Notes on Price Measurement [1] August 21, 2014.

Chapter 9: Recommendations

W. Erwin Diewert
University of British Columbia and the University of New South Wales
Email: erwin.diewert@ubc.ca
Website: http://www.economics.ubc.ca/faculty-and-staff/w-erwin-diewert/

1. Introduction and Summary

In Chapters 1 and 2 of these notes, we looked at the four main approaches to *bilateral index number theory* (the comparison of price levels over two periods of time or between two countries or regions at the same time) that have been developed over the past 150 years:

- The pricing of fixed baskets approach;
- The stochastic or descriptive statistics approach;
- The test or axiomatic approach and
- The economic approach.

All of these approaches led to three main functional forms for the bilateral price index formula that were "best" for the various approaches:

- The Fisher ideal index P_F;
- The Törnqvist Theil index P_T and
- The Walsh index P_W.

Fortunately, it is not necessary for statistical agencies to agonize over which functional form to choose as their target index: all three indexes will generally approximate each other fairly closely.

In Chapter 3, we moved from bilateral index number theory (the comparison of two price and quantity situations) to *multilateral comparisons* where many price and quantity situations need to be compared. Once straightforward solution to the problem of making multilateral comparisons is to choose one period (or one country) as the base and compare all price and quantity observations to the chosen base observation using bilateral index number theory. The problem with this solution is that the results will generally depend on the choice of the base observation but the choice of the base situation is arbitrary. Various solutions to this problem of base observation dependency were discussed in Chapter 3. One solution is to take an average of all the parities that are obtained by choosing each observation in turn as the base observation and this averaging

[1] These Notes were prepared for the Preconference Training Sessions on Price Measurement held on August 23-24, 2014, sponsored by the 33rd General Conference of the International Association for Research in Income and Wealth held in Rotterdam, Netherlands, August 24-30, 2014.

procedure led to the Gini-Eltetö-Köves-Szulc (GEKS) multilateral method. The GEKS method turned out to be satisfactory from some points of view but not completely satisfactory from other points of view. In particular, when making multilateral comparisons across countries, many analysts want a multilateral index number method that leads to *additive comparisons* of quantity aggregates across countries; i.e., there is a demand for the multilateral method to lead to quantity aggregates that are proportional to the inner product of a set of international prices with the quantity vector of each country in the comparison. Thus in Chapter 3, we discussed the relative merits of two additive methods:

- The Geary Khamis method and
- The Iklé-Dikhanov-Balk (IDB) method.

We also discussed a fourth method for making multilateral comparisons: the *similarity linking method*. This method which has been associated with the work of Robert Hill works roughly as follows: (1) define a suitable measure of the similarity or dissimilarity of the relative prices in two of the observations and (2) link the most similar observations by your favourite bilateral index number formula until all of the observations are linked in a spanning tree. The basic idea behind this multilateral method (i.e., to link observations that had the most similar price structures) emerged later in the course when we discussed whether it is better to use fixed base index numbers or chained index numbers when making price comparisons over time.

Multilateral index number theory has mostly been used when making comparisons of prices and quantities (or volumes) across countries but as we have seen, multilateral index number theory played a key role in Chapter 7 where the chain drift problem was discussed.

Chapter 4 discussed the problems associated with choosing an index number formula for a *bilateral elementary index*. A bilateral elementary index is an index number formula, say $P(p^0,p^1)$, that depends only on the two price vectors.[2] Thus this is the type of index that statistical agencies are forced to work with when only price information is available for the two periods being compared. There are only two main approaches to the determination of the functional form for the elementary price index:

- The stochastic approach and
- The test approach.

Obviously, basket approaches do not work in this context since quantity information is required to form the baskets that would be priced out at the prices of the two periods being compared, using Paasche and Laspeyres type indexes. Economic approaches do not work in this context either; exact index number techniques require both price and quantity information in order to be implemented.

[2] The usual form for a bilateral index number formula is $P(p^0,p^1,q^0,q^1)$; i.e., the index formula depends on the two price vectors being compared, p^0 and p^1, but it also depends on the associated quantity vectors, q^0 and q^1.

From the viewpoint of the test approach to elementary indexes, the Jevons index emerged as being best. This index is also consistent with the stochastic approach.

Chapter 4 dealt only with elementary indexes in the bilateral context with complete price information for the two periods being compared. We looked at multilateral approaches to elementary indexes in section 5 of Chapter 7 where the Time Dummy Product method was discussed.

Chapter 5 looked at "practical" price indexes. In this context, it is assumed that the statistical agency has monthly price information available to it but information on quantities or on expenditure shares is only available with a lag. Examples of practical index number formulae are the Lowe, Young and Geometric Young (or weighted Jevons) indexes. Another complication associated with these practical indexes is that monthly prices are matched with annual (instead of monthly) expenditure shares. The resulting indexes cannot be justified from any theoretical points of view that were studied in earlier chapters but they can be justified as approximations to more theoretically sound target indexes of the type studied in earlier chapters.

