A comparison of price index methods for scanner data

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Outline

- Use of electronic data in Dutch CPI
- Challenges when switching to scanner data
- Study set-up: Data, index methods and choice aspects
- Results
- Analysis
- Conclusions

Electronic data in Dutch CPI

- *Scanner data:*
  - Covers more than 20% in terms of Coicop weights
  - For supermarkets only scanner data are used since Jan. 2013
- *Internet prices:*
  - Different data collection tools have been developed
  - Web scraping: From 1 to 8 retailers/web shops in 2015-2017
  - Web scraping only for clothing, but we have plans to extend this to other types of products

Scanner data: Challenges

- *Price index calculation:*
  - Fixed baskets → dynamic populations:
    - How to include new products?
    - Relaunches: How to handle item replacements when processing 10-100,000 GTINs per retailer?
  - Expenditures at GTIN level:
    - Allow weighting within Elementary Aggregates
    - How to control for drift when weighting and including dynamics?
- *Implications for CPI process:*
  - Large data sets require top-down analysis of results
  - Periodic maintenance: Tracking of metadata changes by retailer
  - Efficient handling of different tasks

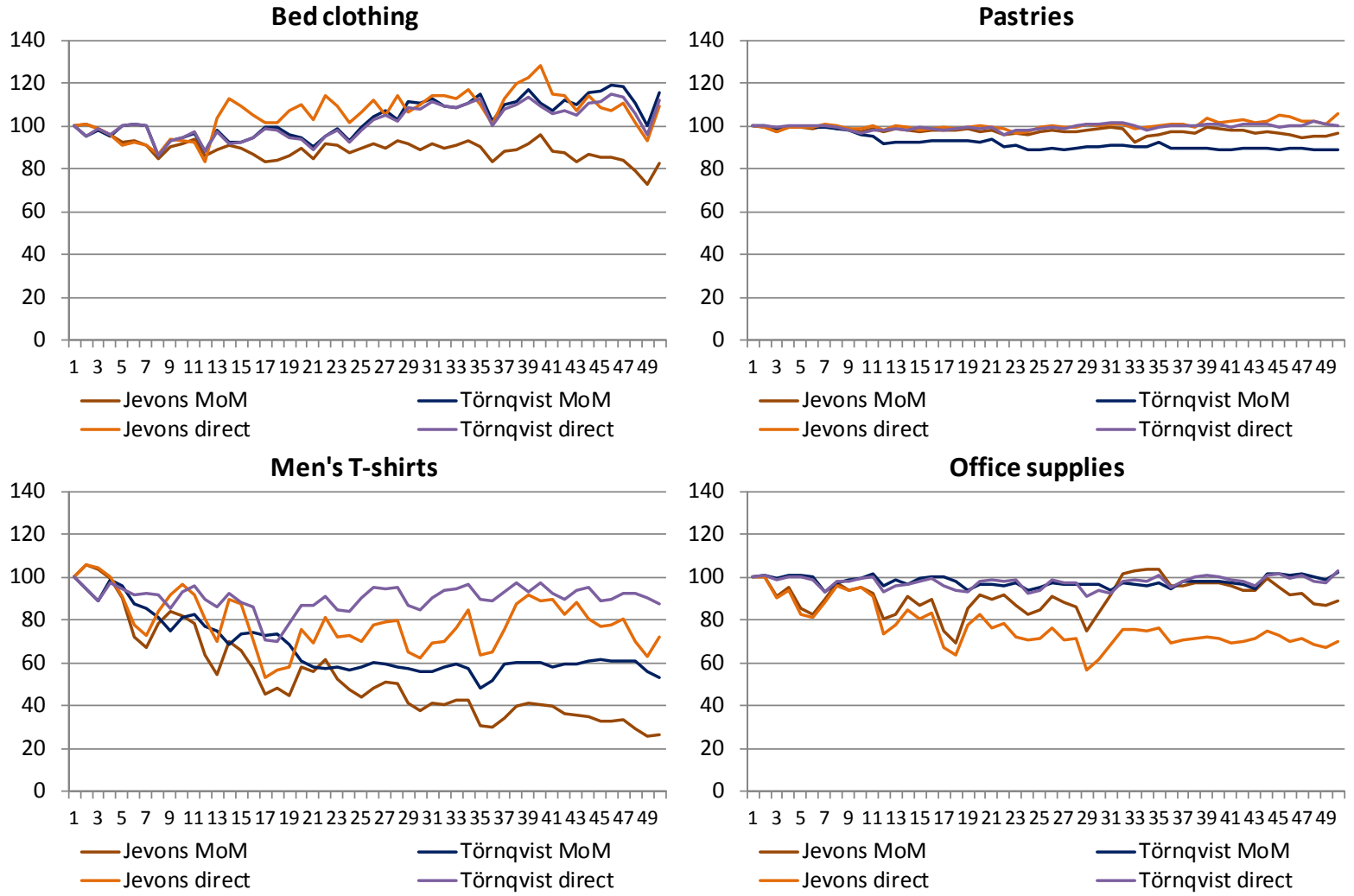
Recent developments in Dutch CPI

- Increased use of electronic data in past three years
- *Introduction of QU/GUV method (Geary-Khamis):*
  - Mobile phones (Jan. 2016)
  - Dutch department store chain (Jan. 2017)
  - Next (July 17 - Jan. 18): DIY stores and drugstores
  - Supermarkets are under study (GK vs current method/Jevons)
- *Research programme:*
  - How does GK compare with other methods?
  - Question is part of a 4-year programme at CBS

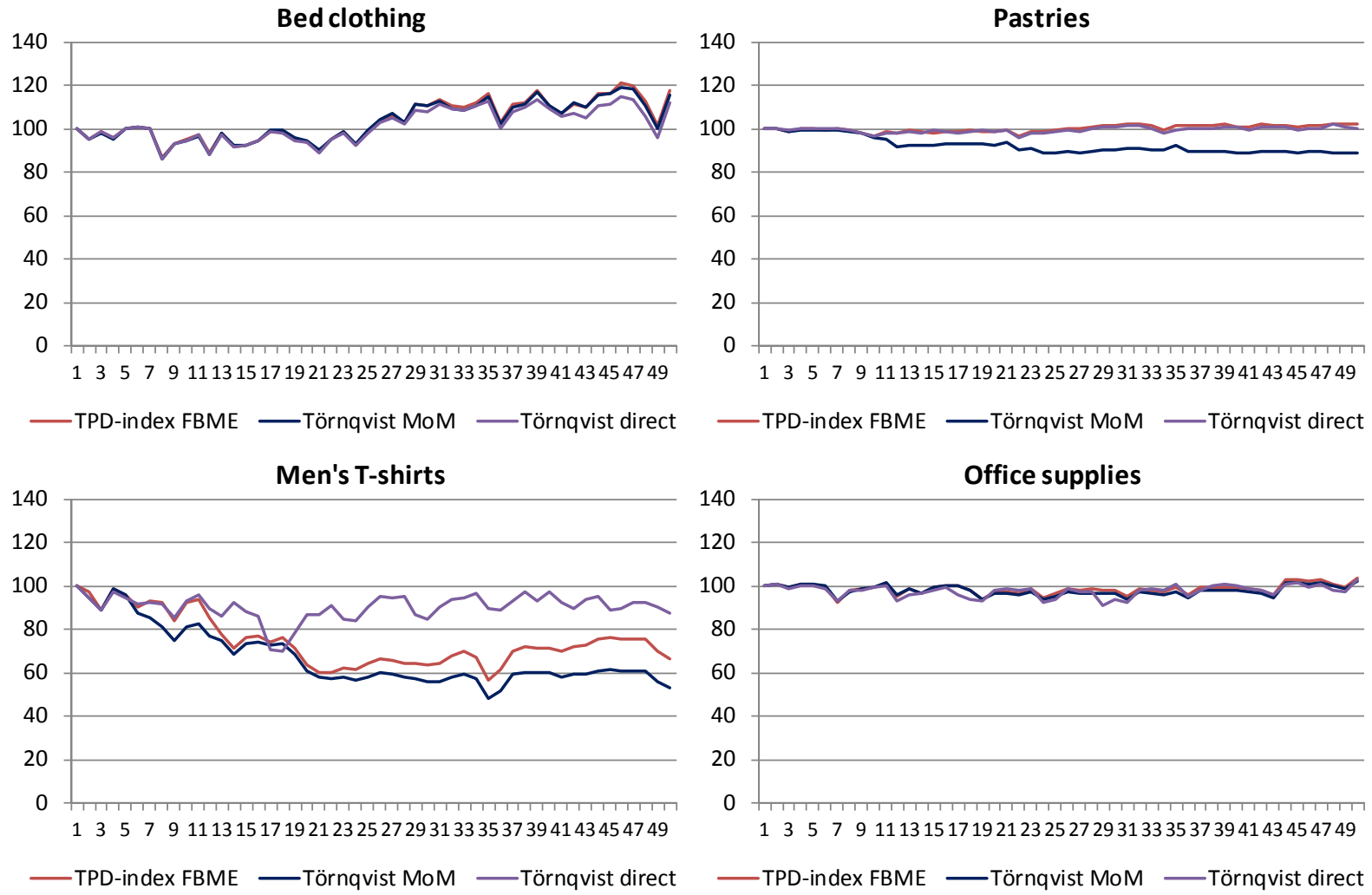
Comparative study

- *Scanner data:*
  - Dutch chain of department stores, 4-year period
  - 4 product groups: T-shirts, pastries, office supplies, bed clothing
- *Index methods:*
  - Bilateral: Jevons, Törnqvist, etc. (chained and direct)
  - Multilateral: GK, GEKS, TPD, hedonic
- *Choice aspects:*
  - Updating method (multilateral methods)
  - Length of time window (multilateral methods)
  - Product differentiation: by GTIN vs GTIN group (common char's)

