The Austrian Scanner Data Project

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(updated 31 October 2013[3]**)**

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The authors gratefully acknowledge the financial support from Eurostat (Agreement No. 61229.2010.001-2010.536)
[3] The update makes only changes to the experimental calculations with abstract data on Page 20 for Method 3 'Chained Superlative Index – Törnqvist'

Contents

1 Executive Summary

Since the start of the project in 2011, Statistics Austria was able to pursue its research agenda on scanner data. The following aims of the project supported by Eurostat have been reached:

1. establishing work relations with retailers and supermarket chains and other suitable institutions (chamber of commerce, ministry of economy, market research companies)
2. Study visits from experts with scanner data experience
3. obtaining Austrian scanner data,
4. Analysis of optimal treatment of sales prices, price fluctuation, missing prices, quality adjustments.
5. Application and analysis of different index formulas and calculation methods

Austrian retailers and supermarket chains currently continue to deny direct access to their scanner data. However, a compromise was agreed upon to provide Austrian scanner data to Statistics Austria. In November 2012, Statistics Austria acquired scanner data from the market research company A.C Nielsen and started to use it for experimental index computation. As demanded by the participating retailers, the scanner data sample delivered cannot be regarded as fully representative for the Austrian market. Nevertheless, Statistics Austria has been able to effectively implement its theoretical knowledge on index computation using the scanner data. As a result, it can be shown that this new kind of price data has the potential to be successfully used for future price index computation. In particular, it provides a broader and more detailed assortment of products and goods. It also shows the importance of promotions and discounts in retail as the absolute turnover of products heavily depends on promotion activities. Overall, there is evidence that price indices compiled from scanner data may be of a higher quality than price indices which are solely relying on conventional price collection methods.

Statistics Austria currently promotes the adoption of a regulation that requires owners of scanner data to provide access to their price information for price statistics purposes.

2 Accessing scanner data from Austrian retailers

2.1 Ongoing discussions with Austrian retailers

The acquisition of scanner data from Austrian retailers has been a long process which continues to be an issue well beyond the finalization of the current project. In general, potential providers of scanner data are very reluctant to make available any detailed sales data to national authorities. There is a fear that detailed sales information would be used for other purposes than price index compilation (e.g. antitrust investigations, price monitoring) and Statistics Austria carries on to discuss with the major retailers about its high level of data integrity and security and about the advantages of using scanner data.

Statistics Austria currently promotes the adoption of a regulation that requires owners of scanner data to provide access to their price information for price statistics purposes.

2.2 Scanner Data – Sample from A.C. Nielsen

At the end of the year 2012, Statistics Austria purchased a set of scanner data from the market research company A.C. Nielsen. Hereby, Austrian retailers still do not directly provide scanner data - but enable Statistics Austria to carry out its research pilot project. The scanner data set from A.C. Nielsen does not feature all the qualities needed to reach every aim of the scanner data project. Nevertheless, the results of the scanner data analysis show that market research data can be seen as the minimum to establish a profound knowledge on the work with scanner data. The following chapter describes the analysis performed with the data delivered by A.C. Nielsen.

2.3 Data delivery

In November 2012 Statistics Austria obtained a sample of scanner data from the market research company A.C. Nielsen. The data contained sales information on item level for the retail segment 'non-alcoholic beverages' (COICOP 01.2.2) in three major Austrian cities (Vienna, Linz, Graz) from November 2011 until March 2012. However, due to restrictions imposed by retailers, the data was manipulated by A.C. Nielsen to deny any identification of a single retail chain. Thus, on item level the scanner data was aggregated over all shops and retail companies in the selected city. Also, EAN codes were not included in the scanner data sample. Overall, these data manipulations made it hard to calculate a representative price index. Nevertheless, the data still permits the majority of actions which were planned to be conducted within the scope of the scanner data project. Its quality was therefore regarded as acceptable.

Table 2 *- Characteristics of the Scanner data delivered by A.C. Nielsen*

Data Structure	**Variable**	**Format**
Product groups		
	Mineral water	text
	Soft drinks	text
	Juice	text
	Lemonades w/o CO2	text
	Ice tea	text
	Energy drinks	text
	Sport drinks	text
Characteristics	Manufacturer	text
	Brands	text
	With CO2/ without CO2	text
	Single use / returnable package	text
	Flavour	text
	Type of packaging	text
	Volume in litre	alphanumeric
	Multipack	text
Facts	Sales in Euro	Numeric
	Sales in units	Numeric
	Sales in litre	Numeric
Period	Calendar week	text
Markets	Vienna	text
	Linz	text
	Graz	text

Table 3 shows some example data sets from the A.C. Nielsen delivery.

Table 3 - *data sets from the A.C. Nielsen delivery (anonymized example)*

Cluster	**Period**	**Article description**	**Product group**	**Segment**	**Manufacturer**	**Brand**	**CO2 (with / without)**	**single use (EW) / reusable (MW)**	**Flavour**	**Package type**	**Size**	**Volume**	**Multipack**	**Sales in €**	**Sales in Liter**	**Sales in Units**
City A	20114 4	Brand A ICED TEA NORMAL LEMON 473 ML FL 1 ER NA	AFG TEEBASI S	EISTE E	Brand A	Brand A	O.CO 2	E W	LEMON	FL	00473. 0 ML	473 ML	1 ER	25	4	9
City A	20114 4	Brand B ICED TEA NORMAL PEACH 473 ML FL 1 ER NA	AFG TEEBASI S	EISTE E	Brand B	Brand B	O.CO 2	E W	PEACH	FL	00473. 0 ML	473 ML	1 ER	453	23	23
City A	20114 4	Brand C EISTEE NORMAL PFIRSICH 500 ML PET 1 ER NA	AFG TEEBASI S	EISTE E	Brand C	Brand C	O.CO 2	E W	PEACH	PET	00500. 0 ML	500 ML	1 ER	29	15	29
City A	20114 4	DIV. NA NORMAL PFIRSICH 1500 ML PET 1 ER NA	AFG TEEBASI S	EISTE E	DIVERS E	DIVERS E	O.CO 2	E W	PEACH	PET	01500. 0 ML	150 0 ML	1 ER	695	1.89 6	1.26 4

SOURCE: Statistics Austria – Scanner data project (*anonymized example)*

By using systematic methods of data formatting, the large amount of data was compressed into a manageable and editable format. In particular, the information on product groups and characteristics was used to compute an individual product code for each item (EANs were not part of the scanner data delivery). The steps of the data processing were first performed in excel for the purpose of data exploration and later in the statistical software program SAS for the purpose of building up a knowledge base to process large amounts of scanner data.

3 Computation of a price index using scanner data

The development of index calculation processes with scanner data requires the knowledge of different price index calculation methods. As a first option the conventional price index calculation methods is replicated (Fix based – Laspeyres type index). Other approaches for index computations are methods from other statistical institutes and theoretical works of various price index experts.

