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COST-OF-LIVING INDEX (COLI) AS TARGET FOR THE SWEDISH CPI

Invited Paper submitted by Statistics Sweden*

1. A major purpose oh the Swedish Consumer Price Index (CPI) is to serve as a compensation index, guiding compensation for changes in consumer prices. For that reason, a true Cost-of-Living Index (coli) has explicitly and implicitly been taken as an ideal target for the Swedish CPI. This is reflected in several ways in the construction of the index and the procedures used in its production. Features consistent with the coli target can be seen in the solutions chosen on issues such as:

- Macro-level aggregation; chaining and weighting;
- Elementary aggregation;
- Re-sampling and replacement rules;
- Quality adjustment;
- Owner occupied housing;
- Other particular product areas such as insurance, electricity.

These aspects are dealt with in the paper.

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The coli target

2. The Swedish CPI is to pertain to a constant standard of living. This objective was stated already by a Government Commission in the early 1940's (SOU, 1943). This means that the index should ideally work as a cost-of-living index (coli) and describe the change over time in cost for a constant consumer utility (cf. Allen, 1975, p. 65ff.).

3. In practice however a fixed-basket index has to be used as a proxy for a coli. As was considered by the mentioned Commission, a crucial point is that the basket of consumer products followed by the index should be currently well updated. This is essential to make the index approximate a coli as accurately as possible. The index is thus constructed as a chain index with annually updated weights reflecting a recent consumption pattern.

4. Ideally the index should reflect the consumers' gains and losses from substitutions between products that they make over time. It was however considered to be normally neither necessary nor feasible to explicitly account for substitution effects, else than by timely updating of the basket.

5. Statistically, taking coli as target for the index means that the notions of statistical accuracy and bias of the index become conceptually meaningful. The accuracy concerns how closely the index approximates the coli target (cf. Hill, 1999). From a strict point of view it may however be noted that the coli concept is not entirely unambiguous, as discussed by Triplett (1983), so some tacit choice between alternative variants may be needed.

6. As is very well known, the choice of the basket notably affects the accuracy by which the index approximates a coli. In particular, it is well known that a Laspeyres type index usually has an upward bias compared to coli, sometimes called "Laspeyres bias". This is due to substitution by which consumers get themselves better value for money in the later periods than they would then have got by a Laspeyres basket, which reflects an earlier consumption pattern.

7. As is also well known, a closer approximation to a coli may be expected from certain other indices such as the Fisher index and the Edgeworth index. In those indices the consumption pattern reflected is in principle symmetric in time between the reference period and the current period. These matters have been theoretically elaborated by Diewert (1976).

Macro-level aggregation

8. The Swedish CPI is thus constructed as a chain index with annual links. For the current month m in the current year y the overall price change since last December is measured by an index link, called *short-term index link*, which is in principle computed by the formula

$$K_{y-1,12}^{y,m} = \frac{\sum_k P_k^{y,m} Q_k^{y-1}}{\sum_k P_k^{y-1,12} Q_k^{y-1}},$$

where k runs through all items covered by the index. Here $P_k^{y,m}$ is the price of k in month m of year y (and similarly for $P_k^{y-1,12}$), and Q_k^{y-1} is the consumed quantity of k in year $y-1$.

9. The short-term link just defined is thus a usual Laspeyres type index with quantity weights pertaining to the year of the base period (reference period) for the link.

10. For the years before the current year, the annual price changes are measured by a *long-term index link*, in principle computed by the formula

$$L_{y-1,12}^{y,12} = \frac{\sum_k P_k^{y,12} Q_k^y}{\sum_k P_k^{y-1,12} Q_k^y}.$$

11. Here the quantities Q_k^y pertain to the year y, thus the time span between December of year $y-1$ and December of year y. This means that the long-term index link is similar to an Edgeworth index. Like in the Edgeworth index, the basket quantities are symmetric in time between the two periods compared in the index. The CPI itself is finally computed by multiplication of the long-term links for the years gone and the short-term link for the current year, thus:

$$\mathrm{CPI}_0^{y,m} = I_0^{0,12} \cdot L_{0,12}^{1,12} \cdot \ldots \cdot L_{y-2,12}^{y-1,12} \cdot K_{y-1,12}^{y,m}.$$

12. Here 0 stands for the base year (which is actually 1980 for the present CPI series), and $I_0^{0,12}$ is an initial factor adapting to the base year.

13. By the use of the long-term index links, a Laspeyres bias due to substitution effects is avoided. For the long-term links are Edgeworth-like, and only the last link in the chain, the short-term link, is a Laspeyres-type index. So the CPI should be able to well approximate a coli, suitable for compensation purposes.

