True Cost of Living Indexes

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The theory

In the United States "The BLS has long said that it operates within a cost-of-living framework in producing the CPI. That framework has guided and will continue to guide, operational decsions about the construction of the index"[2] As the Boskin report expressed it, such an index "is a comparison of the minimum expenditure required to achieve the same level of well-being (also known as welfare, utility, standard-of-living) across two different sets of prices."[3] This concept has been expounded by a number of authors, notably Robert A. Pollak[4] and Erwin Diewert[5] in papers notable for their intellectual rigour, formality of expression and minimal reference to the actual behaviour of individual consumers. Parallel concepts have been expounded for producer price indexes, most recently by Franklin M. Fisher and Karl Shell[6].

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[1] I am grateful for comments on earlier versions provided by Jörgen Dalén, Erwin Diewert, Mats Haglund, Peter Hill, Anders Klevmarken and Jack Triplett. I have made some revisions to take account of the latter's comments in his paper for this meeting..

[2] BLS *Updated response to theRrecommendations of the Advisory Commission to study the Consumer Price Index*, June 1998 (http://stats.bls.gov/cpi0698e.htm)

[3] *Toward a more accurate measure of the cost of living*, Final report to the Senate Finance Committee, December 4, 1996. Such an index is referred to as a Konüs index, A.A Konüs "The problem of the true nature of the cost of living" *Econometrica* 1939, vol. 7 no.1, pp.10-29

[4] Robert A. Pollak *The theory of the cost-of-living index*, Oxford University Press, 1989.

[5] "The theory of the Cost-of-Living Index and the measurement of welfare change" in *Price level Measurement*, Statistics Canada, 1983. This volume also contains the first chapter of Pollak's book.

[6] Franklin M. Fisher and Karl Shell, *Economic analysis of production price indexes*, Cambridge University Press, 1997. I have reviewed this book in *The Economic Journal* vol.109 No. 453, February 1999, pages F223-4.

The theory supposes that, with given prices, a consumer buys that set of items which maximises his or her utility subject to an expenditure constraint Although the theory is mainly expounded in relation to to an individual consumer, the minimum expenditures that it defines can, in principle, be aggregated over all consumers to provide an aggregate, plutocratic concept, or their ratios could be averaged to provide a democratic index. The argument for an individual consumer runs in terms of two sets of prices and quantities of consumption items purchased and used, and a given indifference curve. In the context of temporal indexes, it is natural that one of these sets should be taken to be the actual prices ruling, quantities consumed and indifference curve at a reference time. The other is hypothetical, namely, with the prices ruling at a comparison time, the quantities that would minimise the cost of staying on the same indifference curve or, as some would express it, as maintaining the same standard of living. Thus two different values of the index will normally result, as there is a choice of which of the two points of time is taken as the reference one and which the comparison one.

Note that this is a ceteris paribus comparative statics concept. It does *not* compare (i) the sum of expenditures that consumers at the comparison time would have to make to reach the same level of satisfaction that each of them obtained at the reference time with (ii) the total of their reference time expenditures. Their preferences may have changed between these two times. Instead, it compares (i) what they would have had to spend at the reference time to reach their reference time levels of satisfaction if prices had then been what they were at the comparison time with (ii) the actual total of their reference time expenditures. It relates to the given reference-time preferences.

Two questions about this theory lack an answer:

1. Whose preferences are concerned, what is a consumer? Is it a household?
2. How can this static, timeless, theory be applied to a period of time? What is its appropriate length? Presumably it must be short enough for prices

to remain constant throughout[7], but long enough for a consumer to buy the set of items.

A major part of the theory deals with how, if everything but prices remained unchanged (which doesn't happen), true Laspeyres and Paasche indexes (which no Consumer Price Index is[8]) would provide bounds to a true cost of living index. Much

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[7] As Erwin Diewert has suggested for unit value calculations in "Axiomatic and economic approaches to elementary price indexes", Discussion paper 95-01, (Department of Economics, University of British Columbia), January 1995, pp.22-3

[8] There are two main reasons why a Consumer Price Index is not a Laspeyres index:

1. The weight reference-period is a year, the price reference-period is a month;
2. The price reference-period postdates the weight reference-period.

