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**Inflation, the Cost of Living and the Domain
of a Consumer Price Index**

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Summary

The general purpose of this paper is to try to clarify the relationships between consumer price indexes (CPIs) intended to measure consumer *price inflation* and those intended to measure *changes in the cost of living (COL)*. The general conclusion of the first part of this paper is that both objectives lead to the same kind of index formula in practice, provided that 'best practice' is followed. Indexes that are 'biased' as measures of the cost of living indexes can equally well be regarded as 'biased' measures of inflation. On the other hand, in the second part of the paper it is shown that there could be significant differences between the coverage, or domain, of indexes intended to measure price inflation and those measuring changes in the COL and these could lead to significantly different results, especially over the longer term. No consensus may yet exist over what should be the domain of a CPI.

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I. Introduction

1. The compilation of consumer price indexes raises a number of complex and interacting issues. In the interests of clarity, an attempt is made in this paper to separate the issues by dividing the paper into two parts. In the first part of the paper the following simplifying assumptions will be made.

- The price indexes compare two situations, usually time periods, in which the set of goods and services available to the consumer or consumers is exactly the same in both periods.
- The goods and services are individual commodities that are actually traded in market transactions between different economic units.
- A positive quantity of each commodity is bought by the reference consumer, or group of consumers, at a positive price in both periods.

2. Although these are strong assumptions and somewhat divorced from reality, they make it possible to isolate and focus on a number of classical index problems, and in particular on the inter-relationships between 'inflation' indexes and COL indexes. Rigorous expositions of index number theory are also obliged to make similar assumptions, as and when required or appropriate, for the same reasons as here. In many general discussions of index numbers, they are typically made implicitly even if not explicitly. Problems such as the domain of a consumer price index and the treatment of quality change and new and disappearing goods, which are probably the most contentious issues and cause the greatest difficulties in practice, are dealt with in the second part of this paper.

PART I

3. First, it is necessary to explain what is meant by an inflation index and how it differs from COL index. Despite the universal use of the term 'inflation' in economics, it is surprisingly difficult to find a precise, satisfactory definition of 'inflation' in the literature. A typical vague definition is as follows: "The inflation rate is the percentage rate of increase of the level of prices during a given period".¹ As the price level is not defined, such a definition is not very helpful. It can be made more precise by specifying that it refers to a designated set, or basket, of goods and services. The rate of increase of the level of the prices of these particular goods and services can then be interpreted as being measured by the rate of increase in the total value of the goods and services making up the basket. Obviously, any number of different baskets might be chosen, so that there are countless alternative measures of inflation of this kind. Once the relevant basket has been selected, the inflation index for that basket may be defined in the following way.

4. First, define a 'pure' price index as a price index of the following form with fixed quantity weights:

$$P = \frac{\sum p_t q}{\sum p_0 q}$$

where the q 's denote a specified set of quantities and the p_t 's and p_0 's refer to their prices in two different situations, typically two different time periods or locations, t and 0 . The quantities do not have to be those actually observed in either one or other of the situations being compared. Such an index has been described as a 'pure' price index because only the prices may vary between the two situations, the quantities of goods and services remaining constant. An 'inflation' index may now be defined as an inter-temporal 'pure' price. It can be interpreted as *the change in the cost of purchasing a designated set of goods and services* between two time periods. As already noted, there are as many such indexes as there are possible sets of goods and services of economic or policy interest.

5. Diewert (1999)² provides a general survey of this class of index numbers and their properties in which it is noted that these indexes can always be expressed, and interpreted, as weighted averages of the price relatives p_t/p_0 for the individual commodities (provided there are no zero prices in period 0, as assumed here), the weights being the appropriate expenditure shares. Laspeyres and Paasche indexes are examples of pure price indexes. However, the quantities selected as weights could refer to some third period of time, and frequently do so in practice. Moreover, the weights could also be synthetic quantities consisting of averages of the quantities in the two periods being compared. For example, the weights could be simple arithmetic or geometric means of the quantities in the two periods, the resulting indexes being known as the Marshall/Edgeworth and Walsh price indexes.

6. Economic theory has adopted a different approach to the measurement of price change in which neither the concept of the price level nor actual price changes figure explicitly. The theory relates to the cost of living, or COL, index "which may be considered as an idealization of indices like the consumer price index and others of that type".³ By definition, the purpose of a COL index is to measure the ratio of the cost of achieving the same standard of living, or utility, in two different situations, typically two time periods or locations. Pollak defines the COL index succinctly as: "the ratio of the minimum expenditures required to attain a particular indifference curve under two price regimes".⁴ (An indifference curve describes different combinations of goods and services that collectively provide the same amount of utility, or welfare, to some consumer. The tastes or preferences of some representative or average consumer may be chosen for the purpose.)

