Combining Price Indices in Temporal Hierarchies

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There is a growing demand from central banks, governments, banks, real estate developers, and households for reliable and more timely house price indices. The increased availability of housing data and advances in computing power and econometric techniques offer new opportunities for constructing higher frequency quality-adjusted indices, and for deepening our knowledge of the real estate asset class, including through the development of tradable derivatives. Hill et al (2017) estimated a number of weekly hedonic imputed indices and found there are larger discrepancies in the resulting indices obtained from alternative modelling strategy at this higher frequency than that found when the index is constructed for lower frequencies (e.g. quarterly).

Hyndman et al. (2011) and Athanasopoulos et al. (2017) develop a method for optimally combining time series in temporal hierarchies. In this paper we construct temporal hierarchies for hedonic property price indices in Sydney, Australia. The frequency of the indices considered are annual, quarterly, monthly, and bimonthly. The two latter frequencies are of special interest to central banks. For example, the ECB meets bimonthly, while the Reserve Bank of Australia meets monthly. Real time high frequency indices can provide a timely indication of the state of the real estate market.

Here we will consider hedonic imputed indices constructed from semilog hedonic models which control for property location using either postcode dummies or a non-parametric geo-spline. In addition, period-by-period and state-space specifications of these models will be estimated. For the indices calculated at a quarterly, monthly and bimonthly frequency, we may also consider rolling window time-dummy hedonic models (with a window-length of half a year).

We will apply the Hyndman et al. (2011) method to indices of different frequency computed using the same hedonic method, to establish which method generates price indices that are the most consistent over different levels of aggregation. The change can be measured either by some function of the sum of squared errors in the Hyndman et al. regression model, or directly from the price indices using one of Diewert\'s (2000, 2009) weighted relative price dissimilarity (WRPD) measures. Also, the performance of the original and reconciled indices will be evaluated using a

repeat-sales based criterion developed by Hill and Scholz (2017).

The initial analysis using the Hyndman et al. method will give equal weight to each period. We will then consider weighted versions of the Hyndman et al. method, where each period is weighted by the number of observed transactions in that period. All the calculations in an equally weighted setting will be replicated using transaction weights, and then the results compared.

Another extension on the basic Hyndman et al. method is to impose prior restrictions. For example, if we compare just the quarterly and bimonthly frequencies, we can fix the quarterly index and then force all of the adjustment onto the bimonthly indices. We will try using each quarterly hedonic method in turn as the benchmark, and then see how much each of the bimonthly indices changes on application of the Hyndman et al. method. Again the change can be measured either using a function of the sum of squared errors in the Hyndman et al. regression model, or one of Diewert\'s WRPD measures.

Given that quarterly indices are relatively insensitive to the choice of hedonic method, it may be the case that the rankings of methods will be independent of the choice of benchmark quarterly index. In this context, the Hyndman et al. method can itself be interpreted as a performance criterion, in that we prefer whichever hedonic method has the bimonthly index that changes the least on application of this restricted version of the Hyndman et al. method.

Other combinations of higher and lower frequency indices can likewise be compared in this way. For example, the monthly indices can be fixed, and then the bimonthly forced to adjust, or the quarterly indices can be fixed and the monthly forced to adjust. The causation can also be reversed, so that the lower frequency indices are forced to adjust to the higher frequency indices. We will consider a number of variants on this theme.

One more issue we will consider is the construction of lower frequency indices from higher frequency indices. For example, suppose the objective is to compute a quarterly index from bimonthly indices. This can be done using a variant on the Hyndman et al. method, where one must specify a prior for the quarterly index. We will explore the sensitivity of the results to the choice of prior, and attempt to determine what is a good choice of prior.

In summary, the Hyndman et al. method is very flexible, and can be applied in a number of different ways to compare, reconcile and improve price indices of different frequencies.