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Korrigering för urvalsbias

För diskussion/beslut

Prisenheten föreslår att korrigering för urvalsbias skall göras från och med januari 2014 för högteknologiska produkter och vitvaror. Korrigering skall göras enligt samma metod som har använts för kläder och skor under 20 år.

Prisenheten ser gärna att Nämnden tar en diskussion kring att de statistiska urvalen av försäljningsställen, där SCB:s intervjuare samlar in data, skall kedjas in i september eller oktober i stället för december som hittills i KPI.

0. Bakgrund

Nämnden för konsumentprisindex efterfrågade vid sammanträde 247 år 2012 en ”hantering av problemet som uppstår då prisinsamlarna tenderar att välja ordinariepriser i basperioden samtidigt som andelen reapriser blir allt högre i slutet av året.”

Det finns två grupper av åtgärder för att hantera problemet;

1) försök att förhindra källan till bias
2) försök korrigera för den uppkomna biasen.

0.1 Fältarbetet

Instruktionen för intervjuarnas prisinsamling säger om realisationer följande:

”Produktvarianter som har reapris eller kampanjpris ska ändå väljas om ovanstående kriterier gäller. Priset ska i princip inte vara styrande i valet av variant. Reor ska dock inte följas för länge då varianter säljs ut och ersätts av nya varianter.”

Trots att instruktionen tydligt säger att alla typer av priser kan inkluderas, tenderar intervjuarna att undvika produktvarianter med realisationspris när de väljer produkterbjudanden i nyvalda butiker under basmånaden december.

En bias uppstår i konsumentprisindex (KPI) av intervjuarnas medvetna urvalsförfarande. När urvalet är gjort och prisinsamling görs månad efter månad, skall intervjuaren inte avstå ifrån att fortsätta prismäta varor som realiseras eftersom de har i uppdrag att samla in priser så länge som produkterna erbjuds till försäljning. Visserligen bör produkterbjudanden bytas om försäljningen har minskat avsevärt samtidigt som någon annan produkt i sortimentet har blivit storsäljare. I december tolv månader efter introduktionen av det nya butiksurvalet och intervjuarens eget urval av produkterbjudanden kommer andelen sänkta priser därför normalt att vara högre än i basmånaden. Detta skapar en nedåtgående bias i KPI för berörda produktgrupper.

Estimerad urvalsbias för åren 2011 till 2013 är 1-2 procentenheter för högteknologiska produkter och hushållsmaskiner. Detta är samma storleksordning som för kläder och skor.

0.2 Åtgärder mot bias

Det skulle givetvis vara bra om man kunde förhindra att intervjuarna utför ett biased urvalsförfarande i en ny butik, men av erfarenhet tror vi inte att det är en framkomlig väg. Intervjuare vill ofta undvika tidskrävande varubyten och vill därför ha produkter de kan prismäta under så lång tid som möjligt. En vara som redan i basmånaden har ett nedsatt pris kommer förmodligen snart behöva bytas ut. Av den anledningen väljer intervjuaren ofta varor till ordinarie pris i basen. Vi ser ingen möjlighet att designa en procedur för basen som genererar ett urval med samma andel realisationer som ett urval som har använts i 13 månader.

Man kan förhindra bias genom att dra nya butiksurval och låta intervjuarna göra urval av lokala produkterbjudanden några månader före den egentliga introduktionen av prisobservationerna i indexberäkningen. Eftersom detta innebär att två parallella urval måste prismätas samtidigt blir det dyrt.

Vi kan överlag för intervjuarinsamlade data byta månad för urvalsuppdateringar till en ”lugnare” månad än december. Om aktiviteter såsom kampanjer och realisationer är mindre frekventa i t.ex. september än december blir kedjning av två indexlänkar med den överlappande månaden september av högre kvalitet, både i termer av bias och varians.

0.3 Korrigering för bias

Korrigering för uppkommen bias görs med kvoten av realisationernas och kampanjernas effekter på observerade priser under en och samma period (december) då den trettonde prismätningen görs för innevarande år *y* och basen läggs för kommande år *y+1* med ett delvis nytt urval. Denna kvot är en skattning av bias som används för att korrigera index (alternativt baspriserna för de bias valda produkterbjudandena) under det kommande året.

Norberg (1993) tog upp problemet och förslaget till lösning för KPI nämnden. Nämnden beslöt att korrigeringen, som benämndes ”rea-korrigering” skulle införas i KPI för kläder och skor. Korrigeringarna för kläder har varit omkring 2 procentenheter, vilket korrigerar KPI total årligen med cirka 0,1 procentenhet enligt Norberg (1995) och Norberg (1998). Bias för skor har varit något lägre.