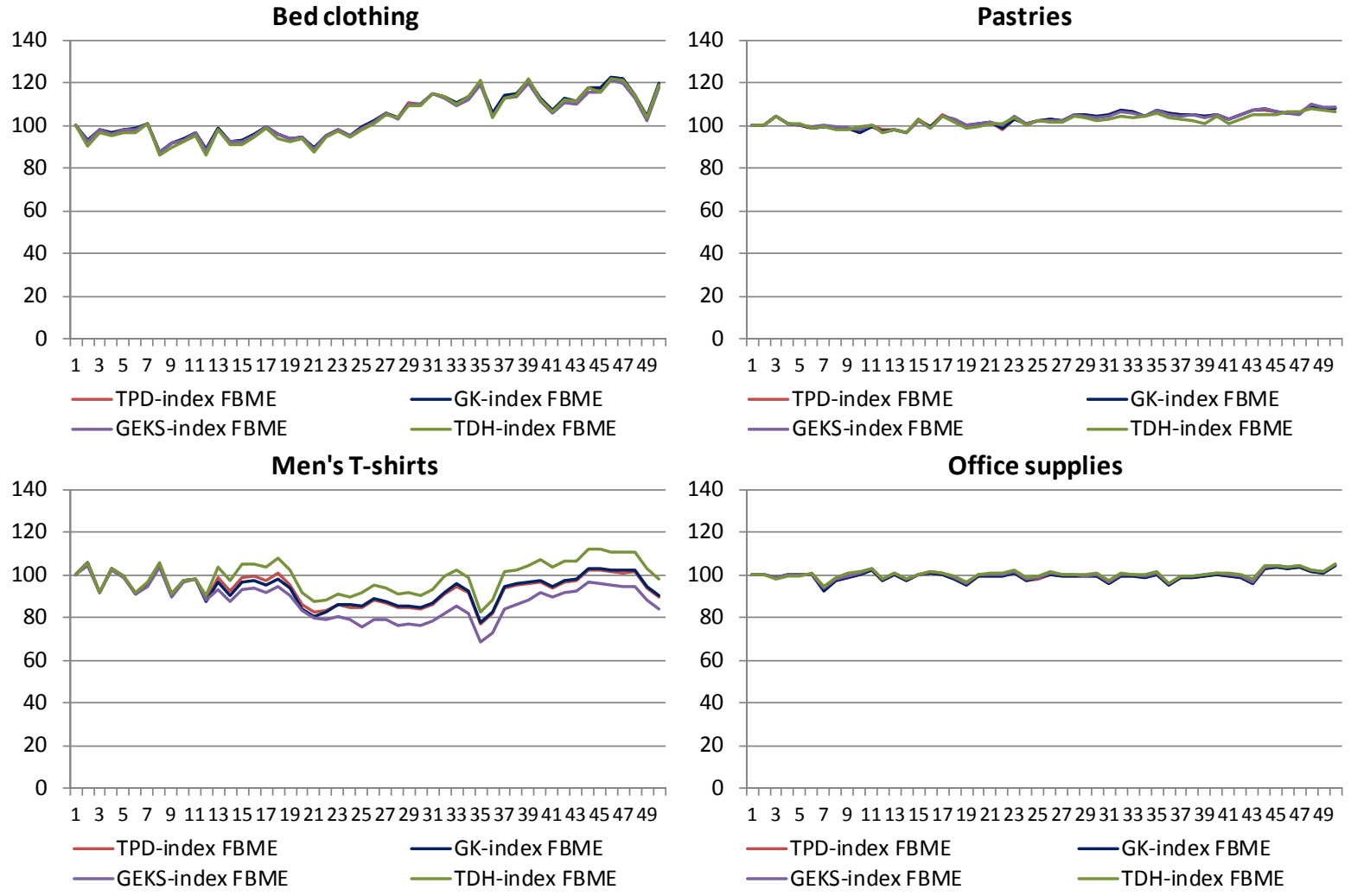
Results: 1. Weighting (GTIN level)