Empirical outcome

14. As expected it turns out that the long-term link actually shows a smaller price change that the short-term link does. The difference between the short-term and the long-term link, in their figures for the price changes from December to next December, is usually a couple of tenths per cent. Since 1980 the difference has been negative only twice, and on average over the years it has been about 0.2 per cent.

15. In view of the important uses of the CPI for compensation purposes, this systematic difference cannot really be considered negligible. If not corrected such an error would of course accumulate over the years and make the index more and more overstating.

Rate of inflation

16. It has been considered that the official rate of inflation, or 12-month price change, should be based on the short-term links only and not on long-term links. The rate of inflation is thus not computed directly from the index numbers, but instead a special computation is used, by which the switch to the long-term link is eliminated. Thus the 12-month change is computed as

$$K_{y-1,12}^{y,m} K_{y-2,12}^{y-1,12} \Big/ K_{y-2,12}^{y-1,m} = \frac{\mathrm{CPI}_0^{y,m}}{\mathrm{CPI}_0^{y-1,m}} \frac{K_{y-2,12}^{y-1,12}}{L_{y-2,12}^{y-1,12}}.$$

17. This figure is meant to reflect a "pure price change", and it is to be used for purposes like monetary policy and not for compensation purposes.

Operational formulas

18. In the practical computation, the annual updating of weights is actually made primarily at the highest level of aggregation. The overall short-term and long-term index links are computed by weighting together of the corresponding sub-indices for product groups g, which together cover the entire universe of items. The formulas used in the actual operational computations for the top level aggregation are thus:

$$K_{y-1,12}^{y,m} = \sum_g w_g^{y,K} \; K_{y-1,12;g}^{y,m}$$

and

$$L_{y-1,12}^{y,12} = \sum_g w_g^{y,L} \; L_{y-1,12;g}^{y,12} \; .$$

19. Here $w_g^{y,K}$ are value weights reflecting the consumption pattern in the year $y-1$, and price updated to December of year $y-1$; and similarly $w_g^{y,L}$ are value weights reflecting the consumption pattern in year y, and price updated to December of year $y-1$. For details see Statistics Sweden (2001, p. 20), or cf. Allen (1975, p. 78f.).

20. The data for the value weights are obtained mainly from the National Accounts, which in turn use various sources, including both household budget surveys and trade statistics.

Method revision

21. The principles of the Swedish CPI were recently reviewed by a Government Commission (SOU, 1999). The Commission suggests that the basic ideas of chaining long-term and short-term links shall remain. However some technical modifications are suggested concerning the details of the chaining and the form of the long-term index.

Elementary aggregation

22. It is well known that the formula for the elementary aggregation affects the reaction of the index to substitution effects in the consumption pattern. The elementary aggregates are at the

lowest level of aggregation, working on the actual collected prices, where usually no weight data are available.

23. The geometric mean of price ratios (or equivalently, the ratio of geometric means of prices; described e.g. by Allen, p. 17f.) is known to follow a coli under certain particular conditions. Namely, this is the case if the price sample is correctly self-weighting and the elasticity of demand for the items is such that the quantity consumed of each item varies in inverse proportion to the price, so that the monetary values of the consumed quantities remain constant. (Proof: If one out of n products with varying prices shows an additional small price change of x per cent, then the geometric mean changes by $x/n + o(x)$ per cent. But this is just the cost change of a basket containing the n products in quantities which are adjusted so that their monetary values always have proportions of $1/n$ each.)

24. The geometric mean is thus somewhat able to reflect substitutions which consumers make in their consumption pattern, in reaction to price changes.

25. The main formula for index aggregation in the Swedish CPI system is the *RA-formula* devised by Dalén (1992),

$$I_{y-1,12}^{y,m} = \frac{\sum_k p_k^{y,m} / (p_k^{y-1,12} + p_k^{y,m})}{\sum_k p_k^{y-1,12} / (p_k^{y-1,12} + p_k^{y,m})} \ .$$

26. Here $p_k^{y,m}$ is the price in month m of year y of a product-offer k, i.e., an instance where a product is offered for sale in an outlet. The summations run over all product-offers k that are sampled for price collection in the stratum of the particular elementary aggregate in question.

27. Dalén (1992) also shows that this formula is actually well comparable to the geometric mean of price ratios. So like the geometric mean, the RA-formula is somewhat able to reflect substitutions as a coli should. It may be added that the samples of outlets and products are to a considerable extent taken as probability samples of design pps (probability proportional to size), so that the samples are in principle self-weighting (for details, cf. Statistics Sweden, 2001).