To consider only point 2, assume away point 1 by supposing that the two periods were of the same length but that the weight reference-period w preceded the price reference-period p. Writing Ew for weight reference-period expenditures and Ix/y for an index from period x to period y, an index with price-updated weights is estimated as:

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$$\text{CPI} = \sum \frac{E_w I_{w/p}}{\sum E_w I_{w/p}} I_{p/t} = \sum \frac{E_w I_{w/t}}{\sum E_w I_{w/p}}$$

Now sum over all individual items instead of over component sub-indexes, thus translating the right-hand expression back into the universe index which it estimates:

$$\text{CPI} = \sum \frac{P_w Q_w \frac{P_t}{P_w}}{\sum P_w Q_w \frac{P_p}{P_w}} = \frac{\sum P_t Q_w}{\sum P_p Q_w}$$

which is not a Laspeyres index. As expressed on p.28 of Statistics Canada's 1995 *Consumer Price Index Reference paper* "the index can be interpreted as an arithmetic average of price relatives for all single commodities contained in the basket, using specific 'hybrid' dollar values as weights. They are referred to as hybrid values because prices in these values are derived from a different period than the quantities." True-cost-of-living arguments cannot be applied to this index because they require the Q's to be optimal with respect to the P's, which the Q_w's are not with respect to the P_p's.

algebra is dedicated to the analysis of the strengthening or simplification of the resulting conclusions that would follow were indifference maps to be describable by particular functional forms. What are known as flexible functional forms can provide second-order approximations to preferences, even though these are indubitably non-homothetic, and hence provide first-order approximations to demand functions This has allowed convincing demand functions to be estimated at a fairly aggregative level[9] and has enabled demonstration that certain indexes are superlative. Such indexes, requiring current as welll as base-period weights, can be computed only retrospectively. Thus none of them can be used for a monthly Consumer Price Index, though ex post comparison with the actual Consumer Price Index can be illuminating and treated as a measure of bias.

Writers on this theory express no view of which functional form is most realistic for an individual consumer. They do know a lot about one such consumer, themselves, but their epistomological principles apparently inhibit them from complementing or strengthening their approach by undertaking an introspective mapping of their own preferences or, if they don't have preferences but merely act as if they did, investigating what their own behaviour reveals these would be if they existed.

Now consider the purposes of the theory. These are to facilitate the interpretation of movements in a published Consumer Price Index, to justify its use for various purposes and to inspire its design. I do not examine the use of preference or utility theory in other contexts, such as applied welfare economics or demand estimation.

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[9] e.g. Erwin Diewert in "Normalized quadratic systems of consumer demand functions" *Journal of Business and Economic Statistics*, vol. 6 no. 1 July 1988 pp. 303-12 where it is stated, p.303, that "It is essential to estimate a demand model that is consistent with utility or welfare maximising behaviour" and "the direct utility function should be quasi-concave in prices". No account is taken of preference change over time, p.308, and it is not clear, at least to this reader, how the "direct utility function" is dervived from the utility fucntions of the millions of households whose expenditures were covered by the data.

Interpretation

Analysis of the direction and possible magnitude of the difference between the real-world Consumer Price Index and an imagined true cost-of-living index requires that each consumer was successfully maximising utility subject to an expenditure constraint in a reference-period common to both these indexes and in the comparison period. Unfortunately there are several reasons for doubting that this condition is always fulfilled when, as we have to do in practice, we deal with consumption during a period of time as long as a month or a year rather than a point of time.

1. The static theory assumes that a consumer has only one set of consistent preferences. But many consumers have more than one set and these are inconsistent. Consumer behaviour over even a short space of time reveals this. The evidence is that people often regret their recent actions. For example, I decide to avoid fatty food but sometimes yield to temptation and then wish that I had not.

2. The preferences of individual consumers are assumed to be independent, the utility of an item to an individual being unaffected by the consumption of others. The notion of reference groups is not entertained by the theory. Yet emulation and imitation are important. They do not occur instantaneously. They explain why, when new items appear on the market, their sales take time to reach a plateau even when their prices are unchanged.

3. Price and weight reference-periods do not coincide. The prices ruling during the weight reference-period will usually differ from the prices of the price reference-period and many of them may even change during it. Consequently, the quantities consumed during the weight reference-period (1993-5 in the USA) at the varying prices that ruled during it will *not* be those which would have maximised consumers' utilities at the prices of the price reference-period.