7. A crucial property of a COL index is that only a *single* indifference curve is used. A COL index does not make comparisons between baskets of

goods and services which lie on different indifference curves, even for a single consumer. In practice, most COL indexes are intended to compare the actual expenditure of a utility maximising consumer in one period with the *hypothetical minimum* expenditure that the consumer *would* have to make at the prices of the other period in order to stay on the same indifference curve. COL indexes are always defined on the assumption that the consumer maximises utility or, equivalently, minimises the expenditures needed to attain a given level of utility.

8. Suppose, for example, the COL index is defined on the basis of the consumer's utility level in the first period so that consumer's actual expenditure in the first period forms the denominator of the index. The numerator of the inter-temporal COL index is the *minimum* expenditure needed to purchase a set of *hypothetical quantities* of goods and services at the prices of the second period that would collectively provide exactly the same utility, or welfare, as in the first period. In other words, it is the expenditure that would be just sufficient to maintain the consumer's standard of living.

9. If the actual utility level of the second period were to be used as the base instead, a different COL index would be obtained, unless the consumer's preference ordering happens to be 'homothetic'⁵. These two indifference curves are by no means the only possibilities, and any number of COL indexes could be associated with two price regimes. For example, the indifference curve could be one referring to a higher or lower level of utility, or real income, than that attained by the consumer in either of the two periods compared. In this case, *both* expenditures in the COL index would refer to hypothetical quantities. Just as any number of pure price indexes may be defined between two periods by choosing different baskets of goods and services, any number of COL indexes may be defined by using different indifference curves relating to different levels of utility, or real income, or more generally by using the tastes and preferences of different consumers or groups of consumers.

10. As already noted, one important property of a COL index is that the quantities of goods and services in at least one of the two periods compared are not directly observable because they are hypothetical. A COL index cannot therefore be calculated directly from observed price and quantity data. (Of course, it must be possible to *estimate* a COL index indirectly: otherwise it would be of no practical interest.) A second important property is that a COL index measures the ratio of the expenditures on two *different* baskets of goods and services. This highlights the crucial difference between a COL index and a pure price index that measures the ratio of the expenditures on a single, fixed basket of goods and services under two different price regimes. This property of the COL index is a source of concern to advocates of a pure price index who consider that a 'price' index should not be partly dependent on changes in quantities and, moreover, to an extent that is not readily apparent.

11. On the other hand, this property of the COL is not seen as a disadvantage from the point of view of economic theory. The basic difference between the 'economic approach' to price indexes and the 'statistical approach' as exemplified by 'pure' price indexes is that the economic approach recognises that quantities consumed, or produced, are *not* independent of prices. To hold the quantities constant in the face of changing relative prices distorts economic reality. The economically significant fact about the differences between the two COL baskets is that they are systematic and predictable because, in seeking to minimise the expenditures needed to maintain the same level of utility, the consumer is bound to substitute, at least at the margin, goods and services which have become relatively cheaper for those which have become relatively dearer. This is the well known 'substitution effect'.

12. There is a dilemma. A COL index invokes at least one set of hypothetical quantities that cannot be observed, so that a COL index can never be measured exactly in practice. On the other hand, while a pure price index can be measured exactly (at least under the assumptions made in Part I of this paper), it abstracts from reality by comparing situations, at least one of which would never occur in the real world. The quantities in at least one of the situations being compared in a pure price index would never actually be consumed at those prices, at least not by rational utility maximising consumers. Like at least one set of quantities in the COL, they can be regarded as hypothetical quantities, even though they are specified and do not have to be estimated.

13. Conceptually, the basic difference between a pure price index and a COL index is that whereas a pure price index is attempting to measure the average price change for a set of goods and services a COL index is attempting to measure the change in a single price, namely the 'price' of 'utility' or welfare. Good and services are not the same as the utility derived from consuming them. This is obvious even at the level of a single good where changes in utility are usually not proportional to changes in the quantity of the good consumed, especially if diminishing marginal utility sets in. It then becomes a matter of choice as to what the analyst or policy maker wishes to measure. Many economists take it for granted that because goods and services are consumed for the utility derived from them that the change in the price of utility is what the index *must* measure. This is not self evident, however, as consumers use their incomes to buy goods and services and not utility and are therefore properly concerned about changes in their prices. However, rather than trying to resolve this divergence of view, it is more useful to examine how much difference the two approaches are likely to make in practice, bearing in mind that even if the objective is to *estimate* a COL it will almost certainly be necessary to calculate one or more pure price indexes in order to do so. The first step is to clarify the relationships between Laspeyres, Paasche and COL prices indexes.