In the course of working with scanner data, several methods of calculating elementary aggregates were developed and tested. Price indices for elementary aggregates usually contain only price information. EU Regulation No 1749/96 nominates for the compilation of elementary aggregate indexes the ratio of arithmetic mean prices and the ratio of geometric mean prices and formulae not differing systematically from these. Scanner data offers the chance to include quantity information in the index compilation (Superlative index). Table 5 lists the elementary price index equations used to calculate a price index with scanner data.

Table 5 – *Elementary aggregate index compilation formulae*

Method for compilation of the elementary aggregate index	**Computation formula** $\boldsymbol{\pi_a^{t1/t0}} =$
1) unweighted fixed base geometric mean of prices (HICP standard)	$\prod_{i=1}^{n}\left(\frac{p_i^{t1}}{p_i^{to}}\right)^{\frac{1}{n}}$
2.) unweighted monthly chained Jevons Index (Dutch method)	$\prod_{i=1}^{n}\left(\frac{p_i^{t1}}{p_i^{y,to}}\right)^{\frac{1}{n}}$
3) Monthly Chained Superlative Index – (Törnqvist)	$\prod(\frac{p_i^{t1}}{p_i^{t0}})^{\frac{(s_i^{t0}+s_i^{t1})}{2}}$

Where:
$\boldsymbol{p_i^t}$ **:** Price of article *i* at period t
$\boldsymbol{\pi_a^{t1/t0}}$:price change of the elementary aggregate index *a* between periods t0 and t1
n**:** number of articles in the sample that can be attributed to the elementary aggregate and are used for index compilation
$\boldsymbol{s_i^t}$ **:** market share of article *i* at period *t*

3.1.1 Method 1) - unweighted geometric mean of prices (HICP standard)

$$\boldsymbol{\pi_a^{t1/t0}} = \prod_{i=1}^{n} \left(\frac{p_i^{t1}}{p_i^{to}}\right)^{\frac{1}{n}}$$

Method 1, the unweighted fixed base geometric mean of prices index, follows the conventional approach of calculating elementary aggregate indices as described in HICP reference documents. The reference price at period *t0* constitutes a fixed base in this formula. Price information for article *i* must be available for the current and the reference price period. Product substitution should be applied for products with continuously missing price information to keep the price sample up to date.

For a model calculation of this method with abstract data→ see appendix 'Method 1)'

3.1.2 Method 2) - unweighted monthly chained Jevons Price index

(currently used method in the Netherlands)

$$\boldsymbol{\pi_a^{t1/t0}} = \prod_{i=1}^{n} \left(\frac{p_i^{t1}}{p_i^{y,to}}\right)^{\frac{1}{n}}$$

Where $\pi_a^{t1/t0}$ describes the price level development (or adjustment factor) of an elementary aggregate between reference period *t0* and current month *t1*. This is calculated by the ratio of the geometric mean prices. The number of prices *n* which are used for the computation of the index depends on the market share of each article. The price level developments (adjustment factors) of all consecutive months are multiplied and chained with the index of the reference month. According to this method, the formula for the elementary aggregate index in the first month of chaining is:

$$I_a^{t1/t0} = 100 * \pi_a^{t1/t0}$$

The formula for the elementary aggregate index in the second month of chaining is:

$$I_a^{t2/t0} = 100 * \pi_a^{t1/t0} * \pi_a^{t2/t1}$$

Where:

$$\pi_a^{t2/t1} = \prod_{i=1}^{n} \left(\frac{p_i^{t2}}{p_i^{t1}}\right)^{\frac{1}{n}}$$

Thus, article prices are always matched with the corresponding article prices of the previous month.

For a model calculation of this method with abstract data→ see appendix 'Method 2)'

3.1.3 Method 3) - monthly chained superlative index – (Törnqvist)

$$\prod \left(\frac{p_i^{t1}}{p_i^{t0}}\right)^{\frac{(s_i^{t0}+s_i^{t1})}{2}}$$

The Törnqvist index is the geometric mean of the *n* price ratios between the current and the reference period. This index is 'superlative' because it uses quantity data on article level. Each price is weighted using the arithmetic average of the market share of each article for the two observed periods.

As in method two, the price level development (adjustment factors) of all consecutive months are multiplied and chained with the index of the reference month.

The share *s* of each article *i* is $s_i^{t1} = \frac{Q_i^{t1}}{\sum Q_a^{t1}}$ where Q_i^{t1} represents the sales of the particular article *i* in Euro during period *t1* in a certain market and $\sum Q_a^{t1}$ describes the sum of all *matched* articles belonging to the elementary aggregate CPI basket of goods category.

For a model calculation of this method with abstract data→ see appendix 'Method 3)'

3.2 Data cleaning

3.2.1 Plausibility of scanner data

Scanner data must undergo plausibility checks before being included into the index calculation. The quality of price observations is best ensured by identifying and eliminating outliers and inconsistent data. Price information from scanner data is only used for index-compilation when fulfilling the following requirements:

1. The price of a product in may be up to 300% higher or 75% lower than its price in the month before. Price P_i^{t1} will be excluded from the index compilation if:

   $\frac{P_i^{t1}}{P_i^{t0}} \geq 4$ OR $\frac{P_i^{t1}}{P_i^{t0}} \leq 0{,}25$→ Exclusion of P_i^{t1}

2. According to Regulation (EC) No 2602/2000 Article 2, discounts shall be included in the HICP for "individual goods and services which are likely or expected to be available again at standard prices." Price observations of articles which are sold cheaper in stock sales (closing shop sales and end of article production sales, respectively), are not included in the index calculation. To identify such sales it is assumed that they are characterized by the declining prices **and** total volume of sales in Euro. It follows that price observations are not included in the index if:

   $\frac{P_i^{t1}}{P_i^{t0}} \leq 0{,}8$ AND $\frac{Q_i^{t1}}{Q_i^{t0}} \leq 0{,}2$ → Exclusion of P_i^{t1}, where P_i^t represents the price *P* of a product *i* at time *t* and Q_i^t represents the sales in Euro of product *i* at the time *t*.

3.2.2 Minimum market share of an article

Another measure to reach the aim of only including relevant price observations in the index calculation is the exclusion of non-significant articles by applying a market share criteria. Taking only articles with a minimum market share solves a couple of problems that arouse from the massive quantity of scanner data: Non-significant articles and sales information are filtered out; unweighted geometric Jevons indices will be less biased as the exclusion of products with low sales do not reduce the representativeness of the data sample. In this analysis Statistics Austria has mainly used a market share of 1% as a benchmark for including articles into compilation of an elementary aggregate index. It follows that price observations are not included in the index calculation if: $\frac{Q_i^{t1}}{\sum Q_i^{t1}} \leq 0{,}01$ → Exclusion of P_i^{t1} of article *i* in *t1*,

where Q_i^{t1} represents the sales of product *i* at time *t* and $\sum Q_i^{t1}$ stands for the sum of the sales volume for all articles in a market/shop that can be attributed to a specific CPI basket of goods item category.