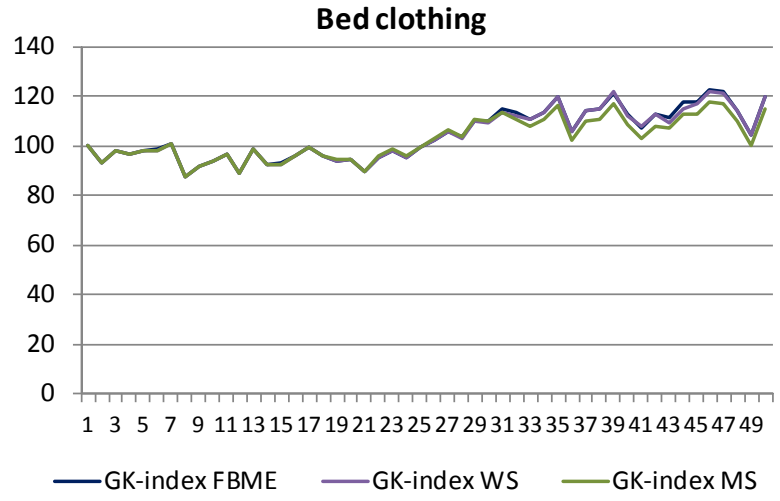
2. Bilateral vs Multilateral (GTIN level)

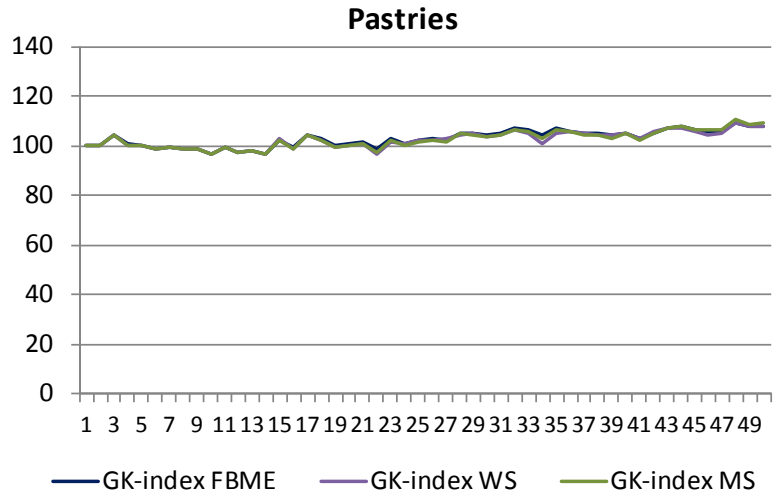


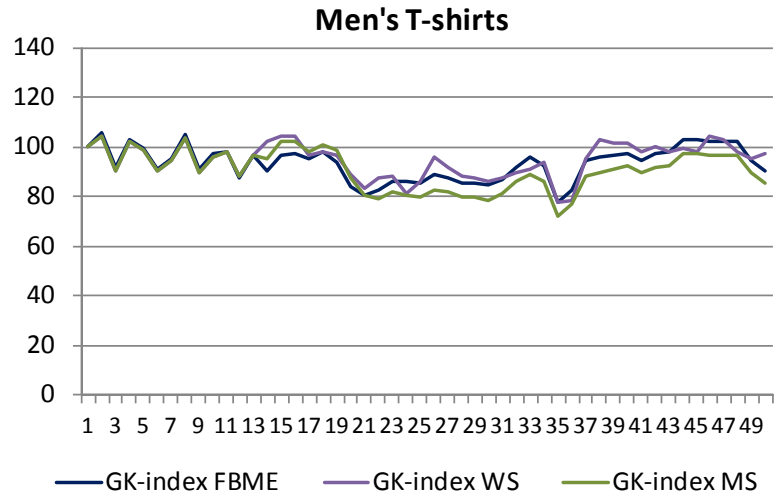
3. Multilateral methods (GTIN groups)