COL, Laspeyres and Paasche price indexes

14. The inter-relationships between pure price indexes and the corresponding COL indexes have been intensively studied. Although COL indexes may not be directly calculable, they may be used as theoretical norms which help to explain and evaluate the properties or behaviour of pure price indexes that can actually be calculated, such as Laspeyres and Paasche price indexes. Perhaps the most well known result in index number theory is that, on the assumptions made here, the Laspeyres index provides an upper bound to the COL index based on the indifference curve of the first period.⁶

15. If the consumer's expenditure were to increase in proportion to the Laspeyres price index, the consumer would have the purchasing power in the second period to buy the base period basket of goods and services, but this basket would no longer be optimal if relative prices have changed. A utility maximising consumer would be able to reach a higher indifference curve, i.e., to achieve a higher standard of living, by making substitutions in response to the changes in relative prices. If the objective is to measure the change in the cost of an unchanged standard of living, the Laspeyres index tends, therefore, to have an upward bias. Intuitively, it can be seen that the greater the change in the pattern of *relative* prices, the greater the scope for the consumer to make substitutions, and hence the greater the upward 'substitution' bias. The longer the lapse of time between the two periods being compared, the more the pattern of relative prices is likely to have changed and the greater the substitution bias is likely to be.

16. Conversely, by analogous reasoning, the Paasche index can be shown to provide a lower bound to the COL index based on the second period. The COL index based on the second period will not be exactly the same as that based on the first period but the two COL indexes are likely to be much closer together than the corresponding Laspeyres and Paasche indexes. In general, one advantage of COL indexes is that they are likely to be much less sensitive than pure price indexes to the choice of base period. Indeed, if the consumer's preferences happen to be homothetic, the two COL indexes coincide even though the Laspeyres and Paasche indexes could diverge significantly, especially if relative prices change considerably.⁷ In any case, it can be proved there must be some COL index based on an intermediate indifference curve lying somewhere between those of the first and the second periods, which lies between the Laspeyres and Paasche indexes (see, for example, Diewert (1999)). Such a COL index may actually be preferred to the COL indexes based on either the first or the second periods themselves because it is not determined by the consumer's consumption and utility level at one or other of the two extremes of the comparison but based on an intermediate situation which is more representative of the entire length of time spanned by the two periods.

17. If the Laspeyres and Paasche indexes are not very far apart the various possible COL indexes will usually not be very different from each other and will tend to lie approximately midway between the Laspeyres and Paasche

indexes. These relationships have been exploited by Diewert (1976) who has shown that certain types of index number, described as 'superlative', may be expected to provide acceptable *approximations* to a COL index under fairly general conditions.⁸ These superlative indexes tend to treat the two periods compared symmetrically although not all symmetrical indexes are superlative. The Fisher index, which is the geometric mean of the Laspeyres and Paasche indexes, is one example of a superlative index, another being the Tornqvist index which uses the arithmetic mean expenditure shares in the two periods as weights for the price relatives. Another superlative index is the Walsh index which uses geometric means of the quantities in both periods as quantity weights. This is particularly interesting in the present context because the Walsh index is also a pure price index, as Diewert (1999) notes. This throws light on the kind of pure price index which may be expected to provide an acceptable approximation to a COL index. While Laspeyres and Paasche indexes may be biased, by no means all pure price indexes provide biased estimates of a COL.

18. It is possible to find pure price indexes which coincide exactly with the COL index. One such index, which may be described as an 'equivalent' pure price index, can be obtained by taking a linear combination of the quantities in both periods, as shown by Hill (1997)⁹. Any COL index may be expressed as weighted average of the Laspeyres and Paasche indexes. The quantities required for an equivalent pure price index coinciding with the COL are then obtained by taking the same weighted average of the quantity vectors in the two periods, but only *after* the quantities in the second period have been scaled by dividing them by the Laspeyres volume index between the two periods. (Alternatively, the quantities in the first period could be scaled by multiplying them by the Laspeyres volume index.) The scaling adjustment is required to avoid the quantity weights in the equivalent index being dominated by one period in the event that the absolute levels of the quantities tend to be systematically higher in one or other of the two periods. (This type of scaling adjustment is important in international price indexes (PPPs) where one country may be much larger than the other.) If the COL index were midway between the Laspeyres and Paasche the quantities would be simple averages of the quantities in the two periods, but again only after scaling the quantities in the second period, as indicated above. The resulting index is therefore not quite the same as the Marshall/Edgeworth price index which lacks the scaling adjustment.¹⁰

19. These kinds of results are invaluable for interpreting a COL index and understanding its relationship to a pure price index. The interesting feature of the equivalent index just defined is that it shows that a pure price index exists which is equal to the COL and uses a linear combination of the quantities in both periods as weights. Provided the COL index is not far from the mid-point between the Laspeyres and Paasche indexes, the pure price index gives more or less equal weight to the *relative* quantities in both periods and therefore treats both periods more or less symmetrically. Such an index is not merely a pure 'inflation' index but one that is much more

representative of both periods, as the quantities in the equivalent pure price index are intermediate between those of the first and the second period. The Laspeyres and Paasche indexes, however, are entirely dominated by quantities in only one of other of the two periods compared. They provide biased estimates of a COL precisely because they are very *unbalanced* price indexes, not because pure price indexes are inherently biased.