The method minimum market share requirement of 1% will be under scrutiny in future analyses. Commodity groups differ and might require a more sophisticated method of market share filtering.

3.2.3 Imputation of missing values

For products with sales information in period *t0* but missing sales information in period *t1* price imputation may be applied using the following two methods:
1. The missing prices are simply replaced by the values of the previous month.
$P_i^{t1*} = P_i^{t0}$

Imputation with estimated price adjustment

$P_i^{t1*} = P_i^{t0*} \pi_a^{t1/t0}$

Where P_i^{t0} is observed Price of a product *i* at period *t0*, P_i^{t1*} is the imputed price for a product *i* at period *t1*; $\pi_a^{t1/t0}$ stands for the general price development between *t0* and *t1* of the specific CPI basket of goods item category that product *i* belongs to.

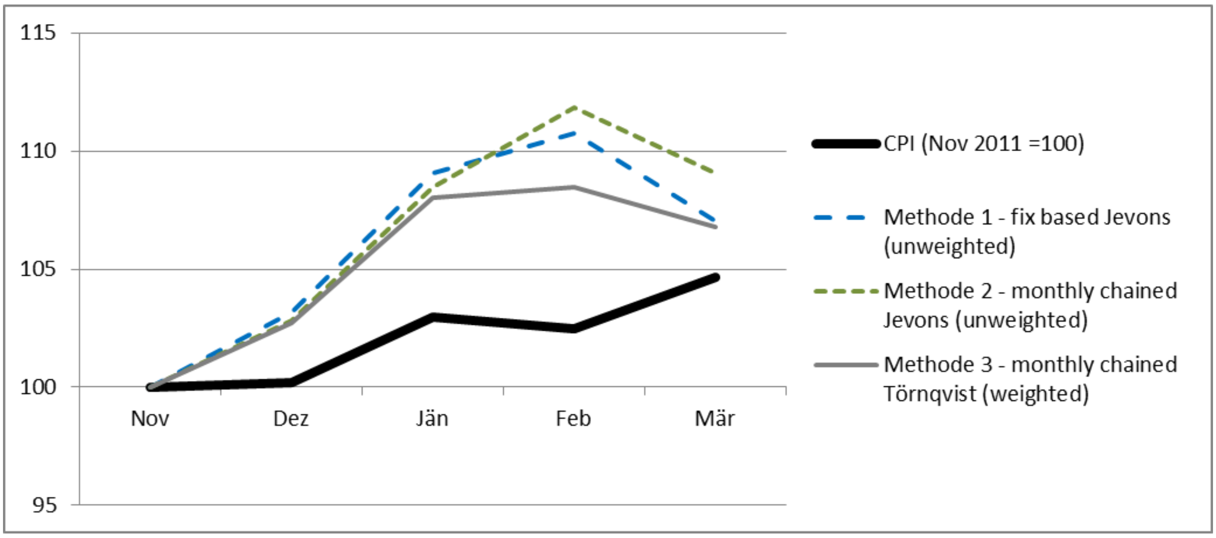
4 Results

4.1 Comparison of Index formulae

Figure 1 shows the official Austrian CPI Index development for COICOP group 01.2.2 ‘non-alcoholic beverages’ and the price indexes computed according to the different methods of elementary aggregate index compilation described in Chapter 4.

The different indexes seem to show the same tendency to some extent. Scanner data indexes are showing a somewhat more volatile behavior than the conventional CPI. The difference between CPI and Scanner data indexes is largest in February but closes down in the following month. The quantity weighted Törnqvist index (Method 3) seems to be less volatile than the unweighted fixed base monthly chained Jevons, respectively.

***Figure 1**– 01.2.2. Non-alcoholic beverages. Price indexes from CPI and Scanner data.*

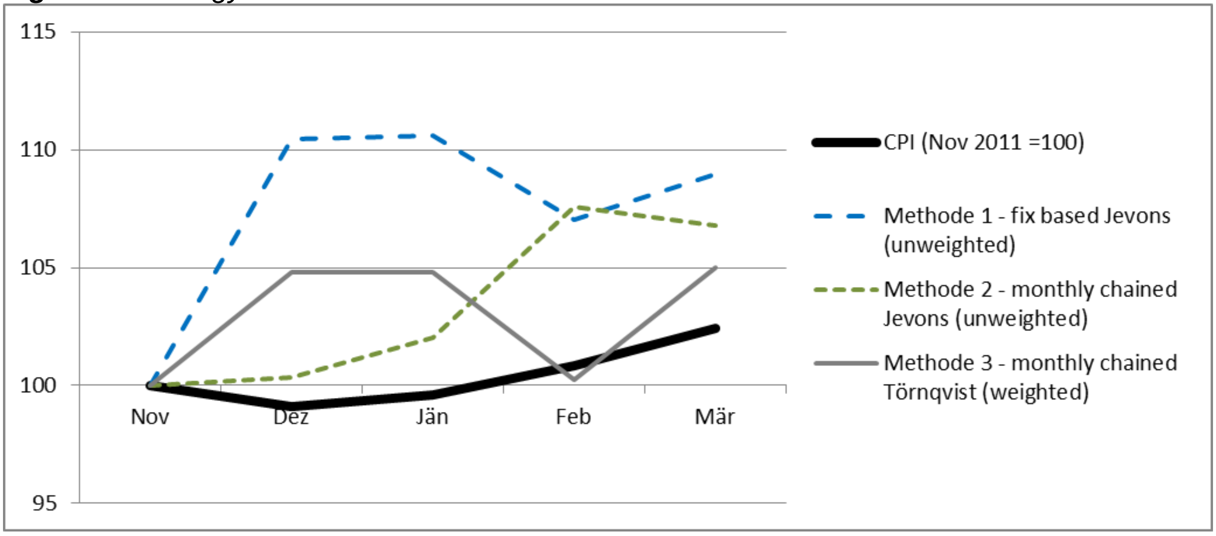


SOURCE: Statistics Austria – Scanner data project

Hints on the quality improvement by using scanner data may result from the analysis of developments on elementary aggregates of which the aggregate to 0122 – ‘non-alcoholic beverages' is composed of. Figure 2 compares the obtained CPI price data index and scanner data index of the CPI basket item "energy drinks". The conventional price survey measures a continuously increasing price development between December 2011 and March 2012. In contrast, two of the price indexes calculated from scanner data show a declining price trend in February. A detailed comparison of the prices for the CPI index data and scanner data unit values shows that in February 2012 in particular high-volume energy drink products of retailer-owned brands were sold at heavily reduced prices. These price reductions were only marginally detected by the conventional price survey because the price collectors select only one single product with a high-turnover for every commodity group.