Another difficulty with the theory is the 'endowment effect' "whereby people become more attached to objects they receive than would be predicted from their prior desire to possess the object." This would not create a problem for the theory if they

were able to predict this, but an experiment showed that "subjects underestimated how much they would value the object when they received it."[10] Thus ex ante and ex post utility can differ and it is not clear which is relevant to a true cost-of-living index.

Use

The notion of consumer optimisation becomes more complex once it is recognised that, in the case of durable goods, use extends beyond the period in which they were purchased. Theoretically, this could be dealt with by extending the cost-of-living index concept to a multiperiod index. Since its formulation would require the assumptions of perfect foresight and perfect capital markets[11] this does not seem very helpful. An approach formulated in terms of annual user costs of durables has been proposed instead..

In the particular case of owner-occupied housing, an imputed rental value is used to represent user cost in the American and some other CPIs. Thus the set of prices and of quantities of consumption items entering these indexes consists of the period's purchases of consumer goods and services, *excluding* owner-occupied housing, *plus* the rental value of the stock of owner-occupied housing. Consistency would require a similar treatment of *all* durable goods *and* for durable services, i.e. services whose benefits last for several years such as hip replacements, root canal treatment or the preparation of wills, though even in principle it is not clear how to impute user costs for such services.

As a measure of the standard of living, the inclusion of imputed user costs obviously makes sense; we judge how well off people are by looking at their service-yielding possessions as well as at their spending. But does this make sense for a Consumer Price Index used (1) as a deflator, (2) as a compensation index and (3) as a measure of inflation? I think that it does not:

1. It would mean that the expenditure to be deflated to estimate real consumption would consist of consumer expenditure on non-durables only, *N*, plus an imputed rental value, *R*, for owner-occupied dwellings, furniture, furnishings, linen and

[10] G. Loewenstein and D. Adler "A bias in the prediction of tastes", *The Economic Journal*, vol. 105 no. 431, July 1995, p.929.

[11] Pollak, *op cit*, p.186

clothing, hardware, cars and durable services. (Surely it would be easier to estimate the movement of real consumption by deflating only *N*, using an index limited to the prices of non-durables, and then adding an estimate of the movement of *R* measured at price-reference-period prices. Estimating *R* for weight reference-period quantities at comparison-period prices and then using the result as a component of a deflator for *N* + *R* entails unnecessary effort.)

2. Use of the Consumer Price Index as a compensation index is widespread in practice. The Boskin report devotes considerable attention to such use when arguing that bias in the US Consumer Price Index seriously affects the federal deficit.[12]

   Would a true cost-of-living index calculated using the rental equivalent approach be appropriate in principle for indexing pensions, unemployment benefits, taxes and so on? This is a political, not a scientific issue. Most people will judge it absurd to regulate social security benefits, pensions and taxes partly to compensate for changes in the amounts consumers are deemed to be paying themselves for the use of their owner-occupied dwellings, furniture, furnishings, linen and clothing, hardware, cars and durable services.

3. To include the imputed rental values of new owner-occupied dwellings, furniture, furnishings, linen and clothing, hardware, cars and durable services rather than the actual prices paid for them in a measure of inflation would not appear sensible to economists who regard inflation as a monetary phenomenon manifested in monetary transactions.

These arguments apply equally if user cost is thought of in terms of interest cost, anticipated capital gains or losses and depreciation rather than in terms of rental value.

Is true cost-of-living theory useful for interpreting Consumer Price Index figures by comparing it with the upper and lower bounds to a true index? This issue has primarily to do with substitution effects. These, it is asserted, can be measured ex post by the difference between a superlative and a Laspeyres index. Leaving aside the very major point noted above, that price and weight reference-periods do not coincide,

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[12] *Toward a more accurate measure of the cost of living,*, section II.

so that, as Shapiro and Wilcox say, it is only possible to "approximate the index formulas prescribed by theory" [13], this difference will only measure the substitution effects if everything else remains constant. Usually it does not. Consumers die and new consumers enter the market, babes grow into toddlers, children into teenagers, employees retire, fashions evolve, incomes change and so on and so on.