28. Although the geometric mean index may be considered suitable for the coli target, it may be interesting to note that this index formula is nevertheless stipulated for the Harmonized Indices of Consumer Prices (HICPs) of Eurostat (2001). These are meant to be “pure price indices” rather than colis. This apparent paradox may perhaps be seen as validation of the conclusion by Hill (1999) that there seems to be no conflict between the objectives of measuring pure price changes and of measuring changes in the cost of living.

Re-sampling and replacement rules

29. The products and the outlets selected for price collection are re-sampled annually. This is normally done in December for the new annual link. The annual re-sampling may be seen as another means of keeping the basket updated so as to make the index able follow a coli.

30. Another point concerns the replacements of product-offers that are needed from time to time, because of occurring changes in the set of product-offers that are available on the market. These replacements are mostly made by the price collectors. In the instructions to the price collectors, two guiding principles may be noted:

- The replacing variety chosen should be the one that meets the product specification in question and is most sold – thus not primarily the one that is most similar to the replaced variety.
- Replacements should be made when a variety in the sample is no longer among the most sold ones – thus possibly before it disappears from the market.

31. The following is an excerpt from the instructions to the price collectors, quoted by Statistics Sweden (2001):

> "It is important that you try to *measure the price for the same variety throughout the year*. At least once a year, however, you should check with your contact person that the selected variety is still among the most sold. For many product groups this should be done more often. When the selected variety is no longer among the most sold you should choose another one. But you should not change variety during the year if the selected variety is slightly less sold than before. It has to sell significantly less than the most sold one for a replacement to be made during the year.
>
> "You should avoid making these checks in December. If the outlet remains in the sample also next year, it is an advantage if the selected varieties are used across the turn of the year."

32. The two replacement rules just mentioned may be seen as a way of maintaining the user functionality of the products in the sample. The first rule says "take the most sold one" rather than " take the most similar one". The user functionality is generally likely to be better preserved by the presently most sold variety than by the most similar one, which is likely to be about as dated as the replaced one.

33. So the replacement rules used could be seen as consistent with the coli principle of constant utility. But they can also be motivated from a fixed-basket approach, under some conditions; cf. Ribe (2000).

Quality adjustment

34. Explicit quality adjustment is applied when a replacement is made in the sample of product-offers, and the replacing variety differs form the replaced one and is not essentially equivalent to it. In the Swedish CPI various methods for quality adjustment are used, including hedonic regression for clothing.

35. However a major method for quality adjustment in the Swedish CPI is judgment by the price collectors. This approach is motivated partly by the idea that the price collectors in their judgment should represent the consumer perception of product quality. So the quality difference between a replaced and replacing variety should be judged and valued form a consumer perspective, and the index adjusted accordingly. This again is consistent with the coli principle of a constant utility.

36. The following is an excerpt from the instructions to the price collectors, quoted by Statistics Sweden (2001):

> **"***Principles for quality adjustment*
> "By quality difference is understood a difference in material or design. Differences due to fashion changes are not counted as quality differences. Factors in the products that you should consider are e.g. function, comfort, durability, security, guarantees and easiness of handling.
>
> "Differences in quality are to be valued from the viewpoint of the consumer. Differences in e.g. production or distribution costs should not be considered. You should instead try to assess how the average consumer experiences differences in material and design. This is difficult and in practice it means that you will have to use your own assessment of the differences.
>
> "Please note that the quality of a variety can also change by changing the service provided to the consumer. Examples are rules concerning guarantees and home delivery.
>
> "Differences in material and design are often difficult to detect. Also, the old variety is rarely available for inspection. Ask for help from a shop assistant in detecting the differences. But remember that it is your own valuation and not that of the assistant that you are to report. The valuation of the assistant should only guide your own valuation. This is because it is difficult for the assistant, due to her role as a seller, to make a true personal valuation.
> "Two varieties differ in a number of characteristics. One way of making the valuation could therefore be characteristic by characteristic, in money terms, summing the valuation over the characteristics.
>
> "You should ignore the price differences between the varieties. If the price difference is large, it does not necessarily mean that the quality difference is large. There can also be a quality difference although the price is the same. Companies often compensate themselves for changes in cost in connection with the introduction of a new model. Therefore, a higher price does not necessarily mean that the new model is of higher quality than the old one."

Cars

37. New cars are a particular case. Here as in several product areas, the prices are collected by the central office, not by price collectors. For new cars quality adjustment is made by a method which may be called "option pricing by expert judgment". Features by which a replaced and a replacing car model differ are priced by a particular price list, maintained for the CPI by means of an expert panel. The expert panel normally meets annually to update the price list, where the prices are set with a consumer perspective in mind.

Owner occupied housing

38. Owner occupied housing has several components in the Swedish CPI:

- Depreciation;
- Interest of mortgages and capital;
- Real estate tax;
- Leasehold site rent;
- Repairs;
- Insurance;
- Water, sewerage, chimney sweeping;
- Oil, electricity.