Most of the retailer-owned brands, however, are not the best-selling products in a commodity group and are usually less often included in price index calculations.

***Figure 2** – Energy drinks. Price indexes from CPI and Scanner data.*



SOURCE: Statistics Austria – Scanner data project

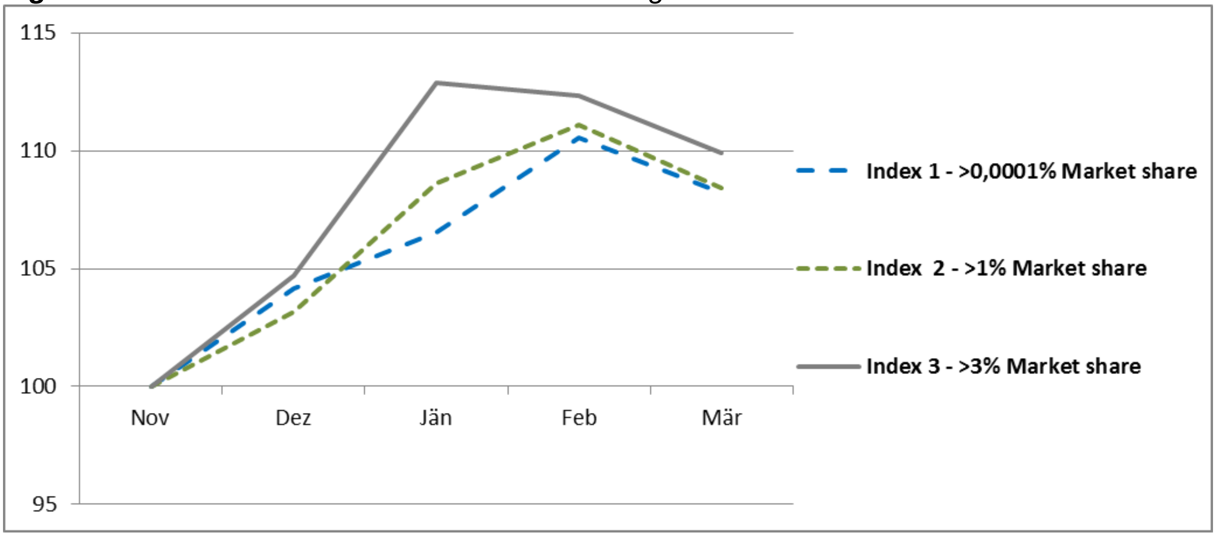
Figures 5 to 10 in the Appendix show the scanner data indexes for all other elementary aggregates for Cola drinks.

Some general conclusions can already be drawn from the comparison. Austrian scanner data has the potential to be successfully used for future price index computation. The analysis of detailed price data shows that scanner data provides a broader and more detailed assortment of good. In the sample, the monthly chained Törnqvist index (which weights each article according to turn-over) seems to be closer to the conventionally measured CPI than the other unweighted indexes.

4.2 Influence of market share and discounts

Figure 3 shows that the filter of a minimum market share has a considerable influence on the index compilation with scanner data. The index that includes only products with a minimum market share of 3% (Index 3) shows a significantly different index development compared to indexes 1 and 2 with a lower market share filter of 1% and 0.0001%, respectively.

Figure 3 – *COICOP 01.2.2- Non-alcoholic beverages. Influence of market share*



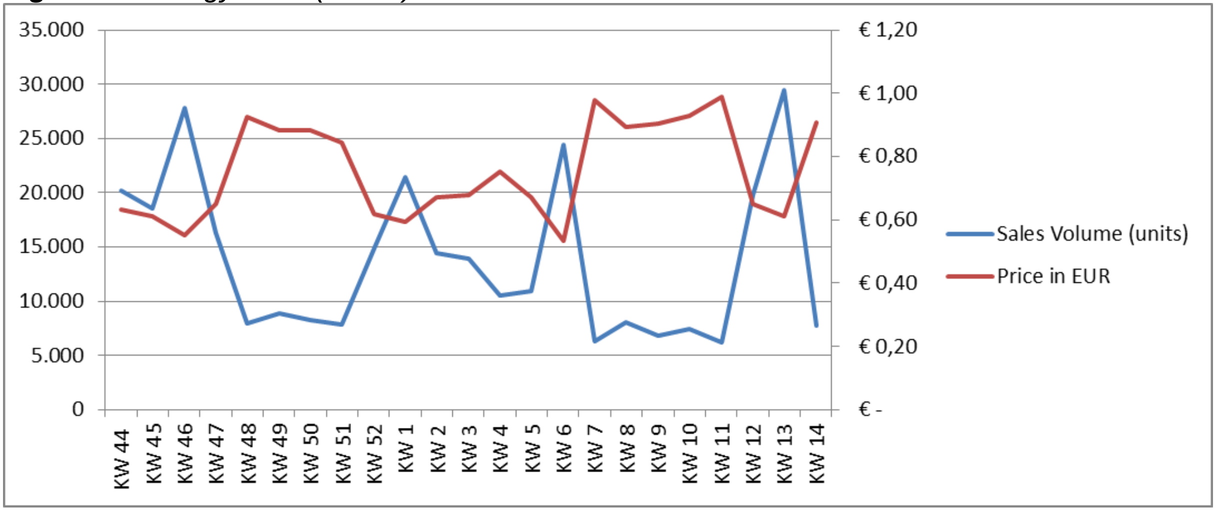
SOURCE: Statistics Austria – Scanner data project

Any index compilation with scanner data should carefully consider the inclusion or exclusion of products based on market share. Whether a fixed filter of 0.5%; 1% or 3% market share leads to reliable results might depend on the specific commodity group. The variety of products differs from group to group. In reaction to this, Statistics Netherlands uses a flexible filter by using not only the market share information but also the number of matched items within an elementary aggregate to decide about the inclusion or exclusion of an item[4].

The importance to carefully assess and process the article sales information becomes apparent in Figure 4 which visualizes the effect of discounts on the sales performance of a single energy drink article in the region of Vienna. Only the price and sales of a single product are displayed in this chart.

[4] http://www.unece.org/fileadmin/DAM/stats/documents/ece/ces/ge.22/2010/zip.6.e.pdf (P. 10)

***Figure 4** –Energy drink (article). Sales in Euro and volume in units Nov 2011 – March 2012.*



SOURCE: Statistics Austria – Scanner data project

Notably, the sales volume reaches its peaks when the price of the product is on discount. In this particular example a -30% discount leads to up to 600% sales increase (see calendar weeks KW11 – KW13). Just about 35% of the total products turnover in the covered period falls into calendar weeks without discount. Thus, discount and promotion activities of retailers can have a large influence on the market share of an article. This finding proofs the complexity of using the market share of a product as information for including or excluding articles into an index. Articles should be observed for a longer period in order to assess their market share. Furthermore, the evidence of a tremendous correlation between price incentives and sales volumes underlines that the use of sales information may be highly beneficial for the compilation of a modern superlative price index with weighted price relatives.