Nevertheless the difference *is* interesting, because of the superiority of a superlative index. The theory of the true cost-of-living index is not necessary to establish this superiority. Commonsense suffices. The commonsense view is simply that the best way of comparing 1998 prices with 1997 prices is to take account of both the 1997 and the 1998 patterns of consumption rather than just one or the other. Commonsense also tells us that substitution effects are but one of the factors affecting the changes in these patterns.

Practical guidance

Now consider the alleged usefulness of the true cost-of-living conceptual apparatus, for both guiding and securing consistency between decisions concerning the methods to be employed in respect of particular components and practical problems in Consumer Price Index compilation.

The friends who commented on an earlier draft of this paper have suggested three Consumer Price Index problems where they believe that cost-of-living theory is or could be useful. They relate to the treatment of:

1. Two-part tariffs. There is a commonsense solution: the fixed charge and the unit charge, are respectively the price of being able to consume and the price per unit consumed, so should be given separate weights.

2. Taxes. In my view, whether a compensation index used to regulate social security benefits or pensions should include any indirect tax component in prices is a policy issue, not a theoretical issue. Whether an inflation index should be computed as a Net Price Index is a question to be answered by a theory of inflation, not by cost-of-living theory.

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[13] Matthew D. Shapiro and David W. Wilcox "Alternative strategies for aggregating prices in the CPI", *Federal Reserve Bank of St. Louis Review*, May/June 1997, p.114.

3. Risky products such as property insurance and gambling. The main contributions to understanding choice when risk is involved come from psychologists.[14] Experimental evidence on choice under uncertainty shows that "over a wide range of conditions, people do not make consistent judgements about uncertain events, violating the axioms of utility maximisation and frequently violating the laws of probability".[15]

There are six larger problems where the fruitfulness of cost-of-living theory is not apparent:

1. Quality adjustment is the biggest one. It is generally recognised that, when robust estimates can be made, the use of hedonic coefficients is an appropriate procedure. This can be justified by formulating the theory in terms of the utility-relevant characteristics of items of consumption. But it can also be justified without it, by treating some components of consumption as bundles of market-price-relevant characteristics. This means regarding the index as measuring changes in the cost of buying a reference-period collection of bundles of such characteristics rather than a set of consumption items.[16]
2. The treatment of new goods is another major problem. A theoretical solution would be to use an imputed reference-period price equal to a weighted average of the reference-period reservation prices of all consumers who subsequently buy the new good. However, econometric estimation of such prices requires extensive data that are not generally available, and the few estimates that have been made are the subject of contention among the experts. The true cost-of-living conceptual apparatus is not necessary to arrive at the unavoidably imperfect practical solution. This perforce ignores the consumer surpluses created by the advent of

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[14] See, in particular, the work of D. Kahneman and A. Tversky, for example "Choices, values and frames", *American Psychologist*, vol. 39 no.4 pp. 341-50 where the summary includes the following: "Decision problems can be described or framed in multiple ways that give rise to different preferences, contrary to the invariance criterion of rational choice. The process of mental accounting, in which people organize the outcome of transacions,, explains sone anomalies of consumer behaviour. In particular, the acceptability of an option can be evaluated as a cost or an uncompensated loss."

[15] Herbert Simon *An empirically based microeconomics*, (Cambridge University Press, 1997), p.78.

[16] Jack Triplett, who proposed this as long ago as 1971, argues that it is an example of the usefulness of the theory of consumption.

new goods and lost by the disappearance of old ones. When possible, it imputes reference-period prices to new items, by quality adjustments of the prices of items available in the price reference-period; otherwise it links the new items into the index as promptly as possible after their first appearance

3. The treatment of seasonally unavailable products. [17]
4. Arguments about the appropriate formula for computing elementary aggregate indexes have to dispense with the true cost-of-living conceptual apparatus.[18]
5. Nor has this apparatus provided assistance in selecting the best ways to deal in a monthly Consumer Price Index with missing observations and outliers, item sampling, discounts and other sales inducements, brokerage fees, insurance or the timing complications of utility tariff alterations.
6. Another practical problem is the treatment of income-dependent prices. This has been analysed to produce an expression for a true cost-of-living index when such prices exist. It is shown to be equal to or less than a Laspeyres index[19]. But this requires information about the income of each and every consumer as well as the parameters of the income dependence, so is not implementable. Hence a rule of