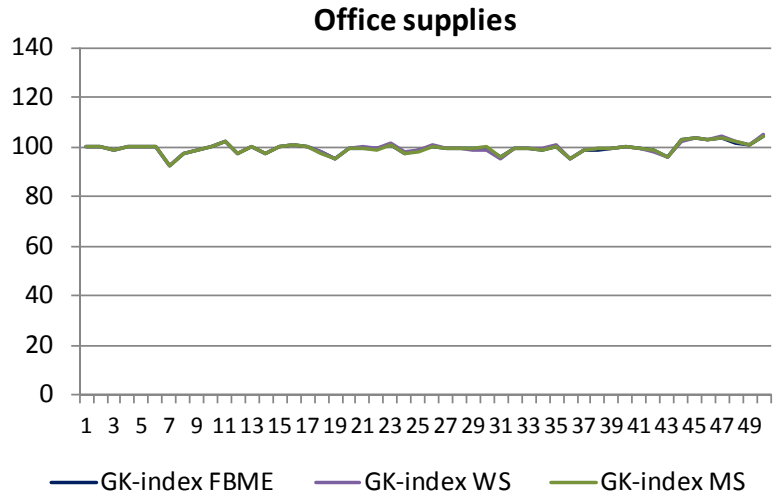


4. Updating method (GTIN groups)









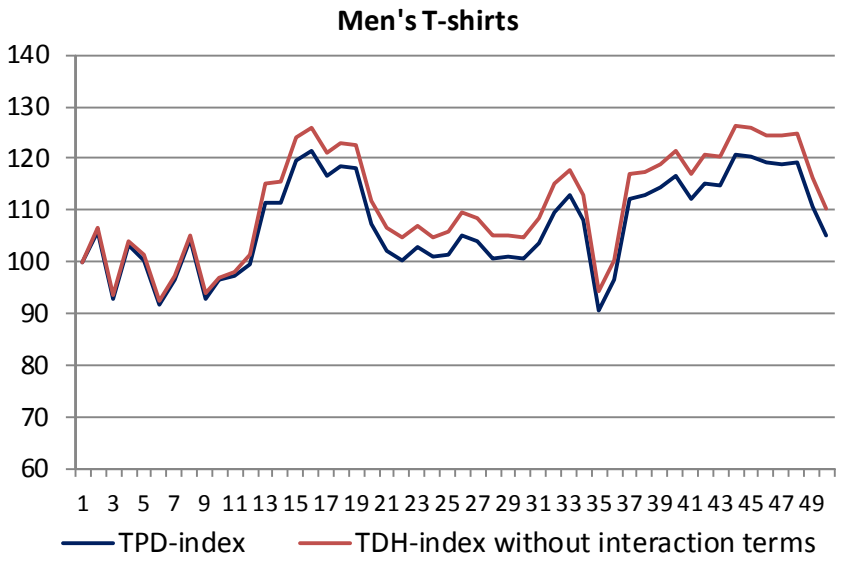
Analysis: 1. Bilateral methods

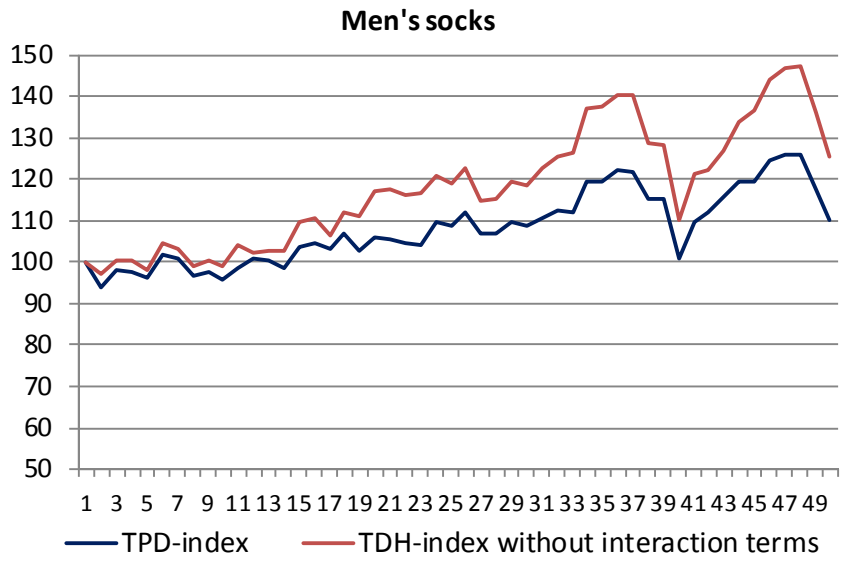
- Equal weighting may severely distort indices
- Chained methods may lead to severe drift
- Direct methods miss contributions from new products
- Problematic for dynamic populations

2. Multilateral methods

- GK and TPD give practically the same results
- *Hedonic vs TPD:*
  - TPD: Model parameters for combinations of characteristics
  - Traditional hedonic models: No interactions among attributes
  - Does this explain the differences between TPD and hedonic?
- *Differences GEKS method:*
  - Only for T-shirts. Exceptional case?
  - How does the GEKS relate to other methods?