5 Summary and Outlook

The first stage of the Austrian scanner data project has achieved considerable advances on the long way towards a consumer price index computation with scanner data. By now, a network of Austrian scanner data stakeholders has been established which continuously discusses the issue of providing scanner data for price statistics. Statistics Austria takes part in the international discussions on the use of scanner data for price indexes by means of study visits, workshops and bilateral discussions with Member States which have already implemented scanner data in their CPI. Even though Austrian retailers still hesitate to directly provide scanner data, a first step has been taken by the transmission of Austrian scanner data via a market research company. This first sample of scanner data has been used to apply theoretical knowledge on index computation. As a result, it can be shown that Austrian scanner data has the potential to be successfully used for future price index computation. Several characteristics of scanner data may contribute to a higher quality of consumer price indexes: a broad and more detailed assortment of goods, detailed sales information for every calendar week with which promotions and discounts can be identified etc.

The scanner data analysis also reveals that the choice of computation method has an impact on the index results. Elementary aggregate index may be 'fixed base', 'monthly chained', 'weighted' or 'un-weighted'. Sales volume and quantity information may be used to include or exclude articles from index calculation. Computation methods for elementary aggregate indexes are currently being discussed about on the international level. The Austrian scanner data project enables Statistics Austria to contribute to the exchange of experience.

The results of the first stage of the Austrian scanner data project serve as the basis for the second stage starting in January 2013:

- Further promote the transmission of scanner data from Austrian retailers, by:
  - continuously informing stakeholders about the achievements of the scanner data research;
  - keeping close contact with Austrian retailers with the aim to receive scanner data;
  - pushing forward a regulation to oblige Austrian retailers to transmit scanner data
- Further analyze the scanner data sample from A.C. Nielsen with focus on:
  - assessing the impact of using the different index computation methods;

  - analyzing attrition rates and their impact; develop techniques of product replacements;
  - analyzing chain drift that occurs when using superlative indexes;
  - developing sophisticated imputation techniques for scanner data;
  - building up a knowledge base to easily integrate Scanner data from retailers;
- Take part in the international discussion on using scanner data for price index computation by attending relevant workshops, meetings and task forces.