20. The symmetry properties of an equivalent index are similar to those of a superlative index. Whereas a superlative index can be calculated, however, the equivalent index can only be derived assuming the value of the COL is already known in advance, so it is not a practical alternative to a superlative index. An equivalent pure price index can be used to give some insight into the properties of a COL index by identifying a pure price index whose value would be identical with that of any given COL index, but it does not provide a way to estimate a COL index. As Diewert (1999) has pointed out, the Walsh index is an example of a pure price index that can be calculated and is also superlative. It may be expected to provide an acceptably close approximation to a COL index while also providing useful insights into the relationship between pure price indexes and COL indexes.

"Bias" in CPIs

21. The question of 'bias' in consumer price indexes (CPIs) can be examined against the background of the previous section. CPIs in many countries consist of time series of pure price indexes in the form of Laspeyres indexes on a fixed base. They may be expected to record progressively larger increases than the corresponding COL indexes because of the substitution effect the further away the observation period is from the base period. This is often interpreted as showing that such CPIs are subject to an upward 'bias', which must be true if the official purpose of the CPI is to measure changes in the cost of living. Discussions of such potential bias have received a lot of attention in many countries, especially in the United States following the 'Boskin' report¹¹.

22. A price index which uses a fixed basket of goods and services may be greater or less than the corresponding COL index. The direction of 'bias' depends on whether the base period precedes or follows the observation period. Suppose, for example, a time series of pure price indexes is required for the decade from 1990 to 2000. If 1990 is selected as the base year, a time series of Laspeyres indexes based on 1990 is obtained. Assuming that changes in relative prices and quantities are negatively correlated, as will happen when consumers make substitutions in response to changes in relative prices, the Laspeyres indexes may be presumed to have upward bias which is likely to become gradually larger as the decade progresses, being greatest for the year 2000. On the other hand, if 2000 is used as the base year, a time series of Paasche indexes is obtained, all subject to a presumed downwards bias which is greatest for the year 1990, becoming gradually smaller as the decade progresses.¹²

23. Now suppose the base year itself is gradually shifted forward from 1990 to 2000. When the base year reaches 1995, the first half of the time series consist of Paasche indexes and the second half Laspeyres indexes. Between 1990 and 1995 there is likely to be a negative bias, followed by a positive bias from 1995 to 2000. Unless the rate of inflation is very different between the two halves of the decade, the *absolute* size of the bias in the measured rate of inflation between 1990 and 2000 is therefore likely to be at a minimum for a pure price index which uses the quantities of 1995, the middle year of the decade, as weights. *A priori*, there is no reason to presume that, in general, there will be any bias in the rate of inflation in the index based on 1995 as compared with the COL index also based on 1995.

24. This example also illustrates the point that the historical rate of inflation over a span of years as measured by a pure price index is, to some extent, subjective. The rate can be varied arbitrarily at the discretion of the compiler by moving the base year backwards or forwards. Choosing a later year will tend to reduce the rate of inflation, while choosing an earlier one will tend to increase it. The rate of increase in a COL index, on the other hand, cannot usually be manipulated to nearly the same extent because it is much less sensitive to the choice of base year.

25. Thus, the extent of the bias in pure price indexes is inextricably linked with the question of choice of base year or, more generally, with the choice of quantity weights. Up to now 'bias' has been interpreted as the extent of the divergence between a pure price index and the corresponding COL index. However, an objective measure of the *change* or *difference* between two situations should presumably assign equal importance to both of them in any case. A pure price index that measures price changes between two periods on the basis of the quantities in only one of them can be considered to 'biased' irrespectively of its relationship to a COL index. It is difficulty to find any good rationale for preferring one period to the other on conceptual or theoretical grounds.

26. Suppose the two periods are consecutive so that they form a continuous time period. A measure of the average price change occurring within that continuum should make use of information not only on all the prices but also all the quantities to which those prices refer. This suggests using the average quantities in the continuum, i.e., in both periods, as weights in a pure price index. If the quantities change smoothly within the continuum, an alternative would be to take the quantities in the middle as weights on the grounds that they are likely to be more representative of the total quantities than those of any other point of time.

