriptions, random replacements, explicit QA; also smaller sample
    • IT: narrow product descriptions or strata, implicit QA

• Method does not point to substantial QA biases in Austria and Italy
  – Small differences to the corridor, if at all

• Even within the corridor, QA methods can drive inflation rates (AT: laundry detergent)

• Limitations:
  – No bias within the corridor does not mean bias outside the corridor (propositional logic)
  – Method needs stable market conditions, i.e. order of LNP and DPC indices
  – Method needs long time range for meaningful results (use of indices and long-term averages)
Conclusion
Conclusion

• New approach for QA bias determination
  – Corridor – no unambiguous definition of quality value, subjective decisions by statistician needed
  – Micro-data driven approach – this is where QA is applied
• No evidence of systematic and sizeable QA biases for Italy and Austria
• Italy: index close to lower bound => Italian CPI close to a minimum of reasonable quality-adjusted indices
• Differences in explicit and implicit methods calls for more harmonisation of quality adjustment, sampling and replacement strategies for the HICP
• Studies on QA should be conducted on microdata level
The views expressed in this paper are those of the author and do not necessarily reflect the views and policies of Banca d’Italia, European Central Bank, Oesterreichische Nationalbank or the Eurosystem.