6 Appendix

Figure 5 *– Cola-drinks. Price indexes from CPI and Scanner data.*

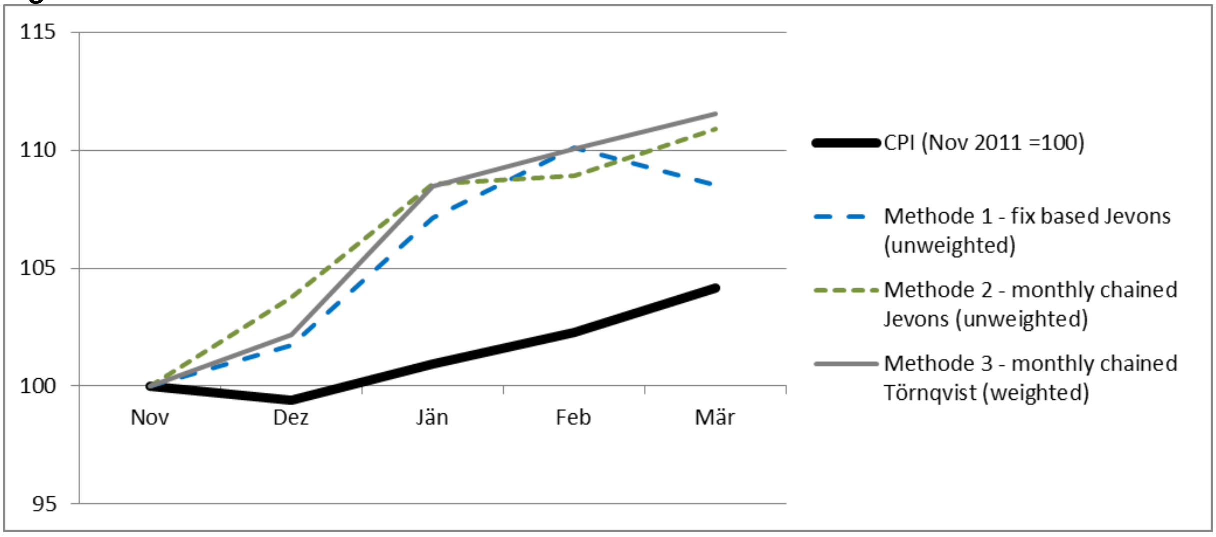


Figure 6 *– Lemonades (carbonated). Price indexes from CPI and Scanner data.*

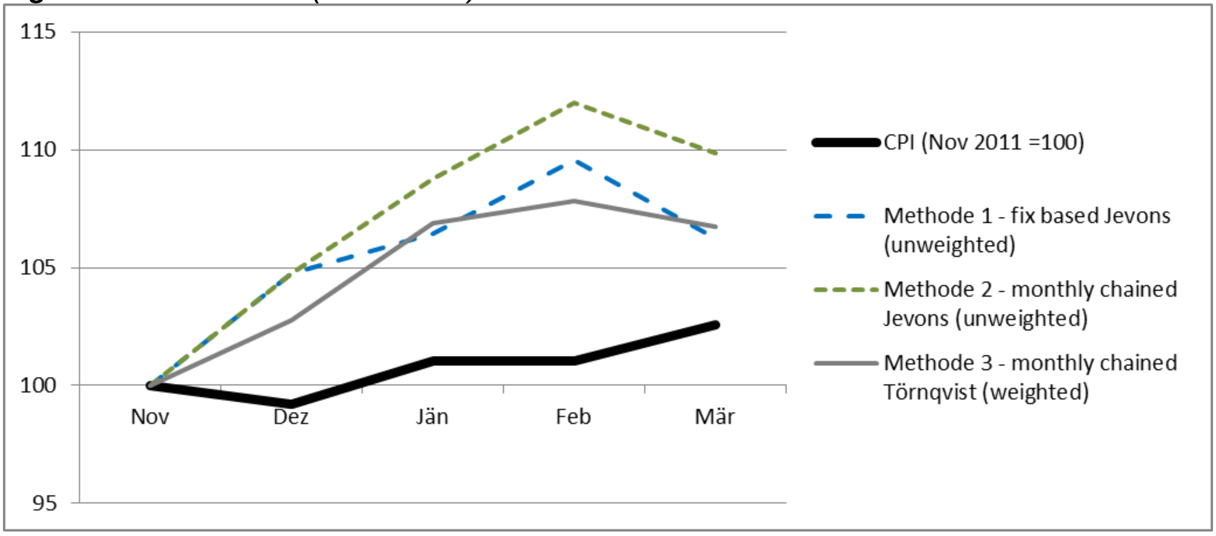


Figure 7 *– Ice tea. Price indexes from CPI and Scanner data.*

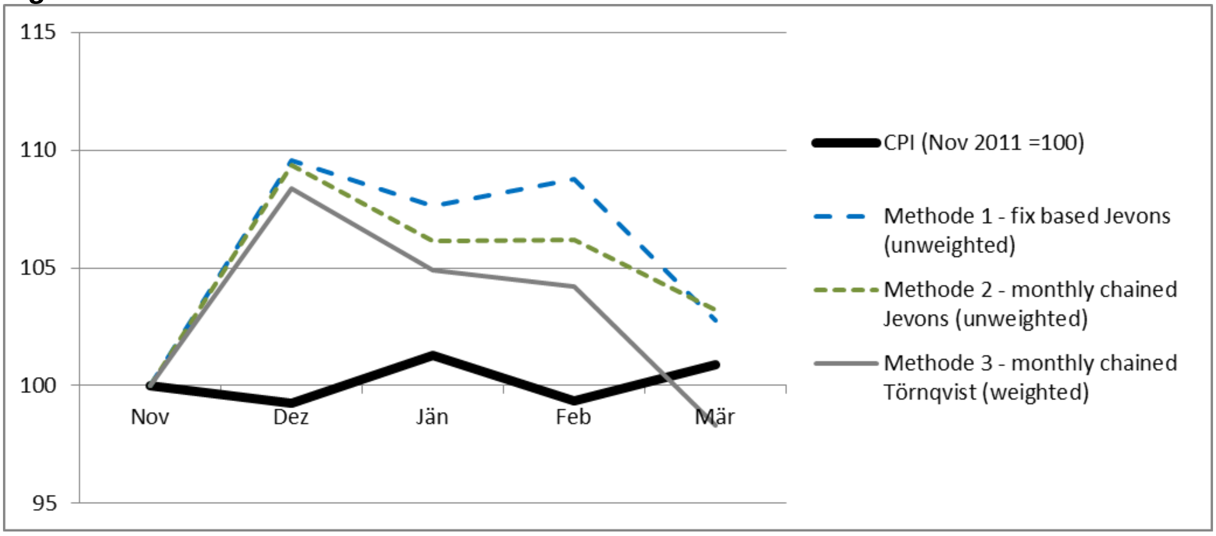


***Figure 8** – Juice. Price indexes from CPI and Scanner data.*

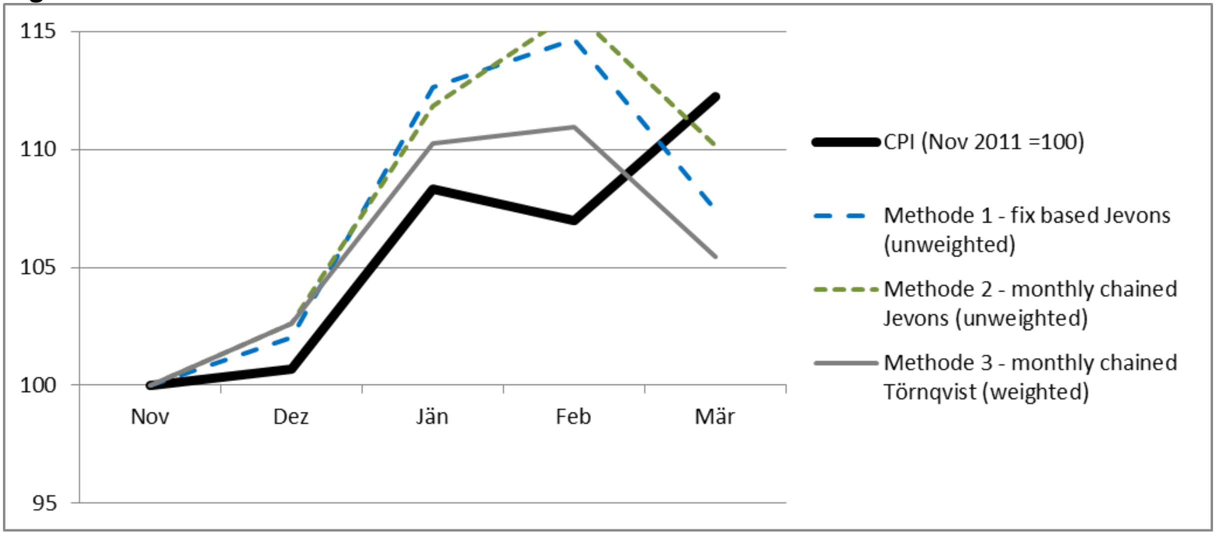


***Figure 9** – Mineral Water. Price indexes from CPI and Scanner data.*

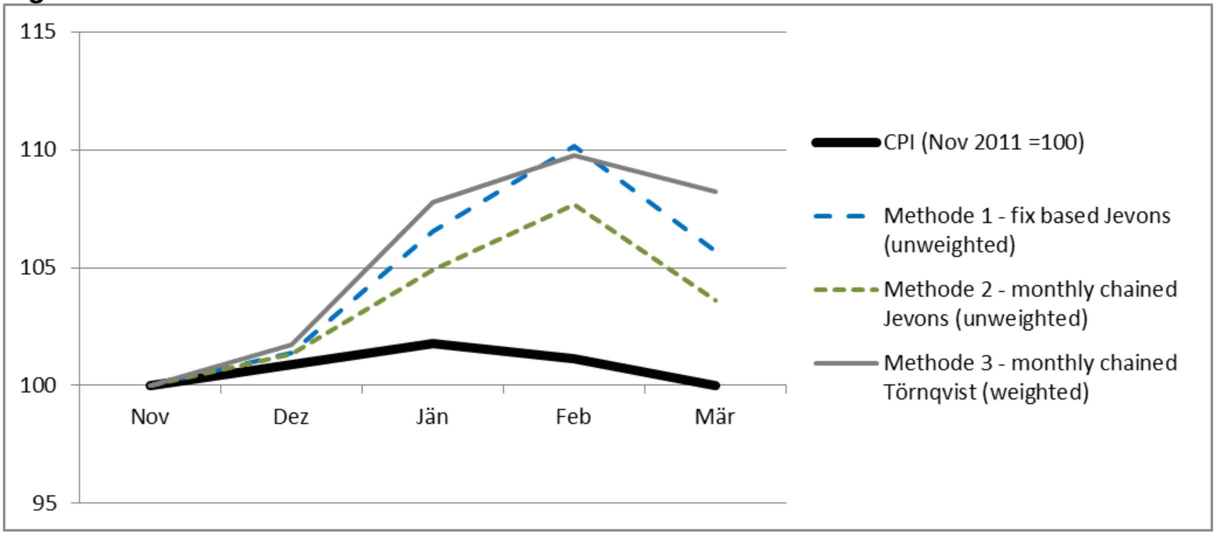
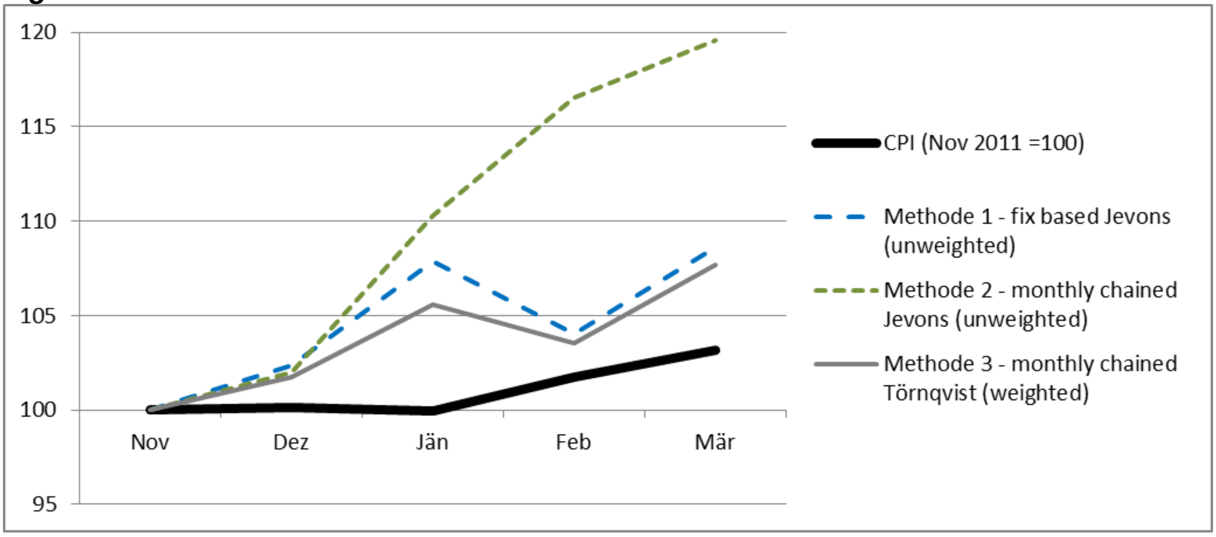