27. If the periods are not consecutive, similar conclusions are reached. The most neutral, or unbiased, way in which to compile a pure price index between the years 1990 and 2000 taken in isolation is to use some kind of average of the quantities in both periods as weights. On the other hand, if

1990 and 2000 are the end points of a time series of pure price indexes covering the entire decade, the most neutral, or unbiased, way in which to do so would be to choose the year in the middle of the decade as the base.

28. These types of arguments all lead to the same kind of conclusion, namely that the most neutral and objective type of pure price index is one which uses either some average of the quantities in both periods as weights or the quantities in some intervening third period which is intermediate between the two periods being compared. As already shown, however, these are precisely the same kind of indexes which are likely to have the least bias if the objective is to measure changes in the cost of living. There appears to be no conflict in practice between the objective of measuring inflation and measuring the changes in the cost of living, provided that best practice is followed in both cases.

29. Of course, there are very good practical reasons why CPIs tend to be time series of Laspeyres price indexes because the quantity weights are available in advance and do not have to be continually re-estimated with the passage of time, bearing in mind that the estimation of weights for a price index can be a costly and time consuming business. However, this should not be allowed to create the impression that pure price indexes are inherently biased, whatever criterion of bias is adopted. In practice, the real problem for all prices indexes, whether they are intended to be measure inflation or changes in the cost of living, is to get the most appropriate or relevant weights. It should be noted that even when the objective is to measure the changes in the cost of living, the indexes actually calculated in practice are always pure price indexes of one kind or another. When the weights are 'right', it matters little whether the index is intended to be an inflation or a cost of living index.

30. As already noted, one of the superlative indexes which can be expected to provide close approximations to the COL index, namely the Walsh index, can equally well be regarded as unbiased pure price indexes. However, the superlative Fisher index is not itself a pure price index but an average of two pure price indexes, the Laspeyres and Paasche, which may be expected to cancel out the biases in those indexes. However, the fact that the Fisher satisfies both the time and factor reversal tests is often treated as a decisive advantage which is sufficient to justify its widespread use.

PART II
THE DOMAIN OF A CPI

31. The scope or domain of a CPI is an issue of fundamental importance. Part II of this paper addresses some conceptual points concerning the domain of an index which can have a major bearing upon the value of a CPI. The first relates to the question of whether a COL index that is meant to measure price changes should be a 'conditional' or an 'unconditional' COL index.

Unconditional and conditional COL indexes

32. A consumer's overall standard of living, or total welfare, depends not only on the quantities of goods and services consumed but also on the general environment in which those goods are consumed, where 'environment' is to be understood in a broad sense to cover not only physical and climatic factors but also general economic, social and political factors which affect consumer welfare. A consumer may compensate for changes in these environmental factors by adjusting the quantities of goods and services consumed in order to maintain total welfare constant. A COL index may therefore be defined as the ratio of the minimum consumption expenditures needed to maintain a constant level of total welfare under two different regimes between which both the prices of goods consumed and also the 'environment' in which they are consumed may vary. Such an index has been described as an 'unconditional' COL index because it does not depend only on changes in consumer prices.

33. Whether or not it is appropriate to broaden a COL index in this way to include factors other than price changes depends on the interests and purposes of the user of the index. Broad measures of the cost of welfare are relevant for users interested in the overall welfare of consumers and not just that part attributable to consumption. Such users may include the general public, politicians, the press and historians as well as welfare economists.

34. On the other hand, an unconditional COL index that includes non-price factors can no longer be interpreted as simply measuring price changes but the combined effects of changes in both the price and non-price factors. When intended as an 'idealised price index', a COL must be a 'conditional' index that holds all the environmental variables constant with only the prices varying between the two situations.¹³ Although a conditional index involves a comparison with a hypothetical situation, all COL indexes (indeed most index numbers) involve comparisons with hypothetical situations.

35. Consider the example of the weather. Exceptionally hot, cold or severe weather, such as a hurricane, has an adverse effect on the welfare of consumers. Assume that consumers compensate by purchasing just sufficient additional quantities of some goods and services such as electricity, heating oil or repairs in order to maintain their welfare. Assuming also for

purposes of argument that other things remain equal, including all prices, does the COL index rise because of these increased expenditures?

36. If the COL is an unconditional index that includes the effects of changes in environmental factors as well as price, the answer is obviously 'yes'. Consumers have to spend more to remain as well off as they were before the adverse weather. If the COL is a conditional index that holds the environmental variables constant, the answer is equally obviously 'no', assuming prices also remain constant. The conditional COL must remain constant.

