An Evaluation of the Methods Used by European Countries to Compute their Official House Price Indices

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Introduction

- Since 2012, National Statistical Institutes (NSIs) in the European Union are supposed to compute official House Price Indices (HPIs).
- The methods chosen by HPIs are as follows:
  - Repricing: used by Austria, Finland, Hungary, Italy, Latvia, Luxembourg, Norway, Slovenia;
  - Average characteristics: used by Romania, Spain (and UK);
  - Hedonic imputation: used by Germany, UK;
  - Rolling time dummy (RTD): used by Croatia, Cyprus, France, Ireland, Portugal;
  - Mix adjusted (or stratified) median: used by Bulgaria, Estonia, Lithuania, Poland, Slovakia;
  - Sales Price Appraisal Ratio (SPAR): used by Denmark, the Netherlands, and Sweden.

Repricing

Estimate the following hedonic model only in year 1:

$$\ln p_{(1,q),h} = \sum_{c=1}^{C} \beta_{1,c} z_{(1,q),h,c} + \varepsilon_{(1,q),h}$$

Now use estimated shadow prices as follows:

$$\frac{P_{(t,q)}}{P_{(1,1)}} = \frac{\tilde{p}_{(t,q)}}{\tilde{p}_{(1,1)}} \Bigg/ \frac{\exp(\sum_{c=1}^{C} \hat{\beta}_{1,c} \bar{z}_{(t,q),c})}{\exp(\sum_{c=1}^{C} \hat{\beta}_{1,c} \bar{z}_{(1,1),c})}$$

Average characteristics

Estimate the following hedonic model for every quarter (t, q):

$$\ln p_{(t,q),h} = \sum_{c=1}^{C} \beta_{(t,q),c} z_{(t,q),h,c} + \varepsilon_{(t,q),h}$$

Now use estimated shadow prices as follows:

$$\frac{P_{(t,q)}}{P_{(t,q-1)}} = \frac{\exp(\sum_{c=1}^{C} \hat{\beta}_{(t,q),c} \bar{z}_{t-1,c})}{\exp(\sum_{c=1}^{C} \hat{\beta}_{(t,q-1),c} \bar{z}_{t-1,c})}$$

Hedonic imputation

Again the hedonic model is estimated separately for each quarter (t, q).

$$\text{GL}: \quad \frac{P_{(t,q)}}{P_{(t,q-1)}} = \left[\prod_{h=1}^{H_{(t,q-1)}} \frac{\hat{p}_{(t,q),h}\left(z_{(t,q-1),h}\right)}{\hat{p}_{(t,q-1),h}\left(z_{(t,q-1),h}\right)} \right]^{1/H_{(t,q-1)}}$$

$$\text{GP}: \quad \frac{P_{(t,q)}}{P_{(t,q-1)}} = \left[\prod_{h=1}^{H_{(t,q)}} \frac{\hat{p}_{(t,q),h}\left(z_{(t,q),h}\right)}{\hat{p}_{(t,q-1),h}\left(z_{(t,q),h}\right)} \right]^{1/H_{(t,q)}}$$

$$\text{Törnqvist}: \quad \frac{P_{(t,q)}}{P_(t,q-1)} = \sqrt{GL \times GP}$$

Rolling-Time-Dummy Method

Estimate the following hedonic model for each rolling window of $k+1$ quarters. Now we denote each quarter by $t, t+1, t+2, \ldots$.

$$\ln p_{sh} = \sum_{c=1}^{C} \beta_{(t/t+k),c} z_{shc} + \sum_{i=t+1}^{t+k} \delta_i D_{ih} + \varepsilon_{sh}$$

The price indices are now derived from the time-dummy coefficients as follows:

$$\frac{P_{t+k}}{P_{t+k-1}} = \frac{\exp(\hat{\delta}^t_{t+k})}{\exp(\hat{\delta}^t_{t+k-1})}.$$

Results for Sydney

Micro-level transaction data for Sydney for 2002-2014 from Australian Property Monitors

380 414 house transactions

250 005 apartment transactions

Hedonic model:
log price = constant + number of bedrooms + number of bathrooms + land area + postcode

We estimate separate hedonic models for houses and apartments.

Note: land area is excluded for apartments.