Korrigering för bias på detta sätt torde också resultera i lägre varians i långsiktig prisutveckling. Det är uppenbart att korrigeringsfaktorerna i sig har stor varians men det finns samtidigt stor negativ kovarians mellan skattningarna av korrigeringsfaktorn för år *y+1* och indexlänken mellan december år *y-1* och december år *y*.

En tveksamhet till metoden kan motiveras av att ”ordinarie priser” möjligen inte är tillförlitliga uppgifter i detaljhandeln. En analys av KPI-data 2010-2013 visar att prishöjningar inför en realisation inte är mer vanliga än prissänkningar och att bägge prisrörelserna har låga frekvenser.

0.4 Förslag

Primärt bör bias undvikas. Det görs genom att byta urval i september eller oktober för detaljhandel. Den nuvarande indexkonstruktionen sätter inga hinder i vägen. Det blir två länkar under året, en från prisbasen till september och en från september till månad (oktober, november och december).

Urvalsbias kommer att finnas kvar. För högteknologiska produkter och vitvaror bedöms korrigering vara särskilt angelägen och bör göras så snart möjligt.

Correction of Sample Selection Bias

1. Introduction

A bias occurs for a consumer price index, CPI, when price collectors tend to avoid product varieties on sale when selecting the sample in the reference month. Once the sample is fixed, the price collector cannot avoid sales prices since they are commissioned to collect prices almost as long as products are offered for consumers to buy. In December twelve months later the proportion of reduced prices will normally be higher than in the reference month, creating a downward bias in the CPI for the affected product groups.

The opposite effect occurs when price collectors tend to favor products in the new outlet sample that have low campaign prices.

Statistics Sweden has used a correction for selection bias for clothing and footwear since 1993 for the Swedish KPI and the HICP. It has been discussed whether the same correction method is applicable and needed for other product groups. In this report, we evaluate methods for hindering selection bias to occur and explore the need for a correction of bias.

2. Sampling

The sampling of product offers has three stages; 1) sampling of outlets annually, 2) definition of product groups (Strata) and a definition of the representative item and finally, 3) the selection of specific product offers for the combinations of outlets and representative items.

2.1 Sampling of Outlets

For product groups where local price collection or scanner data is used, outlets are divided into 38 retail trade and service strata according to the Swedish Standard Industrial Classification (SNI, which closely follows NACE, Rev. 2, the EU standard). In each stratum a gross sample of outlets is drawn from the SAMU version of the Central Business Register by the method Sequential Poisson sampling which is an *order pps technique*. This first gross sample is drawn about six months before the year in which the sample is to be used. This sample is screened in October and November, both in the central office and by the price collectors visiting the outlets. Some of the outlets initially drawn are excluded for various reasons. For example, they may be head offices rather than outlets, or they may not sell any of the sampled products. After screening, outlets are picked from the list one by one in order, until the predetermined net sample size is reached. Positive coordination of outlet samples between years is obtained through the use of random numbers “permanently” associated with each outlet in the sampling frame, Ohlsson (1995). Sampling rotation is performed so that 20 per cent of these random numbers are changed every year. Combined with changes in the sampling frames, this results in some 70-75 per cent of outlets remaining in the sample from one year to the next.

2.2 Sampling of Representative Items

Following common practice, most products in the Swedish local price survey are chosen using the representative item method. General product specifications are drawn up in the central office using the Household Budget Survey (HBS) as one reference among others. Price collectors then get specific instructions on how to choose between the different varieties of each product.

For daily necessities like food, beverages, detergents etc. SCB make a probability sample of fully specified products. Prices are collected from scanner data.

2.3 Sampling of Product Offers

Price collectors are instructed to choose the variety that is *most sold* in terms of volume within this specification in the sampled outlet. This method could be viewed as a special case of cutoff sampling. Outlet staff are often asked to assist in the judgments that have to be made when applying this criterion. For new varieties it is sometimes difficult to know in advance which items will have the highest sale numbers. It is not certain that the selection in practice always catches the variety that will be the most sold. The *most sold* rule also applies to replacements when an item disappears from the market. Example 1 show four examples of product specifications from the central office. Some products have tight specifications with several criterions for the price collector to follow, illustrated here by the skirt. Other products, like yarn, have more generic or loose specifications.

Example : Item specification and selected variety

- **Skirt, version 1,** Central specification: *Size 38-42 or similar. Not a pantskirt. Not wool, linen or silk.* The price collector selects the most sold variety in the outlet.
- **Digital Camcorder, A,** Central specification: *Digital recording, flash memory and HD supported*. The price collector selects the most sold variety in the outlet.
- **Skis,** Central specification: *Cross country skis, suitable for a recreational skier, length 200 cm*. The price collector selects the most sold variety in the outlet
- **Yarn,** Central specification: *Wool, wool/synthetic mix or fully synthetic*. The price collector selects the most sold variety in the outlet.