37. Consider the consequences for real consumption when consumers' expenditures are deflated by the two alternative COL indexes. When the broad unconditional COL index is used as deflator, real consumption appears to be unchanged even though some quantities have increased. Even so, it may be argued that 'real' consumption cannot increase if total welfare does not increase. On the other hand, using the narrower COL as deflator, real consumption increases even though total welfare does not.

38. As prices are assumed constant, consumption expenditures have risen at constant prices in the example. This suggests not only that real consumption has increased but that consumers have benefited from the additional expenditures. It is necessary to draw a clear distinction between changes in welfare *over time* and the different levels of welfare associated with different quantities of goods and services consumed as represented by a set of indifference curves or surfaces. If the second period with the bad weather is used as the base, the welfare or utility derived from the higher quantities of goods and services consumed in the second period must be compared with the welfare that *would be* derived under the same bad weather conditions from the lower quantities consumed in the first period. *Consumers are better off with the increased consumption than they would be without it.* The fact that they may be actually worse off over time is irrelevant. Comparisons of real consumption should be *conditional* on a given set of environmental variables in the same way as the corresponding COL index. Measures of real consumption should not be expected to capture the actual change in total welfare between two periods of time but only that part of the welfare change attributable to changes in the quantities of goods and services consumed in the two periods. The two changes can be very different.

39. In practice, the change in real consumption may be estimated by deflating consumption expenditures by a conditional COL index whose domain is limited to same set of goods and services. As noted in Part I, any COL index involves a comparison between two situations of which at least one must be hypothetical in the same way that the estimated change in real consumption involves a comparison with a hypothetical situation.

Alternative conditional COL indexes

40. A 'conditional COL index' is an index that holds constant any of the variables affecting the utility and not necessarily the environmental variables. Conditional indexes do not have to be conditional 'price COL index'. For example, there may be interest in the extent to which the cost of living is affected by changing crime rates. A conditional 'crime COL index' could be defined as the ratio of the minimum expenditures on goods and services that consumers need to make under two different crime regimes in order to maintain an unchanged level of welfare, all other variables, including prices, remaining constant. Such an index would measure the cost of any increased expenditures on deterrents, security, etc. in response to a rise in the crime rate. Other specific conditional COL indexes could be envisaged such as a pollution index measuring additional costs incurred to offset the harmful effects of increased pollution.

41. While there are many possible conditional COL indexes, only conditional 'price COL indexes' in which all non-price variables are held constant can legitimately be described as "idealised" price indexes. Other conditional COL indexes may be of analytic and policy interest but they are not price indexes. Unconditional COL indexes which implicitly include crime, pollution, etc., components as well as a price component are also not price indexes.

42. In retrospect, it can be seen that Part I of this paper implicitly examined the relationships between conditional 'price cost of living indexes' and pure price indexes. Generalising the concept of the cost of living index to the unconditional index may be interesting from a theoretical point of view. It is also useful to clarify that a price COL index is, in fact, conditional on a particular set of non-price variables. There is always a risk, however, that a pure price index may be wrongly accused of being biased because it fails to take account of changes in non-price factors which belong in an unconditional COL index but have no place in a price index.

The domain of goods and services

43. In this section, it is explicitly assumed that the domain of the COL index is restricted to marketable goods and services consumed by households so that it is a conditional price COL index. Even so, the exact scope of a CPI needs to be clarified, the same boundary problems affecting both pure price and COL indexes.

Social transfers in kind

44. One issue is whether to include "social transfers in kind" in a CPI. These are defined in the 1993 SNA (para. 8.99) as "individual goods and services provided as transfers in kind to individual households by government units and non-profit institutions...". These are individual goods and services such as health, education, transport or housing services provided free, or at

low nominal prices, to consumers. Such goods or services must be marketable. They are provided free not because of market failure but as a matter of social or economic policy. They are not 'public goods' although they often account about a half of public expenditure. Social transfers in kind enter into the utility functions of consumers in exactly the same way as the same kinds of goods and services sold on the market. There is no reason to exclude them from a CPI, whether it is meant to be a COL or a pure price index. It should be noted, however, that the quantities of goods and services consumed as social transfers in kind are not at the discretion of the consumers. They do not depend on their prices or the consumers' resources. The quantities are determined by the government units supplying them. Typically, there is excess demand for them.

45. When they are sold, even at artificially low prices, they can be treated in the same way as ordinary market goods and services. The relevant prices for a CPI are the prices actually paid by the consumers even though these may be much lower than the costs incurred by the government or other units that provide them. When they are provided free they should be included at zero prices. There are no imputations involved. Both the prices and the quantities of these individual goods and services are observable.