Another complication that causes problems for index compilers is the problem of *seasonality*; i.e., some product groups are subject to very large seasonal fluctuations in prices and lesser fluctuations in quantities. Thus in Chapter 6, we studied various remedies that have been suggested in the index number literature in order to deal with the seasonality problem. Various year over year indexes were suggested in Chapter 6:

- Year over year monthly indexes using the price data pertaining to a specific month and appropriate monthly expenditure shares or quantity data;
- Year over year annual Mudgett Stone indexes that treat each commodity in each month as a separate commodity and
- Rolling year Mudgett Stone indexes that compare the price and quantity data of the last 12 months with the corresponding price and quantity data pertaining to a base year.

These indexes were suggested in the *Consumer Price Index Manual* along with various approximations to them. There is nothing conceptually wrong with these indexes; the only problem with them is that they require monthly expenditure information and most statistical agencies do not have the required information. However, all of the above year over year indexes do not give an accurate signal about short term price movements. Thus a month to month price index is also required. The *Consumer Price Index Manual* suggested that a chained superlative month to month index would be a suitable target index in this context. However, since the *Manual* has been written, there have been a number of month to month chained superlative indexes that have been constructed using scanner data from retail chains. These studies generally find that chained indexes in this context are subject to *chain drift*; i.e., usually, the chained indexes drift far below their fixed base counterparts. The chain drift problem is usually caused by sales (or more generally, by price bouncing behaviour) and it is explained in section 5 of Chapter 6.

In Chapter 7, we presented a method that addresses the chain drift problem: the Rolling Year GEKS method. This method basically applies the GEKS multilateral index number method to the last 13 months of price and quantity data and obtains a sequence of 13 indexes for these last 13 months. These indexes are free of chain drift. The rate of change in these indexes over the last two months in the rolling year is used to update the index level of the previous month.[3] This Rolling Year GEKS method was implemented in Chapter 8 and it does seem to work well.

In section 6 of Chapter 7, the Rolling Year Time Product Dummy (RYTPD) method for constructing multilateral elementary indexes was described.[4] This method simply extends the Rolling Year GEKS methodology to an adaptation of Summer's (1973) Country Product Dummy method that is used to construct multilateral elementary indexes in the cross country comparison context. The RYTPD method is (we believe) an improvement over existing Eurostat HICP methodology where January prices are singled out to play an asymmetric role in the construction of elementary price indexes for the following years.[5]

In section 8, we tested out most of the index number formulae that were discussed in these notes using an Israeli data set on the household consumption of seven kinds of vegetables. Some tentative conclusions and recommendations for statistical agencies that seem to follow from our numerical results are presented in the following section.

2. Conclusion and Recommendations

It is possible to use the material that we have covered in this short course on index number theory to make some recommendations.

- Household expenditure surveys should be put on a continuous basis so that monthly weights can be collected and utilized in a timely fashion. The bias in the various practical indexes that are used by statistical agencies cannot be evaluated without this monthly expenditure information. This is the most important recommendation that we can make.
- The Carli or Harmonic elementary indexes should not be used as elementary indexes due to their built in biases. Jevons indexes or the CSWD indexes, or more generally, the Rolling Year Time Dummy Product (RYTPD) indexes should be used in their place.
- Rolling Year Time Dummy Product indexes appear to be the "best" method for aggregating item prices in a stratum when quantity or expenditure information is not available and there are missing prices for some months.

[3] There is the possibility of introducing a small amount of chain drift in the final index by making this last step.
[4] This method is basically due to de Haan and Krsinich (2012).
[5] Thus prices collected in the months of a year following January are always compared to their January counterparts and thus the January prices play an asymmetric role in the index construction for the year. This can lead to problems if the January prices are not "typical". Of course, some strongly seasonal products may not even be present in January and so comparisons of these prices with their January counterparts are not possible (and so various ad hoc solutions to this problem have to be found).

- Young indexes should not be used at any stage of the data aggregation due to their built in upward bias.
- Lowe indexes with lagged annual quantity weights or Geometric Young indexes with lagged annual expenditure share weights can be used as fairly good approximations to RYGEKS indexes; see Table 15 in Chapter 8. However, their biases with respect to our preferred RYGEKS indexes should be evaluated on a retrospective basis as the monthly expenditure information becomes available for the current period.
- Rolling Year GEKS with approximate weights or the Weighted Rolling Year Time Product dummy method [6] should be used to aggregate prices when approximate weights are available.
- If scanner data are available, Rolling Year GEKS should be used.
- Approximate Rolling Year Annual Mudgett Stone indexes should be produced on a monthly basis. These indexes can serve as seasonally adjusted target indexes that central banks can use to guide their monetary decisions. As current monthly expenditure information becomes available, actual Rolling Year Mudgett Stone indexes should be computed.

References

de Haan, J. and F. Krsinich (2012), "The Treatment of Unmatched Items in Rolling Year GEKS Price Indexes: Evidence from New Zealand Scanner Data", paper presented at the Meeting of Groups of Experts on Consumer Price Indices Organized jointly by UNECE and ILO at the United Nations Palais des Nations, Geneva Switzerland, May 30-June 1, 2012.

Diewert, W.E. (2012), *Notes on Price Measurement*, Chapters 1-8, presented at the 32nd General Conference of the International Association for Research in Income and Wealth held in Cambridge, MA, August 5-11, 2012. Available at: www.econ.ubc.ca/diewert/hmpgdie.htm

Summers, R. (1973), "International Comparisons with Incomplete Data", *Review of Income and Wealth* 29:1, 1-16.

[6] See de Haan and Krsinich (2012) for an application that also allows for quality change.