2.4 Non-Probability Sampling Techniques

Using a judgments sample, i.e. letting price collectors choose the varieties when creating the new base sample, is of course a non-probability sampling technique. In a statistical setting, it is sometimes hard to argue the benefits of such methods. The International Labour Organization (2004) supports such methods under certain circumstances (Appendix A, Consumer Price Manual: Theory and Practice, chapter 5.27-5.31). In particular, when non-probabilistic replacements are made throughout the measurement period, as is practice in clothing in the KPI, the benefits of a probability sample is destroyed (chapter 5.31).

There are draw backs of non-probability sampling. Since products are chosen arbitrarily, there is no way to estimate the probability of any one product being included in the sample. Also, no assurance is given that each item has a chance of being included, making it impossible to estimate sampling. Judgment samples especially can be highly prone to researcher bias. The selection bias introduced below, is a good example of how the subjectivity of the price collector creates issues in the resulting sample.

3. The Problem

The Swedish KPI is a chain index with annual links. In December, prices are collected for two partially overlapping samples from the same population: the last measurement for year *y-1* and the first measurement for year *y*. Every year about 25-30% of the outlets in the old sample are replaced by a new sample. For

the outlets that remain in the sample from the previous year, price collectors are instructed to select new product varieties if the old varieties no longer represent consumer behavior (as is the instruction for any other month). Instructions also say that all varieties, regardless of type of price, should be considered when choosing the product offer in the base period. However, it has been observed[1] that price collectors tend to choose products that can be expected to remain in stores as long as possible to avoid frequent substitutions. In making the base period selection, price collectors therefore tend to choose varieties sold at regular price and not varieties on sale, thereby creating a sample where sales prices are underrepresented. Throughout the year, up to 30% of the varieties in the sample are substituted each month. It is possible for the price collector to avoid varieties with sales prices in the base period and at substitutions, but the proportion of sales prices in the December sample one year later will almost reflect the proportion of sales prices in the general population of products. The relative lack of sales prices in the base period will lead to a downward bias in the KPI.

Norberg (1993) brought this problem to the attention of the KPI advisory board in 1993. For the index year 1993 a correction for the bias in clothing and footwear was introduced, referred to as a "sales price correction[2]." In can be noted that the estimated average bias for clothing has been around two percentage points downwards annually, which means a decrease in the total KPI of about 0.1 percentage points (Norberg, 1995 and 1998). Bias for footwear is somewhat lower.

We suggest two groups of methods to deal with the problem;

- Hinder the bias to arise
- Adjust for the bias

4. Methods for Avoiding the Bias

4.1 Instruct price collectors to do it right

Instructions say product variants having sales or campaign prices should be selected if they are the most sold. Price itself must not be decisive for the selection. Instructions are clear, but we can see a definite tendency that this requirement is not fulfilled. We strongly question is if more education of price collectors would be a cost effective solution to the problem.

4.2 Draw New Samples in September or October

Selecting the sample one or a couple of months earlier than the base period would allow the sample to "mature," i.e. the proportion of sales prices would increase from the selection month to the base period (December) before it is used for price index calculations.

Norberg (1993) proposed that new samples were collected in November rather than December for clothes. As it turned out, collecting the new sample one month early did have the desired effect but the effect was not strong enough. Although the selection bias was reduced, it was not completely eliminated. Up

[1] The author accompanied several price collectors to learn about the collection process. She then made the observation that collectors purposely stay away from products with sales prices when making substitutions.

[2] Since the introduction of the "sales price correction" it has become clear that the term is unfortunate. The correction does not adjust for sales prices occurring during the year but rather for the bias created when the price collector stays clear of sales prices when creating the base sample. A better fitting term is therefore "correction for selection bias."

for discussion is the possibility to draw the new sample already in September or October. Allowing the sample to mature for three months might be enough for the proportion of sales prices in the sample to better mimic that of the population.

One drawback of carrying double samples is of course the added cost. For two extra months price collectors will have to collect prices for two samples, which will be more time consuming and expensive than collecting prices for one sample. It could also have a negative effect on the motivation of the price collectors if they found out that a lot of their hard work went unnoticed since prices were not recorded.

On the other hand, an added benefit to drawing the new sample in October would be the improvement in work environment for the price collectors. Preparing a new sample and choosing new varieties in December, when Christmas preparations are at a peak, is very stressful. It would be easier and less stressful to perform this time consuming task in October when stores are not heavily occupied by anxious Christmas shoppers.