46. It may appear superfluous to include them in a pure price index when their prices are zero in both periods as the index will take the same value in these circumstances whether they are included or excluded. On the other hand, when the government decides to start charging for social transfers that were previously free there is patently an increase from a zero to a positive price that must be captured by a CPI.

47. In the case of a COL, a change in the *quantities* of these free goods or services will also affect the index, even though their prices remain zero. A change in the quantities provided affects consumers' welfare and must therefore affect the COL index. The effects of changing quantities of free social transfers in kind may cause a COL index to diverge from the corresponding pure price index.

48. Social transfers in kind are extremely important in many countries. In the last decade, there has been a systematic tendency for political and economic reasons both to reduce the quantities provided free and to introduce charges. Examples of the latter include charges for health and education services and the introduction of tolls on motorways or bridges. Such changes obviously have a very direct impact on the cost of living.

New goods

49. The treatment of new goods raises difficult conceptual and practical problems for both pure price indexes and COL indexes. A new good or service is one that is available in the second period but not in the first period. Conversely, a disappearing good is one available in the first but not the

second period. The following discussion will focus on new goods as they are more important. The implications for disappearing goods are usually fairly obvious.

50. Enlarging the set of goods and services from which the consumer can choose must increase welfare, other things being equal, provided that some consumers consider it worth buying some of the new items and substitute them for some of the goods and services bought previously. The appearance of such a new good must, in itself, tend to reduce a COL index. One of the strengths of a COL index is that, in principle, it can deal with situations in which the sets of goods and services available are different in the two situations compared. One set could be larger or smaller than the other or they could be overlapping sets, each with some items not found in the other.

51. Consumers are prevented from buying a new good in the first period. It may be asked, however, how high the price would have had to be in the first period to persuade consumers not to buy any of the good even if it were available. The resulting price, known as the 'demand reservation price', is defined as the hypothetical minimum price that would reduce demand to zero. It must be higher than the price at which a new good is actually purchased for the first time. It can be argued that the appearance of a new good must therefore imply a price reduction, consistently with the COL approach.

52. If the demand reservation price could be estimated it could be used in a pure price index that uses the quantities of the second period as weights or indeed in the pure price that is equivalent to a COL as defined in Part I of this paper. If it were so used it would clearly tend to reduce the pure price index as compared with an index that simply ignores the new good on the grounds that there is no price in the first period.

53. It is necessary to distinguish between two different types of new good on the basis of whether or not they could actually have been produced in the first period. A 'completely new' good is defined as a good that could not have been produced in the earlier period because the knowledge and technology required simply did not exist at that time. An 'ordinary new' good is defined as one that could have been produced in the earlier period. In practice, the vast majority of new goods are ordinary new goods. They are introduced on the basis of market research, advertising and publicity designed to reflect and influence consumer tastes and attract demand. Fashion goods are the clearest example, bearing in mind that fashion is by no means confined to clothes and affects durables, especially automobiles, foods and also many services. Fashion goods are aimed by their producers at both sexes and all age groups.

54. Ordinary new goods which are not very different from some existing goods are usually described as new qualities. The distinction between an ordinary new good and a new quality of an existing good is partly a matter of degree and partly a matter of terminology. It is clear that the compiler of

a price index must try to make a direct comparison between the price of a new quality and the price of the old quality, and even between the price of a new good and some similar kind of old good, if possible. Otherwise, price indexes would collapse through lack of direct price comparisons. The number of goods and services that remain strictly homogeneous over time is very small. Adjusting for quality change is the most serious practical problem confronting index compilers. Various different methods of quality adjustment may be tried, including hedonic regressions. They are not discussed here as they do not affect the domain of a CPI.

55. Completely new goods raise difficult conceptual as well as practical problems. A completely new good is one that can only be produced after an advance in knowledge and technology has occurred. They are conditional on major new inventions or discoveries. Examples are electricity itself and electric goods such as the light bulb, the telephone, television and computers. Other examples are the internal combustion engine and the jet engine; anaesthetics and antibiotics; refrigeration and air conditioning; and so on. These and other major inventions may be responsible for a very large part of the improvement in living standards that have occurred over the last two centuries. Their impact on consumer welfare has been enormous. The way they are treated in COL indexes can therefore have an enormous effect on the resulting indexes, at least over the longer term.

56. The issue is whether the appearance of a completely new good in itself constitutes a reduction in price. There is no doubt that it improves welfare and therefore lowers an unconditional COL index, other things being equal. If there is a reduction in price, it is necessary to specify what price has fallen. A COL measures the effects of changes in the prices of goods and services on utility and these price changes must be identifiable.