Hedonic *without* interaction terms

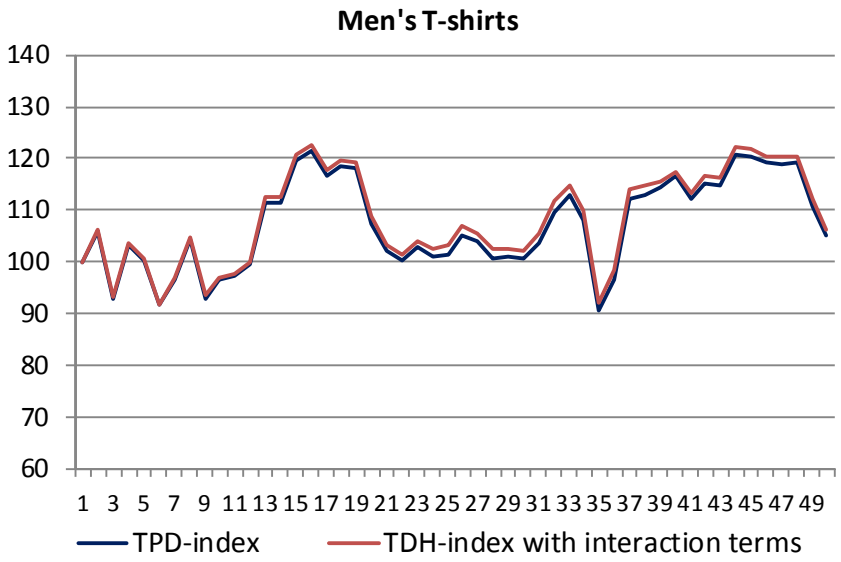


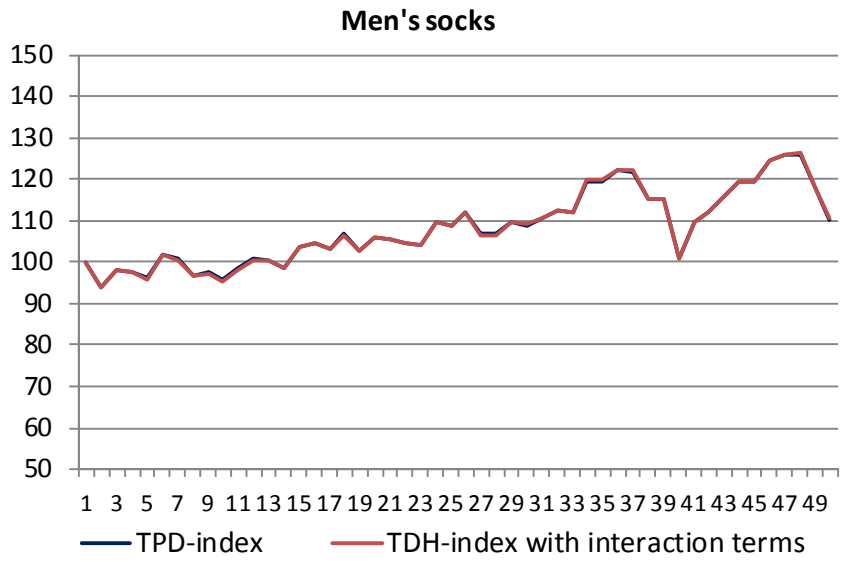


Note:

In the above cases, hedonic models are applied to the full window of 50 months.
In the preceding cases, time windows of 13 months were used.

Hedonic *with* interaction terms





- Pairwise interactions among item attributes are included in hedonic models
- Model fits based on AIC and BIC are improved, in spite of adding parameters

Rewriting the GEKS-Törnqvist

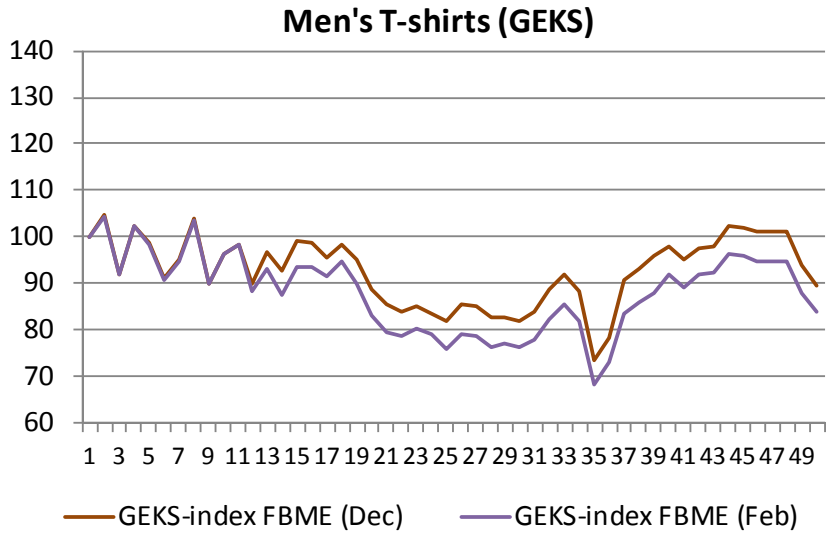
$$P_{0,t} = \prod_{z=0}^{T} \left(\frac{P_{0,z}}{P_{t,z}} \right)^{\frac{1}{T+1}} = \frac{\prod_{z=0}^{T} \left(\prod_{i \in G} \left(\frac{p_{i,t}}{p_{i,z}} \right)^{\frac{s_{i,t}+s_{i,z}}{2}} \right)^{\frac{1}{T+1}}}{\prod_{z=0}^{T} \left(\prod_{i \in G} \left(\frac{p_{i,0}}{p_{i,z}} \right)^{\frac{s_{i,0}+s_{i,z}}{2}} \right)^{\frac{1}{T+1}}} =: \frac{\tilde{p}_t}{\tilde{p}_0}$$