4.3 Changing the KPI Linkage Months

December is not the best month to link short term indices based on the following reasons:

- There are less price activities in September and October than in December. Activities like end of stock sales and campaigns brings variance to the price index link for the month and chaining one index link with low statistical quality to another with low statistical quality is worse than having two higher quality index links. Table 1 below show the percentage of sale or campaign prices in the sample, indicating that September and October are the overall best choices for linking.
- For working conditions for the price collectors in outlets it is an advantage to move the almost double workload of the overlap period from December to a less busy shopping month. September and October seems to be good alternatives.
- For working condition at the central KPI office at SCB it would be an advantage to spread the heavy annual update workload to more months than December – February.

The only drawback found is that computation will be a little bit more complex. The operationalization of the new index structure for the CPI as suggested by SOU 1999:124, documented in Ribe (2003), and approved by the KPI board at the meeting 219 in 2003 does not hinder two pieces of index component from *y-1,12* to *y,m*.

The KPI construction works with a year-to-month-index $I_{y-2;g}^{y,m}$ for the product group g, which in the simplest form is

$$I_{y-2;g}^{y,m} = \frac{I_{y-3,\mathrm{Dec};g}^{y-2,\mathrm{Dec}}}{\frac{1}{12}\sum_{m=1}^{12} I_{y-3,\mathrm{Dec};g}^{y-2,m}} \cdot I_{y-2,\mathrm{Dec};g}^{y-1,\mathrm{Dec}} \cdot I_{y-1,\mathrm{Dec};g}^{y,m} \ .$$

For the months after September (say) the last piece can be computed as $I_{y-1,\mathrm{Dec};g}^{y,m} = I_{y-1,\mathrm{Dec};g}^{y,Sept} \cdot I_{y,Sept;g}^{y,m}$.

In fact, the implementation can be made like imputation of base prices. For all product offers within a product group, the base price for the last months are the price in September divided by the index from December last year to September current year.

Table 1: Percentage of price observations that are on sales or campaign, per month 2010 to 2013

Group	*Month*											
	1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***
Car Accessories	6	5	4	4	4	5	5	4	4	5	6	6
Clothes	31	21	12	10	9	18	32	19	7	7	9	12
Footwear	35	35	23	15	11	16	27	22	11	9	12	13
Furniture	9	7	6	6	6	7	8	6	5	6	6	6
High-Tech Products	16	10	11	13	12	14	19	11	10	13	10	9
Household Equipment	17	10	10	10	9	11	16	13	10	12	11	12
Household Goods	6	5	4	5	4	4	6	4	3	3	3	3
Household Textiles	20	16	14	15	10	16	17	18	12	14	14	17
Kitchen, Bath and Floors	6	7	7	7	6	7	6	6	5	9	9	8
Office Equipment	2	1	1	1	1	2	1	3	3	2	1	1
Optics	0	0	1	1	0	0	0	0	0	1	1	1
Other Personal Goods	14	14	13	16	15	15	16	17	14	9	10	12
Personal Hygiene	5	3	5	3	3	4	5	3	4	3	7	5
Tools & Garden Equipment	3	5	2	5	5	4	4	6	4	3	3	3
Toys and Sport Articles	16	19	20	16	15	16	18	16	16	16	15	15
Yarn & Fabric	1	2	1	1	0	0	1	1	1	0	0	0

5. Correcting Method

December is the last month of last year's link and the price reference period for the next year's link. This means that prices and information are collected for two partially overlapping samples during the same week(s). Based on the two samples we make two estimates of the effect of sales and campaigns on the mean price level. If there is a purposive avoidance of sales prices in price reference period, the effect of the sales price effect will be higher for the price reference period sample than for the final December sample, for the identical period. The ratio between these two estimates of the sales price effect is not only stochastic but also systematic and would lead to a continuous bias in the KPI for the affected products.

The formula for the index link for an elementary aggregate from December last year to the current month this year in the Swedish KPI is

$$I_{y-1,12}^{y,m} = \frac{\left(\prod_k w_k p_k^{y,m}\right)^{\frac{1}{n}}}{\left(\prod_k w_k p_k^{y-1,12}\right)^{\frac{1}{n}}}$$

We use a similar formula as in the elementary aggregate of CPI-computation to calculate the effect of sale prices, *S*. Put the actual prices in the place of the comparison period prices, *y* and the regular prices in the place of the price reference period prices, *y-1*, to calculate the sales effects for the two samples.

$$S_{y-1,12}^{y-1,12} = \frac{\left(\prod_k w_k p_{k,obs}^{y-1,12}\right)^{\frac{1}{n}}}{\left(\prod_k w_k p_{k,reg}^{y-1,12}\right)^{\frac{1}{n}}}$$

$$S_{y,0}^{y,0} = \frac{\left(\prod_k w_k p_{k,obs}^{y,0}\right)^{\frac{1}{n}}}{\left(\prod_k w_k p_{k,reg}^{y,0}\right)^{\frac{1}{n}}}$$

The bias of the prices of the base period is on average

$$BIAS = \frac{S_{y,0}^{y,0}}{S_{y-1,12}^{y-1,12}}$$

We adjust either the prices for the base period by multiplying by 1/*BIAS* or multiplying by the index numbers for the months *y,m* by *BIAS*.