***Figure 10** – Near Water drinks. Price indexes from CPI and Scanner data.*



Method 1) unweighted geometric mean of prices (Model calculation with abstract data)

	Reference month t0 Nov 11				t1 Dec 11			t2 Jan 12		
Mineral water	Nov 11 Sales (units) (Reference month)	Nov 11 Sales (EUR) (Reference month)	Nov 11 Price (P^{t0})	Nov 11 Market share /Share (S^{t0}) in % (Sales (EUR))	Dec 11 Sales (units)	Dec 11 Sales (EUR)	Price P^{t1} Dec 11	Jan 12 Sales (units)	Jan 12 Sales (EUR)	Price P^{t2} Jan 12
Product A	10	10	1,00	18,2→>1%	10	11	1,10	-	-	
Product B	15	10	0,67	18,2→>1%	40	20	0,50	40	20	0,50
Product C	20	20	1,00	36,4→>1%	-	-	-	-	-	-
Product D	20	15	0,75	27,3→>1%	20	15	0,75	20	15	0,75
Product E	-	-			20	24	1,20	50	50	1,00
Total	**65**	**55**		**100**	**90**	**70**		**110**	**85**	

Dec 2011 with reference month Nov 2011

$$\pi_a^{t1/t0} = \prod_{i=1}^{n} \left(\frac{p_i^{t1}}{p_i^{to}}\right)^{\frac{1}{n}} = \sqrt[n_a^{t1}]{\left(\frac{(P_A^{t1})*(P_B^{t1})*(P_D^{t1})}{(P_A^{t0})*(P_B^{t0})*(P_D^{t0})}\right)} = \sqrt[3]{\left(\frac{(1{,}10)*(0{,}50)*(0{,}75)}{(1{,}00)*(0{,}67)*(0{,}75)}\right)}$$

$\pi_{Mineral\ water}^{Dec11/Nov11}$ = 0,93633077

$MZ_{Mineral\ water}^{Dec11/Nov1}$ =**93,633077**= Elementary aggregate index for Mineral water in Dec11 with reference month Nov11

Jan 2012 with reference month Nov 2011

$$\pi_a^{t2/t0} = \prod_{i=1}^{n} \left(\frac{s_i^{t0} p_i^{t2}}{s_i^{t0} p_i^{to}}\right)^{\frac{1}{n}} = \prod_{i=1}^{n} \left(\frac{p_i^{t2}}{p_i^{to}}\right)^{\frac{1}{n}} = \sqrt[n_a^{t2}]{\left(\frac{(P_B^{t2})*(P_D^{t2})}{(P_B^{t0})*(P_D^{t0})}\right)} = \sqrt[2]{\left(\frac{(0{,}50)*(0{,}75)}{(0{,}67)*(0{,}75)}\right)}$$

$\pi_{Mineral\ water}^{Jan12/Nov11}$ =0,86386843

$MZ_{Mineral\ water}^{Jan12/Nov11}$ =**86,386843 =**Elementary aggregate index for Mineral water in Jan12 with reference month Nov11

Method 2 – monthly chained price index (Dutch method) (Model calculation with abstract data)

	Reference month t0 Nov 11				t1 Dec 11				t2 Jan 12			
Mineral water	Nov 11 Sales (units) (Reference month)	Nov 11 Sales (EUR) (Reference month)	Nov 11 Price (P)	Nov 11 Market share /Share (S) in % (Sales (EUR))	Dec 11 Sales (units)	Dec 11 Sales (EUR)	Price Dec 11	Nov 11 Market share (S) in % (Sales (EUR))	Jan 12 Sales (units)	Jan 12 Sales (EUR)	Price Jan 12	Nov 11 Market share (S)in % (Sales (EUR))
Product A	10	10	1,00	>1,0%	10	11	1,10	>1,0%	-	-	*1,10**	
Product B	15	10	0,67	>1,0%	40	20	0,50	>1,0%	40	20	0,50	>1,0%
Product C	20	20	1,00	>1,0%			*1,00* *		-	-	-	
Product D	20	15	0,75	>1,0%	20	15	0,75	>1,0%	20	15	0,75	>1,0%
Product E	-	-			20	24	1,20	>1,0%	50	50	1,00	>1,0%
Total	**65**	**55**		**100**	**90**	**70**			**110**	**85**		

* inputed prices

Dec 2011 with reference month Nov 2011

$$\pi_a^{t1/\ t0} = \prod_{i=1}^{n_a^{(y,m-1),(y,m)}} \left(\frac{p_i^{y,m}}{p_i^{y,m-1}}\right)^{\frac{1}{n_a^{(y,m-1),(y,m)}}} = \sqrt[n_a^{t1}]{\left(\frac{(P_A^{t1}) * (P_B^{t1}) * (P_C^{t1}) * (P_D^{t1})}{(P_A^{t0}) * (P_B^{t0}) * (P_C^{t0}) * (P_D^{t0})}\right)} = \sqrt[4]{\left(\frac{(1{,}10) * (0{,}50) * (1{,}00) * (0{,}75)}{(1{,}00) * (0{,}67) * (1{,}00) * (0{,}75)}\right)}$$