39. Relevant to the discussion here is the capital cost, which corresponds to the first two components above, i.e., depreciation and interest.

40. Depreciation stands for the consumer cost due to the decrease in value of the houses as they age and by time need to be replaced or repaired. Until some year ago this CPI component was based on a Building Price Index, where however some accuracy problems emerged. Presently the depreciation CPI component is instead based on prices for repairs.

41. The interest component follows a calculated cost which may be expressed as follows (Konjunkturinstitutet, 2001):

$$\left(K_s^t + K_N^t\right) \cdot \sum_i w_i^{RS} \overline{R}_i^t \quad .$$

42. Here K_s^t is the capital invested in existing houses and K_N^t the price of newly built houses, at time t .. Further $\overline{R}_i^t$ is the interest rate of mortgages of type i at time t, computed as a moving average over a period back in time during which the interest rates of individual such mortgages may have been fixed. Changes in $K_s^t + K_N^t$ and $\overline{R}_i^t$ are shown in the index, while the weights w_i^{RS} for types of mortgages are fixed throughout the annual link.

43. It may be noted that the interest considered is based on the total capital value of the house, irrespectively to what extents it is paid-up or borrowed. To the consumer the interest for the paid-up capital is not a monetary expenditure transaction but it is nevertheless a cost, corresponding to the savings interest forgone.

Revised user cost approach

44. The recent CPI Commission (SOU, 1999) suggested a new treatment of capital cost for owner occupied housing. The starting point is the following expression for the capital cost of houses:

$$K_t = P_t\left[r_t - \pi_t + d\right] .$$

45. Here P_t is the current market value of the house at time t, while r_t is the interest rate for consumers' borrowing or saving, π_t is the rate of inflation for house prices, and d is the rate of depreciation. The CPI Commission suggests that the term $r_t - \pi_t$, called the "real interest" of housing, should be assumed to be constant during each annual index link, as house buyers should be likely to take a long-term view on it. Likewise d would be considered constant, and consequently the index for capital cost is proposed to follow P_t.

46. A user cost approach is taken both in the present and in the proposed treatment, but in the later perhaps more consistently. It may be noted that changes in market interest rates are shown in the present index but not in the proposed one. The view of the proposal is apparently that short-term changes in interest rates are of concern not to housing or consumption *per se* but to financing, which is something separate.

47. The CPI Commission's proposal for owner occupied housing has turned out to be highly controversial, whence the Government very recently called on the Swedish Institute for Economic Research for a supplementary analysis, which was presented in a report (Konjunkturinstitutet, 2001). The report gives a modified form of the proposal, with and index which does show interest changes but in a smoothed way.

Special issues

48. For *insurance*, the Swedish CPI until recently used a "gross concept", meaning that both prices and weights pertain to the full premiums paid by the consumers. Recently however a switch was made to the "net concept" stipulated for the HICPs (Eurostat, 1999, p. 28ff.), meaning that the weights for insurance sub-indices are based on the "net" premiums, where the proportion needed to cover claims is deducted. Although the gross concept is considered the most appropriate one for compensation purposes and the coli target, practical aspects were here considered more important. The impact of the switch on the CPI is limited, while on the other hand it would be unpractical to run double procedures for CPI and HICP separately.

49. For *electricity* and *telecom services*, the CPI Board considered it essential to let the index show occurring consumer gains due to substitutions in connection with a recent deregulation. This concern is motivated particularly by the exceptional homogeneity of just these services. Similar reasoning has been heard in the international context of the HICPs, even though coli is not a target there.

50. For the Swedish CPI (and HICP), prices per kWh of electricity are now taken as weighted means of prices for different contract forms, with currently updated weights reflecting the current consumer choices. This implies that consumers' substitution gains by swaps between contract forms are shown in the index. Swaps between suppliers are not treated in this way but have not turned out to be of important frequency.

51. For *income-dependent prices*, as occur for social protection services, the recent CPI Commission (SOU, 1999) proposed a solution like the one now implemented for the HICPs (Eurostat, 2001, p. 30). This means that purchaser price changes due to purchaser income

changes shall be shown in the index. Strictly this may be seen as a slight deviation from the coli target, where a somewhat different solution would be called for, as reviewed by Ribe (1999).

Concluding remark

52. A very brief conclusion would be that the coli target has had a notable impact on the design of the Swedish CPI, but that this does not exclude that the solutions might also meet other objectives (cf. Hill, 1999). It may be noted that largely the same procedures are used for the CPI and the HICP for Sweden, although the former has coli as target and the latter not. The only major differences in methods are that a long-term index is not used in the HICP, and that owner occupied housing is excluded form the HICP and social protection services from the CPI.

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