Dynamic pricing as a challenge for Consumer Price Statistics

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Overview

- What is dynamic pricing?
- Goals of the analysis
- Price collection via internet for the German CPI/HICP
- Set-up of the study
- Results
- Implications for Consumer Price Statistics
- Outlook
What is dynamic pricing?

- Application of automatic algorithms to change prices in short intervals due to market conditions and parameters indicating consumers willingness to pay

- Possible parameters used to set prices
  - Calendar effects (holidays, time of the day)
  - Weather
  - Prices of competitors
  - Devices as indicator for the individual willingness to pay?
  - ...

- Dynamic pricing: price changes in time

- Individualized pricing: different prices for different consumers
Goals of the analysis

- Dynamic pricing is analysed, individualized pricing not
  - To investigate the existence and the extent of individualized pricing would require more complex study designs (different consumer profiles)

- To which extent is dynamic pricing applied by online shops?
  - Identification of online shops applying dynamic pricing
  - Frequency and level of price changes for products relevant for CPI/HICP
Price collection via internet for CPI/HICP

- Centralized price collection for goods in online shops
  - Approx. 10,000 single prices per month
  - Share in whole basket: approx. 5%, increasing...

- Centralized price collection for services
  - Internet as data source

- Way of price collection
  - To a large extent done manually at one time per month
  - Automatized for certain fields (via web scraping)
    - passenger transport by railway, rental cars, long-distant coaches, online pharmacies
Price collection via internet for CPI/HICP

- Sample design
  - 2,680 products out of the sample of CPI/HICP
  - Different product groups
  - 14 online shops
- Automatized price collection via web scraping
- Hourly collection of prices at constant times
- Observed period: 3 months (09.12.2016 - 06.03.2017)
- Overall: 2097 prices per product, 5,559,933 single prices
Set-up of the study

- **Java**
  - Realization of program logic
  - Data cleaning
  - Read/Store data from database

- **Selenium**
  - Extraction of information
  - XPaths are used to find information on respective website
  - Plug-in for common internet browsers

- **MySQL database** is used for input data and to store extracted data

- **Windows Scheduled Tasks** is used to start the automation at a certain time
Results (1)

Price changes per product (observed period of 3 months)

- No price changes: 43.02%
- 1-3 price changes: 22.13%
- 4-15 price changes: 23.13%
- > 15 price changes: 11.72%
## Results (2)

<table>
<thead>
<tr>
<th>Shop</th>
<th>Share of price series with ... price changes</th>
<th>number price series overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1 - 3</td>
</tr>
<tr>
<td>Shop 1</td>
<td>7.91%</td>
<td>9.30%</td>
</tr>
<tr>
<td>Shop 2</td>
<td>47.94%</td>
<td>19.50%</td>
</tr>
<tr>
<td>Shop 3</td>
<td>50.72%</td>
<td>26.09%</td>
</tr>
<tr>
<td>Shop 7</td>
<td>54.39%</td>
<td>19.59%</td>
</tr>
<tr>
<td>Shop 9</td>
<td>4.88%</td>
<td>29.27%</td>
</tr>
<tr>
<td>Shop 13</td>
<td>68.81%</td>
<td>30.28%</td>
</tr>
<tr>
<td>Shop 14</td>
<td>17.86%</td>
<td>30.71%</td>
</tr>
<tr>
<td>other</td>
<td>39.64%</td>
<td>28.25%</td>
</tr>
<tr>
<td>all</td>
<td>43.02%</td>
<td>22.13%</td>
</tr>
</tbody>
</table>
## Results (3)

<table>
<thead>
<tr>
<th>Shop</th>
<th>&lt; 0,05</th>
<th>0,05 - &lt;0,1</th>
<th>0,1 - &lt;0,25</th>
<th>&gt; 0,25</th>
<th>Share on price series overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shop 1</td>
<td>99</td>
<td>46</td>
<td>27</td>
<td>6</td>
<td>82.8%</td>
</tr>
<tr>
<td>Shop 2</td>
<td>67</td>
<td>44</td>
<td>52</td>
<td>19</td>
<td>32.6%</td>
</tr>
<tr>
<td>Shop 3</td>
<td>26</td>
<td>19</td>
<td>2</td>
<td>1</td>
<td>23.2%</td>
</tr>
<tr>
<td>Shop 7</td>
<td>75</td>
<td>40</td>
<td>67</td>
<td>49</td>
<td>26.0%</td>
</tr>
<tr>
<td>Shop 9</td>
<td>47</td>
<td>24</td>
<td>9</td>
<td>1</td>
<td>65.9%</td>
</tr>
<tr>
<td>Shop 13</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0.9%</td>
</tr>
<tr>
<td>Shop 14</td>
<td>5</td>
<td>6</td>
<td>57</td>
<td>4</td>
<td>51.4%</td>
</tr>
<tr>
<td>other</td>
<td>75</td>
<td>44</td>
<td>18</td>
<td>4</td>
<td>32.1%</td>
</tr>
<tr>
<td>all</td>
<td>394</td>
<td>223</td>
<td>233</td>
<td>84</td>
<td>34.9%</td>
</tr>
</tbody>
</table>
Results (4)

Example of extreme frequent price changes: aftershave
Results (5)

- Summarized results
  - Differences in price setting behavior among shops, not among product categories
  - Dynamic pricing is applied by few online shops in a remarkable extent
  - Volatility of prices is critical in some of these shops
  - Time of price changes: more in the first third of the day probably for technical reasons and to hide price changes
Implications for Consumer Price Statistics

- Information about online shops and their price setting behavior can be used to manage resources for price collection

- Concentrate on online shops with high frequency of price changes and high volatility of prices
  - More frequent dates of price collection, additional checks
  - Use of new tools for price collection (web scraping) as soon as possible
Outlook – web scraping

- Automatized price collection (web scraping)
  - Is applied in some fields and will be applied on a broader basis
  - Will be further developed technically, project with IT
- Methodological challenges
  - How to deal with replacements and quality adjustments?
  - How to calculate average prices?
- Legal basis for the access to websites does not exist currently
Outlook – transaction data

- Dynamic pricing in physical shops?
  - Introduction of electronic price signs
- Traditional price collection will no longer be sufficient
- Use of transaction data (scanner data) necessary
  - Project on scanner data has just started
THANK YOU FOR YOUR ATTENTION!

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