57. It is doubtful whether it is reasonable to invoke the concept of a reservation price in the case of a completely new good. The supply reservation price (the lowest price that would induce producers to supply some of a good) does not exist. However high the price of the good might have been in the earlier period, producers could not have supplied it. The demand reservation price is also meaningless for consumers in the earlier period because they were unaware of the existence of the good and its characteristics. Time cannot be reversed. If information about the good existed in the earlier period it would have been produced then and would not be a new good in the later period. The demand reservation price can only be defined using the preferences of the later period. As there is no good in an earlier period with which the demand reservation price can be associated, another problem is that it is not clear when the imputed price reduction occurs: whether there is an instantaneous price fall when the good first appears or whether it is spread over a longer period of time.

58. The basic problem is not the practical difficulty of estimating the demand reservation price but the more fundamental conceptual problem of

whether it is meaningful to say a price *change* has occurred when there is no good existing previously whose price can be compared with that of a completely new good. An alternative approach is to define the domain of the CPI as the set of all goods and services that are available in both periods or are available in one period and could be produced and made available in the other. Such an index would cover all ordinary new goods and new qualities and also all disappearing goods. On this approach, the unconditional COL index would be lowered by a completely new good when it first appears but not the conditional COL price index between that period and the previous period. The appearance of the new good would have no effect on the conditional COL index as it would be treated as a change in an 'environmental' variable attributable to advancing knowledge and technology.

59. The treatment of completely new goods is intrinsically difficult and still remains controversial. It is possible that the appropriate treatment may vary depending on the views and needs of users. It depends, for example, on whether analysts interested in inflation would view the price level as falling instantly and significantly just because a completely new good appears on the market, irrespectively of its initial price which may turn out to be quite high compared with subsequent periods. On the other hand, an unconditional COL index, which may be of interest to some users, must fall when a completely new good appears.

END NOTES

¹ R. Dornbusch and S. Fischer (1994): *Macroeconomics*, p. 10.

² See W. Erwin Diewert, (1999), *The Consumer Price Index and Index Number Purpose*, Paper for the International Working Group on Price Indices, the 'Ottawa Group', Aug. 1999, (revised September 1999 version), pp. 30-36.

³ Franklin M. Fisher and Karl Shell, *The Economic Theory of Price Indices*, Academic Press. New York and London, 1972, p.ix.

⁴ Robert A. Pollak, *The Theory of the Cost-of-Living Index*, Oxford University Press. New York and Oxford, 1989, p.6.

⁵ See Pollak, *op. cit.*, pp. 18-20. Preferences are homothetic when each indifference curve has the same 'shape': that is, each curve is a uniform enlargement, or contraction, of other curves. Pollak remarks: "These results are important not because we believe that people's indifference maps are homothetic but because we believe they are not." This "implies that the cost-of-living index depends on the choice of the base level of expenditure." Pollak, p. 20.

⁶ Numerous references may be cited for a proof of this proposition, such as Pollak (1989), *op. cit.* pp. 10 to 20. Diewert (1999), *op. cit.* provides a proof in the general case for a group of consumers whose utility functions also include environmental variables.

⁷ It can be shown if the consumer's preferences were not merely homothetic but the utility function were a homogeneous quadratic, the COL index would be equal to the geometric mean of the Laspeyres and Paasche indexes, namely the Fisher index. See Pollak (1989), *op. cit.* pp. 10 to 20.

⁸ See W. E. Diewert, 'Exact and Superlative Index Numbers', *Journal of Econometrics*, 4, 1976, pp. 115-145.

⁹ Hill, T. P., 1997, *The Measurement of Inflation and Changes in the Cost of Living*, Joint ECE/ILO Meeting on consumer price indices, Geneva, Nov. 1997.

¹⁰ Diewert (1999), *op. cit.*, p. 33, makes a similar point noting that "the Edgeworth/Marshall is not homogeneous of degree 0 in the components of both q^0 and q^1 ." After a scaling adjustment of the kind proposed here, the index would be homogeneous.

¹¹ Advisory Commission To Study The Consumer Price Index (Boskin Report), 1996, *Toward a More Accurate Measure of the Cost of Living, Final Report*, Washington, December 4, 1996. The Boskin Report identified other sources of bias as well as that arising from the substitution effect, in particular insufficient allowance for improvements in quality, a practical deficiency which would affect any kind of index based on such deficient data.

¹² The statements in this paragraph apply equally, *mutatis mutandis*, to the measurement of the growth of real consumption when fixed weight volume indexes are used.

¹³ See Pollak (1989) *op. cit.* Diewert (1999) *op. cit.* provides a detailed, and extended, explanation of the properties of unconditional and conditional COL indexes and their relationship with Laspeyres and Paasche price indexes.