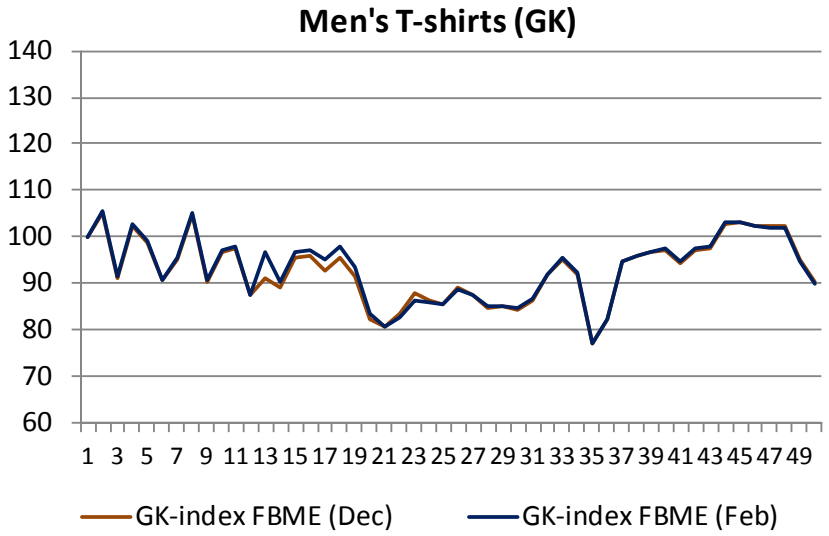
$$\tilde{p}_t = \left\{ \prod_{i \in G} \left(\frac{p_{i,t}}{v_i'} \right)^{s_{i,t}} \right\}^{\frac{1}{2}} \left\{ \prod_{i \in G} \left(\frac{p_{i,t}}{v_i''} \right)^{\frac{1}{T+1} \sum_{z=0}^{T} s_{i,z}} \right\}^{\frac{1}{2}}$$

$$v_i' = \prod_{z=0}^{T} p_{i,z}^{\frac{1}{T+1}} \qquad v_i'' = \prod_{z=0}^{T} p_{i,z}^{s_{i,z} / \sum_{\tau=0}^{T} s_{i,\tau}}$$

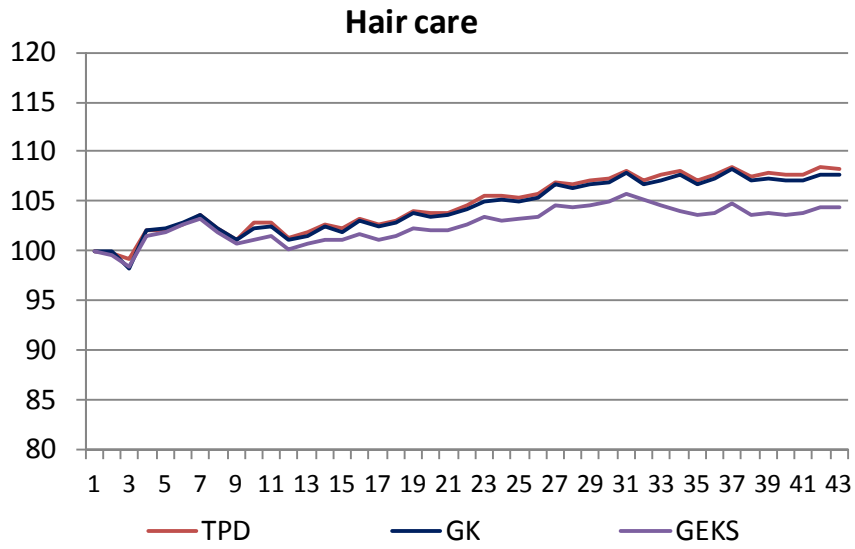
Leads to a **downward bias** in cases with dump prices for disappearing items!