Prices in the base month are now adjusted with the ratio of the sales price effect for the final December sample and the sales price effect for the price reference period sample. Alternatively an adjustment to the monthly price index is made by the ratio between the sales price effect of the base month of the new sample to that of the final month (December) of the old sample. This adjustment is applied during the following year.

The following is a simple example (Norberg, 1995) with a few varieties:

Example: Calculation of Correction for Selection Bias

All prices are collected in December some year. There are four varieties in the survey of the present year and five varieties to be measured the following year beginning in December.

Final month of last year's link			Price ref. month of actual year	
Regular price	Actual price		Regular price	Actual price
199	199		199	199
199	149		239	239
98	78		398	349
595	495		599	599
			899	799
Index (actual/regular) = 83.9			Index (actual/regular) = 95.1	

In this example three out of four varieties had sales prices in the final month of last year's link and the actual prices were on average 83.9% of the regular prices. Analogously the actual prices in the new price reference period sample were on average 95,1% of the regular prices. The price index for every month of the new year must be adjusted up-wards with the ratio 95.1/83.9 = 1.13.

6. Analysis of KPI Data

6.1 Data

Analysis has been carried out on real KPI data from the years 2010, 2011, 2012 and 2013 to see if any product and industry combination shows a big selection bias, indicating that a correction would be beneficial. Only products that are quality adjusted at price changes are included in the study since those are the only products where regular prices are collected continuously.

Product categories considered in this study are:

Category	Products
Clothing	All clothing
Footwear	All footwear
High-tech products	TV, CD/cassette player, stereo, camcorder, DVD player, home entertainment center, MP3 player
Household goods	China and utensils, drinking glass, pots and pans, kitchen scales
Household textiles	Towel, bedding, comforter, curtains and cloth for curtains
Recreational goods	Toys, sport articles, ski equipment, recreational goods, bike, music instruments
Personal hygiene	Cosmetics, electric razor
Furniture	Kitchen table, chair, upholstered chair, sofa, mirror, bed, shelves, rug, mattress, ceiling lamp
Car accessories	Tires, car accessories, booster seat
Optics	Glasses, contact lenses
Household equipment	Laundry machine, dishwashing machine, vacuum cleaner, electric stove, refrigerator, microwave oven, coffee maker, water boiler
Yarn and fabric	Yarn, thread, fabric
Kitchen, bath and interior	Bathtub, toilet, kitchen cupboard, kitchen sink, wooden floor, door
Tools and garden equipment	Hammer, grass mower, knife, garden spade, light bulb, electric screwdriver
Office equipment	Writing paper, ink for printer
Other personal goods	Watch, bag

6.2 Results

Results from the analysis can be seen in the tables 2-5 (tables 4 and 5 are found in Appendix B.

It is not uncommon that some products have low counts in some of the industries and thereby accidently might introduce a significant bias. For example, in 2011 the bias for baby pants sold in hypermarkets is extremely high. A closer inspection of the prices show that there are eight pairs of baby pants sold in hypermarkets in the reference period with only one pair sold at a discount. In December twelve months later there is only one pair left, sold at 35% of the original price.

Clothing and footwear are corrected for the selection bias every year. Looking at table 2 it is clear that this correction is motivated. The extent of the bias varies from year to year and depends on the particular product varieties chosen in the base month sample.

Table 2: Geometric mean of biases from 2010 to 2013

Group	Weight ‰	Mean Bias 2010	Mean Bias 2011	Mean Bias 2012	Mean Bias 2013	Geometric Mean Across Years
Clothes	**44.7**	**1.01**	**1.01**	**1.00**	**1.01**	**1.011**
Footwear	**8.3**	**1.01**	**1.01**	**1.02**	**1.02**	**1.011**
High-Tech Products	7.5	1.01	1.01	1.03	1.01	1.015
Household Goods	6.2	1.01	1.00	1.00	1.02	1.010
Household Textiles	5.8	1.00	1.00	1.01	1.03[1]	1.009
Recreational Goods	12.5	1.01	1.02	1.01	1.00	1.008
Personal Hygiene	3.1	1.00	1.02	1.01	1.00	1.006
Furniture	20.8	1.00	1.00	1.00	1.01	1.003
Car Accessories	6.2	1.00	1.01	1.00	1.00	1.002
Optics	3.7	1.00	1.00	1.00	1.00	1.000
Household Equipment	5.5	1.00	1.00	1.01	0.99	1.000
Yarn & Fabric	0.6	1.00	1.00	1.00	1.00	1.000
Kitchen. Bath and Interior	5.6	1.00	1.00	1.00	0.99	0.999
Tools & Garden Equipment	6.5	1.00	1.00	1.00	1.00	0.998
Office Equipment	0.9	0.99	1.00	1.00	1.00	0.997
Other Personal Goods	3.6	1.01	0.95[1]	1.01	1.02	0.996