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[17] Erwin Diewert has provided an impressive discussion in "Seasonal commodities, high inflation and index number theory", Discussion paper DP 96-06, (Department of Economics, University of British Columbia), January 1996, but his proposed practical least bad proposal for the treatment of seasonal non-availability in a monthly Consumer Price Index appears to be to omit them from it. He also concedes that items for which preferences vary seasonally have to be omitted. (I suppose that the same should apply in longer-term indexes for items for which preferences vary in the longer-term.) His argument about non-seasonal items and those whose prices and quantities, but not preferences, vary seasonally appears to rest on the assumption that the utility function is separable between these and the two other sets of items and that it is linearly homogeneous. If this is a correct understanding of his exposition it seems legitimate to enquire whether these two assumptions hold for his own preferences, if he has any, or, otherwise, whether he behaves as if they did hold..

[18] Erwin Diewert's paper "Axiomatic and economic elementary price indexes", Discussion paper 95-01, (Department of Economics, University of British Columbia), January 1995, pp.17-20, has to assume the availability of quantity as well as price information when discussing the economic approach, which thus cannot help when such information is lacking and only a sample of prices is available.

[19] N. Anders Klevmarken, "Preference-based indices with subsidizes commodities and income-dependent prices", *Economics Letters*, 59 (1998) 31-38.

thumb is necessary, recognising, of course, that the choice is partly a policy matter.

A response to this recital of the inability of true cost-of-living theory to contribute to the solution of the above five problems is the platitude that the theory *would* be useful *if* it were developed sufficiently. However, my concern is with the theory that we have *now*. This tells us little more than that demand curves slope downwards because of substitution effects, which we knew anyway.[20] We can apply this knowledge without using the elaborate theoretical concept of a true cost-of-living index. Its underlying preference-based theory of consumer demand tells us very little about how individual consumers behave, providing few predictions. As suggested earlier in this paper, it fails to recognise both that the utility expected and the utility realised from the acquisition of items that are not repeat purchases often differ and that utility depends upon the consumption of others as well as upon own consumption. This latter point means that how much more or less a consumer would require to spend to preserve his or her utility level depends upon how other consumers would react to the price diffferences, so that an aggregate measure cannot be constructed as a simple sum or average over all consumers.

Conclusion

Whatever the usefulness of consumer preference theory in other contexts, ecconomists' formal theories about a true cost-of-living index can safely be ignored by statistical offices when designing and implementing a Consumer Price Index. The concept does not specify what might be interesting, namely how much more or less consumers need to spend now to attain the standard of living that they enjoyed previously. It would not do this even if all environmental factors had remained unchanged, for consumers change, they become older and acquire experience. What it does specify is only how much more or less people *would have needed* to spend in the

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[20] G. Becker *Journal of Political Economy* 1962, defining rational behaviour as signifying "maximisation of a consistent and transitive function" p3, asserted that "negatively inclined demand curves result not so much from rational behaviour per se as from a general principle which includes a wide class of irrational behaviour as well." as their downward slope "largely results from the change in opportunities alone and is largely independent of the decision rule." p.4

reference period to preserve that period's standard of living *if* prices had then been those of the comparison period. The proposition that this hypothetical index is what an actual Consumer Price Index seeks to approximate

- As yet provides little assistance to the construction of that actual index;
- Results in the inappropriate inclusion of imputed items if it is a compensation index;
- Is congenial to economic theorists but not to most users.

Continued research attempts by distinguished economic theorists to extend true cost-of-living index theory to take account of the features of consumer behaviour that it currently ignores may ultimately be rewarding. They are more likely to be successful if introspection is deemed respectable and they start to collaborate with psychologists[21]. Meanwhile, practitioners can simply describe Consumer Price Indexes simply in terms of what they can and do estimate — changes through time in the cost of weight reference-period consumption baskets. To decide how they should treat problems such as those rehearsed above requires a clear formulation of the purpose to be served by each index and the application of only elementary economics and commonsense. Neither these nor current true cost-of-living theory can provide uniquely correct solutions to some of the problems. In practice, therefore, recourse to arbitrary but acceptable procedures is sometimes unavoidable.

[21] Textbooks on decision theory, for example of A. Garnham and J. Oakhill *Thinking and reasoning* (Blackwell, 1994), chapter 10, make it clear that psychologists have done a great deal of work on decision making.