Measuring Inflation under Pandemic Conditions

Rejoinder

By W. Erwin Diewert and Kevin J. Fox

The discussants have provided informed and thought-provoking commentary on our paper. While we agree with much of what the discussants have written, there are of course some points of disagreement. We are grateful to the guest editors for this opportunity to respond. We focus on what we regard as the main points of disagreement in what follows.

The **first discussant** writes: "Reservation prices themselves are mainly a construct derived from the "economic approach" of index theory; but most consumer price indices rather follow the basket approach, which does, in principle, rule out the use of non-observable prices like reservation prices. It may be argued that quality adjustment with hedonics in a basket index is already some kind of "economic index theory element". However, the fixed basket approach in its very nature needs constant quality and therefore quality adjustment. The statistician has a wide variety of methods at hand, not only hedonics. They are chosen because they can be applied to serve the basket concept, not because of their economic nature."

We see things quite differently. Fixed basket approaches do *not* rule out the use of non-observable prices like reservation prices. Fixed basket approaches are based on the choice of a basket that is *representative* of the purchases of consumption goods and services for the target population for the two periods being compared. Fixed basket approaches are *silent* on what to do if some prices are available in one period but are not available in the other period in the comparison. Faced with the missing price problem, price statisticians can either: (i) restrict comparisons of prices between the two periods in question to the set of common products or (ii) impute prices for the missing products. Both methods are used in practice.

A Lowe type fixed basket CPI is only appropriate if its basket *approximates* actual household consumption for the two periods under consideration. If the actual consumption vectors for the two periods are very different from proportional consumption vectors, then there are two fixed baskets that are relevant for the comparison: the base period basket (leading to a Laspeyres index) and a current period basket (leading to a Paasche index). If a single index is required to measure average consumer price inflation between the two periods, then the Fisher index emerges as a "best" choice since it has good properties from the viewpoints of both the economic and test approaches to index number theory. Since it is an average of two very reasonable basket type indexes, it can be considered to be a close relative to a "pure" basket type index.

The Covid pandemic has created a situation where a basket based on pre-pandemic consumption patterns is not a good approximation to pandemic consumption patterns. There is then a need to obtain information on pandemic consumption patterns so that a more relevant basket type index can be constructed.

The pandemic has caused many goods and services to be unavailable for many households. For example, international travel by air is not permitted for most households in many countries, even though some household "essential" international travel is permitted. As we indicated above, there are at least two ways of dealing with the missing price problem; (i) restrict the comparison to goods and services that are available in both periods, or (ii) impute the missing prices using a carry forward or inflation adjusted carry forward price. The algebra in our paper indicates that under certain conditions and for certain indexes, these two strategies boil down to the same thing.

There are two additional methods for dealing with pandemic induced missing prices: (iii) use available posted prices that may apply to some households and apply them to all households or (iv) estimate reservation prices. Option (iii) has turned out to be the strategy of choice for many statistical agencies; i.e., for example, assume that posted air fares are available to all households instead of just to selected households.

Approaches (i)-(iii) are not (in general) appropriate to deal with prices that are missing due to lockdown restrictions if we take the economic approach to index number theory. From the viewpoint of the economic approach to the construction of a CPI, the missing prices should be replaced by reservation prices. This is the same as saying that the imputed prices in method (ii) should be reservation prices. The issue is then about selecting the most appropriate way of imputing missing prices. The standard imputation methods lack the theoretical justification that underlies the use of reservation prices.

We concede that, at present, it is not possible for statistical agencies to estimate reservation prices at scale for products that are not available to many households due to lockdown restrictions. Nevertheless, we believe that our paper is useful in the sense that it indicates to the public that from the viewpoint of the economic approach to index number theory, current CPIs may have a downward bias compared to a CPI that is based on the economic approach to index number theory.

In principle, the estimation of reservation prices is not conceptually different from the use of quality adjustment procedures, including hedonic regression models, which are used to match the prices of new products to existing products; see de Haan (2010) and de Haan and Krsinich (2014) (2018) and Diewert (2021c) for an overview of quality adjustment methods used by statistical agencies. However, the quality adjustment procedures in use today are well established and relatively easy to implement. It turns out that the estimation of reservation prices is much more difficult than running a straightforward hedonic regression; see Hausman (1996) (1999) (2003), Feenstra (1994), Diewert and Feenstra (2019) and Diewert (2021c). Thus, at present it is not possible for statistical agencies to routinely estimate reservation prices.

The first discussant also raises interesting points about similarity linking and stockpiling. In response we note that Diewert (2021b) and Diewert (2021d) address issues on these topics, respectively, in some detail.

The **second discussant** writes as follows:

"Assume the reservation price is used to price a disappearing product, as suggested in the paper. To be consistent, when the product originally was included in the index, it should have been introduced using the same reservation price for the pre-introduction period. Hence, products would be introduced and exit with the same reservation price and leave the COLI unaffected. When the product first appeared on the market there may have been consumers that would have been ready to pay (almost) the reservation price in the pre-introduction period. However, when the product leaves the market after 2, 3 or 10 years, its price may have changed because of the emergence of other products or shifts in preferences. It is difficult to see why a consumer should be ready to pay the same price in the exit period as in the pre-introduction period. This is particularly the case for products that over their life cycle experience a fall in their relative price, reflecting a decrease in their relative marginal utility. The suggested approach may work for some markets, but most likely not for all. The theory's assumptions may be too far from actual consumer behaviour and market conditions to give useful results in all cases. Are there other, less restrictive theories about consumer behaviour that could be useful to draw on?"