1) The high value for household textiles in 2013 is due to a high proportion of sale prices for curtains in home furnishing textile stores.
2) The low mean correction for ”Other Personal Goods” in 2011 is due to a big proportion of campaign prices for men’s watches and purses in the base sample.

Further examination of the results show strong indications that several additional product groups are affected by the selection bias.

- High-tech products have been a source of uncertainty for the KPI calculations for a long time. Rapid development and changes of the products makes month to month comparisons hard. Prices in this product group are volatile with frequent sales and campaigns.
- Recreational goods can be highly seasonal (ex. ski equipment). Campaigns can be common in the beginning of a product’s season while sales are more common toward the end of the season.
- Other personal goods are often sold at the same outlets as clothes and prices can be expected to fluctuate in a similar fashion. The mean correction in table 2 is heavily affected by the one very low value for 2011.
- Household textiles such as towels and curtains seem to be subject to sales to a large extent.

An analysis of the mean bias for product groups over the years 2010 – 2013 brings up an interesting topic. In 2011, the low mean bias for “Other Personal Goods” is entirely due to campaign prices for men’s watches in watch stores and suitcases in specialty bag stores. In these cases, price collectors seem to have followed the instructions exceptionally well and chosen “most sold regardless of type of price.” One can assume that a nice product sold at a good campaign price would attract customers and choosing these products for the sample was correct.

We can conclude that in cases like these, the correction will be reverse (i.e. a higher proportion of sales prices in the base month compared to the December sample gives a correction < 1) and prices will be adjusted accordingly.

6.3 Discussion of Method

During the measurement year the products chosen in the original sample will go on sale and finally disappear and get substituted. In this fashion, the sample will evolve from the originally low proportion of sales prices toward a proportion of sales prices close to that of the general population. If price collectors in December chose products completely new to the market we can expect this process to take several months since sales prices usually occur in the tail end of the product life. Since the correction for selection bias is the same for all month of the measurement year we could end up with a reverse bias in the beginning of the year. Even if this is the case, the correction of selection bias will have a positive effect overall.

Another thing to keep in mind is the quality of the reported "regular prices." Calculations of the bias is highly dependent on the assumption that the regular price of a sale item is correct. For some product groups it is common practice to use "recommended price" or "list price" rather than a true regular price. A recommended price is almost never paid by the customer, but is used to make a sale price more attractive. In such cases we would overestimate the selection bias.

If all observed regular prices are generally X % higher than the "true" regular prices there will be no effect on the correction for the selection bias. If, on the other hand, regular prices for sale products are increased to make the sale appear better, we will overestimate the selection bias. Table 3 shows that this practice is not very common in Sweden. It appears that it is as common for the regular price to decrease before a sale.

We realize that the quality or relevance of regular prices can be questioned. After examination of the regular prices in the Swedish KPI system, our opinion is that they are trust worthy and of good enough quality to use in our bias calculations.

It should also be mentioned that since the estimates of the effects of sales prices are stochastic, big (or small) values of the bias correction can appear randomly. Table 5 in Appendix B shows that in 2011, the corrections for baby pants is 2.48 which must be considered uncommonly high. It is obvious that the bias has high variance but there is also a strong negative covariance between the estimated correction for year $y+1$ and the index link between December year $y-1$ and December year y. Correcting for the bias should therefore result in less variance in estimates of long term price movement.

Table 3: Change of regular price from month before the sale price to the month with sales price. Proportions of price observations with price decrease and price increase. 2010-2013

Group	Decrease (%)	Increase (%)	Number of obs
Car Accessories	1.7	2.3	346
Clothes	1.1	0.5	12 591
Footwear	1.0	0.9	5 078
Furniture	1.5	1.8	1 499
High-Tech Products	3.4	2.5	1 551
Household Equipment	2.9	3.0	1 811
Household Goods	1.2	1.6	429
Household Textiles	2.3	3.0	1 898
Kitchen. Bath & Floors	1.1	1.8	438
Office Equipment	7.5	5.7	53
Optics	0.0	0.0	10
Other Personal Goods	0.7	1.7	539
Personal Hygiene	1.7	2.2	179
Tools & Garden Equipment	1.5	2.3	263
Recreational Goods	0.9	2.0	2 056
Yarn & Fabric	10.0	0.0	10

7. Conclusions

Statistics Sweden has corrected for the selection bias for clothing and footwear for the past 20 years. Analysis carried out in this study supports this and continues to point out clothing and footwear as product groups where selection bias is present. Other product groups where the analysis indicate that a correction is necessary are high-tech products, household equipment, household textiles, recreational goods and other personal goods. The bias is not as strong or consistent in these industries, but sometimes big enough that a correction could be beneficial.