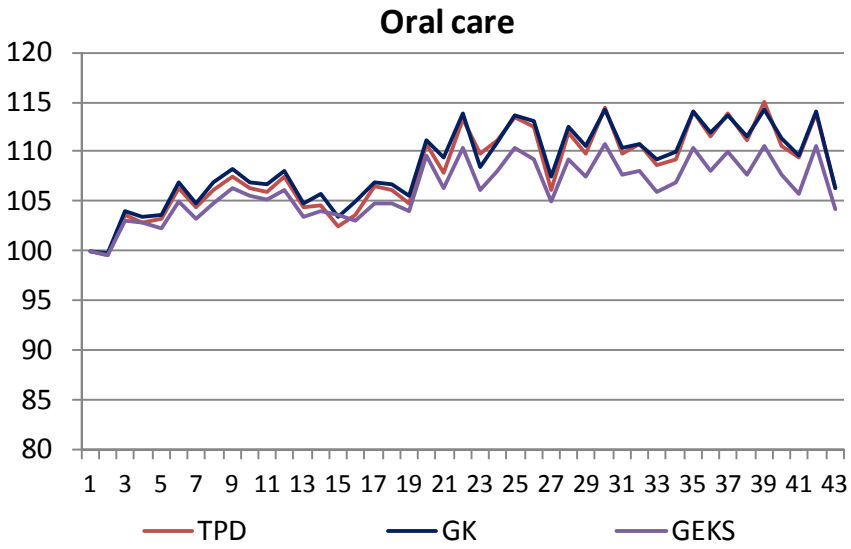
Sensitivity GEKS to choice of base month



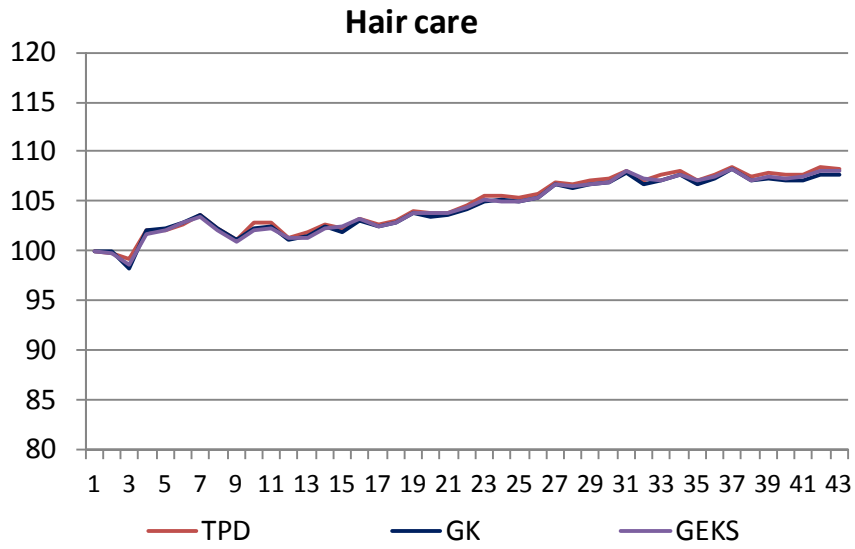


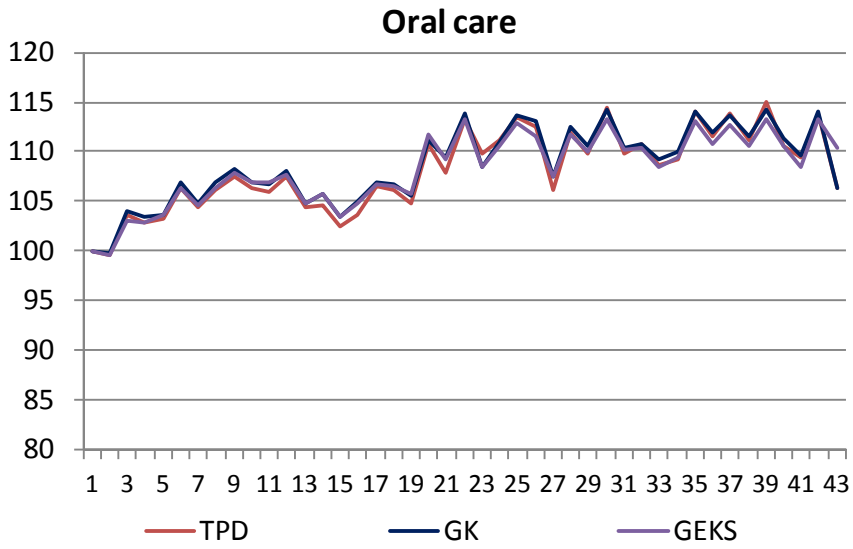
More evidence for downward bias GEKS





After setting a dump price filter...





Concluding remarks

- Consider inclusion of weights within EAs
- *Multilateral methods:*
  - Fixed base updating methods are free of chain drift
  - Cannot be excluded for splice methods
  - 13-month period + fixed base month in line with CPI practice
  - GK, TPD similar results; GEKS, CCDI sensitive to downward bias
- *High priority:*
  - Product differentiation (relaunch problem)
  - Text mining, web scraping, attribute selection
  - Large data sets $\Rightarrow$ efficient handling of monthly work in CPI