$\pi_{Mineral\ water}^{Dec11/Nov11}$ =0,841945571

$MZ_{Mineral\ water}^{Dec11/Nov11}$ =**84,1945571**= Elementary aggregate index for Mineral water in Dec11 with reference month Nov11

Jan 2012 with reference month Nov 2011, monthly chained with Dec 2012

$$\pi_{Mineral\ water}^{Jan11/Dec11} = \prod_{i=1}^{n_a^{(y,m-1),(y,m)}} \left(\frac{p_i^{y,m}}{p_i^{y,m-1}}\right)^{\frac{1}{n_a^{(y,m-1),(y,m)}}} = \sqrt[n_a^{t1}]{\left(\frac{(P_A^{t2}) * (P_B^{t2}) * (P_D^{t2}) * (P_E^{t2})}{(P_A^{t1}) * (P_B^{t1}) * (P_D^{t1}) * (P_E^{t1})}\right)} = \sqrt[4]{\left(\frac{(1{,}10) * (0{,}50) * (0{,}75) * (1{,}00)}{(1{,}10) * (0{,}50) * (0{,}75) * (1{,}20)}\right)}$$

$\pi_{Mineral\ water}^{Jan11/Dec11}$ =0,955442697

$MZ_{Mineral\ water}^{Jan12/Nov11} = 100 * \pi_{Mineral\ water}^{Dez11/Nov11} * \pi_{Mineral\ water}^{Jan12/Dez11} = 100 *$0,8419*0,955442697= **80,43872066** Elementary aggregate index for Mineral water in Jan12 with reference month Nov11

Method 3 – Chained Superlative Index – Törnqvist (Model calculation with abstract data)

	Reference month t0 Nov 11					t1 Dec 11					t2 Jan 12			
Mineral water	Nov 11 Sales (units) (Reference month)	Nov 11 Sales (EUR) (Reference month)	Nov 11 Price (P^{t0})	Nov 11 Market share /Share (S^{t0}) in % (Sales (EUR))	Nov 11 Market share /Share (S^{t0}) for $\boldsymbol{\pi_a^{t1/t0}}$ in % (Sales (EUR)) **(only matched products and rescaled to 1 after sampling)**	Dec 11 Sales (units)	Dec 11 Sales (EUR)	Price P^{t1} Dec 11	Dec 11 Market share /Share (S^{t1})for $\boldsymbol{\pi_a^{t1/t0}}$ in % (Sales (EUR)) **(only matched products with t0 and rescaled to 1 after sampling)**	Dec 11 Market share /Share (S^{t1})for $\boldsymbol{\pi_a^{t2/t1}}$ in % (Sales (EUR)) **(only matched products with t2 and rescaled to 1 after sampling)**	Jan 12 Sales (units)	Jan 12 Sales (EUR)	Price P^{t2} Jan 12	Jan 12 Market share /Share (S^{t2}) for $\boldsymbol{\pi_a^{t2/t1}}$ in % (Sales (EUR)) **(only matched products and rescaled to 1 after sampling)**
Product A	10	10	1,00	18,2	28,6	10	11	1,10	23,9	0 No match with t2	-	-		
Product B	15	10	0,67	18,2	28,6	40	20	0,50	43,5	33,9	40	20	0,50	23,5
Product C	20	20	1,00	36,4	0 No match with t1	-	-	-			-	-	-	
Product D	20	15	0,75	27,3	42,9	20	15	0,75	32,6	25,4	20	15	0,75	17,6
Product E	-	-				20	24	1,20	0 No match with t0	40,7	50	50	1,00	58,8
Total	**65**	**55**		**100**	**100**	**90**	**70**		**100**	**100**	**110**	**85**		

Dec 2011 with reference month Nov 2011

$$\pi_a^{t1/t0} = \prod\left(\frac{p_i^{t1}}{p_i^{t0}}\right)^{\frac{(s_i^{t0}+s_i^{t1})}{2}} = \left[\left(\frac{p_A^{t1}}{p_A^{t0}}\right)^{\frac{(s_A^{t0}+s_A^{t1})}{2}} * \left(\frac{p_B^{t1}}{p_B^{t0}}\right)^{\frac{(s_B^{t0}+s_B^{t1})}{2}} \left(\frac{p_D^{t1}}{p_D^{t0}}\right)^{\frac{(s_D^{t0}+s_D^{t1})}{2}}\right] = \left[\left(\frac{1,10}{1,00}\right)^{\frac{(0,286+0,239)}{2}} * \left(\frac{0,50}{0,67}\right)^{\frac{(0,286+0,435)}{2}} * \left(\frac{0,75}{0,75}\right)^{\frac{(0,429+0,326)}{2}}\right] = 0,90855598$$

$\pi_{Mineralwasser}^{Dez11/Nov11}$ =0,94901601 → $MZ_{Mineralwasser}^{Dez11/Nov11}$ =**94,901601**= Elementary aggregate index for Mineral water in Dec11 with reference month Nov11

Jan 2012 with reference month Nov 2011, monthly chained with Dec 2012

$$\pi_a^{t2/t0} = \pi_a^{t1/t0} * \prod\left(\frac{p_i^{t2}}{p_i^{t1}}\right)^{\frac{(s_i^{t1}+s_i^{t2})}{2}} = \pi_a^{\frac{t1}{t0}} * \left[\left(\frac{p_B^{t2}}{p_B^{t1}}\right)^{\frac{(s_B^{t1}+s_B^{t2})}{2}} * \left(\frac{p_D^{t2}}{p_D^{t1}}\right)^{\frac{(s_D^{t1}+s_D^{t2})}{2}} * \left(\frac{p_E^{t2}}{p_E^{t1}}\right)^{\frac{(s_E^{t1}+s_E^{t2})}{2}}\right]$$

$$\pi_a^{\frac{t2}{t0}} = 0,90855598 * \left[\left(\frac{0,50}{0,50}\right)^{\frac{(0,339+0,235)}{2}} * \left(\frac{0,75}{0,75}\right)^{\frac{(0,254+0,176)}{2}} * \left(\frac{1,00}{1,20}\right)^{\frac{(0,407+0,58,8)}{2}}\right] = 0,90855598*0,92133807=\mathbf{0,83708721}$$

$\pi_{Mineralwasser}^{Jan12/Nov11}$ =**0,83708721**

$MZ_{Mineralwasser}^{Jan12/Nov11}$ =**83,708721**= Elementary aggregate index for Mineral water in Jan12 with reference month Nov11