Applying the method of correcting for the selection bias to all or some of the above mentioned product groups is an intuitive solution to the problem. If the bias is small, the correction will be small and have very little effect. On the other hand, if the bias is big it will result in a stronger correction. For more uncommon situations as the example with a reverse bias due to campaign prices in the base sample (i.e. the proportion of reduced prices is higher in the base sample than in the population) correction will also be beneficial.

We recommend that adjustments for selection bias (using the above mentioned method) should be performed for High-Tech Products and Household equipment starting in 2014. We would also like to start a discussion regarding the possibility of changing the KPI linkage month from December to September or October.

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Appendix A: The Consumer Price Index Manual

Reasons for using non-probability sampling

5.28 *No sampling frame is available*. This is often true for the product dimension but less frequently so for the outlet dimension, for which business registers or telephone directories do provide frames, at least in some countries, notably in Western Europe, North America and Oceania. There is also the possibility of constructing tailor-made frames in a limited number of cities or locations, which are sampled as clusters in a first stage. For products, it may be noted that the product assortment exhibited in an outlet provides a natural sampling frame, once the outlet is sampled as a kind of cluster, as in the BLS sampling procedure presented above. So the absence of sampling frames is not a good enough excuse for not applying probability sampling.

5.29 *Bias resulting from non-probability sampling is negligible*. There is some empirical evidence to support this assertion for highly aggregated indexes. Dalén (1998b) and De Haan, Opperdoes and Schut (1999) both simulated cut-off sampling of products within item groups. Dalén looked at about 100 groups of items sold in supermarkets and noted large biases for the sub-indices of many item groups, which however almost cancelled out after aggregation. De Haan, Opperdoes and Schut used scanner data and looked at three categories (coffee, babies' napkins and toilet paper) and, although the bias for any one of these was large, the mean square error (defined as the variance plus the squared bias) was often smaller than that for pps sampling. Biases were in both directions and so could be interpreted to support Dale´ n's findings. The large biases for item groups could, however, still be disturbing. Both Dalén and De Haan, Opperdoes and Schut report biases for single-item groups of many index points.

5.30 *We need to ensure that samples can be monitored for some time*. If we are unlucky with our probability sample, we may end up with a product that disappears immediately after its inclusion in the sample. We are then faced with a replacement problem, with its own bias risks. Against this, it may happen that short-lived products have a different price movement from the price movement of long-lived ones and constitute a significant part of the market, so leaving them out will create bias.

5.31 *A probability sample with respect to the base period is not a proper probability sample with respect to the current period*. This argument anticipates some of the discussion in Chapter 8 below. It is certainly true that the bias protection offered by probability sampling is to a large extent destroyed by the need for non-probabilistic replacements later on.