The reservation prices in the period prior to the introduction of the "appearing" product and in the period when the product "disappears" will not be identical in general. The prior period reservation price (which is proportional to a marginal utility) depends on the vector of "other" goods and services that the household is consuming in the period prior to the introduction of the new product and the post period reservation price depends on the vector of "other" goods and services that the household is consuming in the period just after the disappearance of the product in question. These two consumption vectors of "other" goods and services will be equal only by accident. Hence the two reservation prices will in general be different. This illustrates why it is so difficult to estimate reservation prices: it is necessary to estimate household preferences, which is a very challenging task!

The discussant makes the following points regarding expenditure weights.

"The use of monthly expenditure weights in most countries is not an option because of lack of data and resource constraints. It may be possible to derive such weights for specific product groups, but it will be difficult to construct monthly weights for the full basket. An index based on monthly weights may change because of both price changes and changes in the basket; in theory it may change even if all prices remain the same only because of changes in the composition of the basket. This is not a suitable property for a basket index and would not be suitable if the index (also) is used for measuring inflation."

The problems associated with the use of using out of date annual weights for a CPI become very apparent when annual weights are used as weights for strongly seasonal commodities. A strongly seasonal commodity is one that is not available in all months. If

a CPI uses an annual basket in this context, there is the problem of finding prices for the missing products when they are not available on the marketplace. An annual basket is simply not representative for monthly purchases of strongly seasonal commodities.

We recommend the use of representative monthly weights for strongly seasonal commodities. The use of monthly baskets will enable the National Statistical Office to construct relevant year over year indexes for each month. These year over year monthly indexes need to be linked by the use of month to month indexes for a base year. But how exactly are these month to month indexes to be constructed? The situation is similar to the problems caused by lockdowns; we have the problem of missing prices associated with zero quantities.

For elementary categories where price and quantity (or expenditure) information is available, bilateral maximum overlap Laspeyres, Paasche and Fisher indexes can be constructed for every pair of months in the base year; a maximum overlap bilateral index is defined over the set of products that are present in both months being compared in the base year. Then the prices for the months in the base year can be linked by fixed base or chained Fisher indexes. Alternatively, similarity linking can be used to link the months in the base year.[1] Once the month to month indexes have been determined for the base year, these indexes are then linked to the year over year indexes for each month.

It is not true that the Laspeyres, Paasche and Fisher indexes can change if prices remain the same; they will all register no change if prices remain constant. The weights change as we move from the Laspeyres to Paasche indexes but when computing these two indexes separately, we hold the weights constant. It seems to us that the Laspeyres and Paasche baskets are equally important in making price comparisons between the two periods in scope. The Fisher index takes both perspectives into account in an even handed manner.

In the case where monthly price and expenditure information is only available for the base year, the above methodology can be used to link the months for a base year where information on prices and expenditures is available. Then year over year monthly Lowe indexes (which use the monthly baskets of the base year) can be calculated and the two sets of indexes can then be linked to give us a "traditional" month to month index. This suggested procedure is very close to "traditional" NSO procedures but it will require a more expensive consumer expenditure survey in order to obtain reasonably accurate monthly baskets for strongly seasonal commodities for the base year.

It is also possible to use estimated reservation prices in the strongly seasonal commodity context, provided that a time series of price and expenditure data is available. But again, this requires the estimation household preferences, which is a complicated econometric exercise and requires many assumptions in order to implement this task; see Diewert and Feenstra (2019). It is not a practical solution at this time.

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[1] See Diewert (2021b) for an exposition of the theory behind linking observations based on how similar their prices are. For a worked example of similarity linking using Israeli data on strongly seasonal purchases of fruits, see Diewert, Finkel and Oren (2021).

The second discussant also raises the issue of democratic versus plutocratic weighting in a COLI. There is a substantial literature on plutocratic versus democratic indexes and the associated literature on measuring social welfare. This literature is surveyed from a CPI perspective in sections 16-19 of Diewert (2021a). Due to rising inequality problems in many countries, there is increased interest in having national statistical agencies produce Consumer Price Indexes for different demographic groups. In order to accomplish this task, it will be necessary to greatly increase the size of Consumer Expenditure Surveys or to look for new methods for obtaining individual consumer expenditure data. Governments should be willing to fund these increased costs if they want to address the inequality problem.

The **third discussant** has presented a very clear alternative interpretation for a reservation price in terms of partial equilibrium supply and demand curves. The Hicksian reservation price that is used in our paper is the price determined by the intersection of the consumer's demand curve with the vertical price axis. The alternative reservation price that the discussant proposes (the pure demand shock case) is the price determined by the intersection of the supply curve with the vertical price axis. In our view, this alternative reservation price concept is an appropriate one for a producer price index, but it is not appropriate for a consumer price index.[2]

We thank the discussants for their engagement with our paper. Their comments have not only helped our thinking on the current paper, but we believe they are helpful in informing future research.

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[2] Reinsdorf (2020; 4) proposed a similar producer oriented approach to the determination of reservation prices.

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