Appendix B: Result Tables

Table 4: Products and industries with the largest biases in 2013

Product	Industry	Index Dec	n Dec	Index Base	n Base	BIAS
Drinking glass	Glassware. china and kitchenware	90.24	7	100.00	12	1.11
Salad bowl	Glassware. china and kitchenware	88.46	8	97.42	11	1.10
Floor mat	Home furnishing textiles	64.32	3	70.73	2	1.10
Woman's coat	Clothing	79.89	58	87.59	71	1.10
Street shoe	Hypermarkets	93.87	7	100.00	6	1.07
Digital camera	Photographic equipment	89.00	12	94.72	15	1.06
Cordless telephone	Telecommunications equipment	90.34	37	95.29	37	1.05
Curtain	Home furnishing textiles	82.37	40	86.40	43	1.05
Men's watch	Watches and clocks	84.42	18	88.07	24	1.04
Men's shoe	Footwear	90.68	39	94.54	40	1.04
Woman's wool coat	Clothing	87.14	78	90.71	122	1.04
Curtain	Hypermarkets	92.50	19	96.26	18	1.04
Floor hockey stick	Sport and leisure	84.96	77	88.07	87	1.04
Rubber boots	Sport and leisure	94.88	23	98.12	27	1.03
Gloves	Sport and leisure	91.39	28	94.44	33	1.03
Coffee mug	Hypermarkets	95.31	23	98.38	25	1.03
Suite case	Hypermarkets	91.86	21	94.64	20	1.03
Men's sweater	Clothing	93.37	107	96.10	126	1.03
Wall mounted mirror	Home furniture	97.46	27	100.00	24	1.03
Woman's boots	Footwear	91.30	68	93.60	66	1.03
Woman's heavy boots	Footwear	93.60	92	95.79	89	1.02
Men's heavy boot	Footwear	94.78	104	96.94	102	1.02
Woman's skirt	Clothing	92.05	82	94.14	119	1.02
Woman's pumps	Footwear	90.99	82	93.03	91	1.02
Salad bowl	Hypermarkets	90.60	7	92.61	9	1.02
…	…					
Booster seat	Other retail sale in specialized stores n.e.c.	91.31	14	89.94	12	0.98
Stroller	Other retail sale in specialized stores n.e.c.	96.26	23	94.72	21	0.98
Door. storage unit	Wood and other building material	100.00	18	98.17	19	0.98
Mountain bike	Sport and leisure	94.38	36	92.59	37	0.98
Washing machine	Electrical household appliances	91.96	13	90.15	20	0.98
Jeans	Sport and leisure	92.18	5	90.32	4	0.98
Men's coat	Sport and leisure	91.24	67	89.37	79	0.98
Espresso machine	Hypermarkets	89.72	18	87.77	18	0.98
Pot	Hypermarkets	99.21	12	97.01	16	0.98
Pot	Glassware. china and kitchenware	96.86	7	94.61	10	0.98
Electric razor	Electrical household appliances	100.00	8	97.14	11	0.97
Hammer	Hypermarkets	100.00	11	96.30	13	0.96
Cordless screw driver	Wood and other building material	100.00	16	95.78	20	0.96
Coffee maker	Electrical household appliances	99.32	14	94.88	18	0.96
Refrigerator	Electrical household appliances	96.49	7	92.11	10	0.95
Mountain bike	Hypermarkets	81.64	10	77.60	11	0.95

Table 5: Products and industries with the largest biases in 2011

Product	Industry	Index Dec	n Dec	Index Base	n Base	BIAS
Baby pant	Hypermarkets	35,35	1	87,81	8	2,48
Man's shirt	Hypermarkets	49,75	1	100,00	5	2,01
Home entertainment center	Photographic equipment, specialized stores	62,50	1	88,23	1	1,41
Floor mat	Hypermarkets	78,52	3	100,00	5	1,27
Television set, small	Photographic equipment, specialized stores	79,99	1	100,00	2	1,25
Men's coat	Hypermarkets	84,09	4	100,00	5	1,19
Jeans	Hypermarkets	83,31	8	96,84	9	1,16
Electric razor	Electrical household appliances, specialized stores	86,37	8	100,00	8	1,16
Dishwashing machine	Electrical fittings, specialized stores	83,26	1	91,25	2	1,10
Woman's coat	Sport and leisure goods	88,30	10	96,48	46	1,09
Digital camcorder	Photographic equipment, specialized stores	86,30	3	93,88	7	1,09
Children's sweater	Hypermarkets	92,15	17	100,00	11	1,09
Floor hockey stick	Sport and leisure goods	86,00	36	91,59	60	1,06
Electric razor	Electrical fittings, specialized stores	88,52	2	94,09	4	1,06
Wool coat	Clothing	86,55	45	91,77	46	1,06
Storage unit doors	Wood and other building material	92,43	21	97,94	10	1,06
Dishwashing machine	Electrical household appliances, specialized stores	92,58	8	97,25	8	1,05
Woman's wool coat	Clothing	84,07	106	88,11	88	1,05
Television set, big	Photographic equipment, specialized stores	95,74	2	100,00	4	1,04
Towel	Home furnishing textiles, specialized stores	72,12	30	75,30	37	1,04
Men's pullover	Sport and leisure goods	92,36	13	96,40	19	1,04
Women's top	Sport and leisure goods	94,62	19	98,65	46	1,04
Digital camera	Hypermarkets	89,60	5	93,36	8	1,04
Water heater	Electrical fittings, specialized stores	90,86	4	94,67	7	1,04
Towel	Hypermarkets	94,39	31	98,10	36	1,04
Back pack	Sport and leisure goods	91,76	12	95,36	17	1,04
Toilet	Carpets, rugs, wall and floor coverings, specialized stores	89,42	2	92,82	3	1,04
Stroller	Games and toys, specialized stores	95,91	30	99,50	25	1,04
Beddings	Home furniture, specialized stores	93,46	41	96,90	44	1,04
Women's dress	Clothing	93,82	78	97,24	95	1,04