We compare the following methods (all are hedonic except 10 and 11):

1. Repricing (no updating of base year)
2. Repricing (base year updated every five years)
3. Average characteristics
4. Double imputation Geometric-Laspeyres
5. Double imputation Geometric-Paasche
6. Double imputation Törnqvist
7. RTD (2 quarters)
8. RTD (4 quarters)
9. RTD (5 quarters)
10. Mix adjusted (Residex- 16 regions)
11. Mix adjusted (postcode - 202 postcodes)

Figure 1 : Price Indices for Houses in Sydney (2003Q1=1)

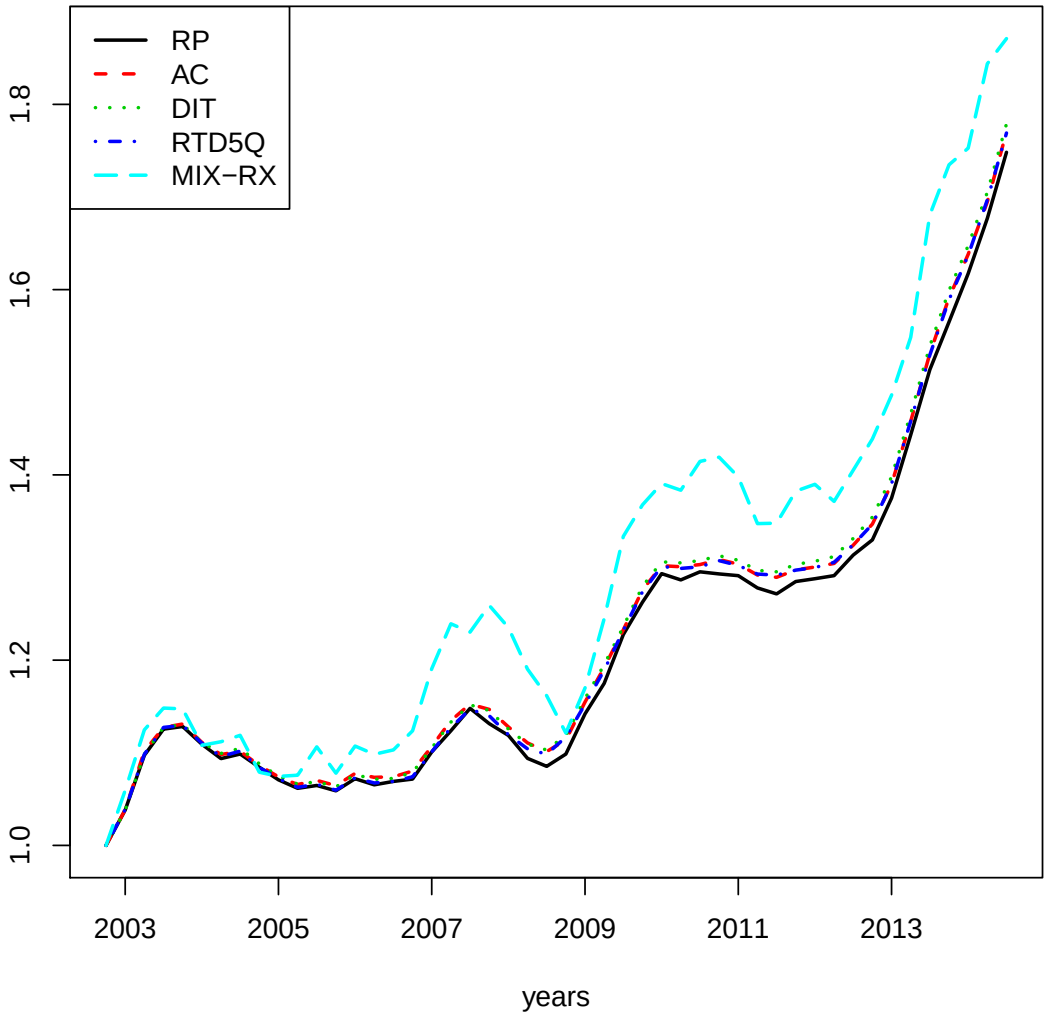

Figure 2 : Price Indices for Apartments in Sydney (2003Q1=1)

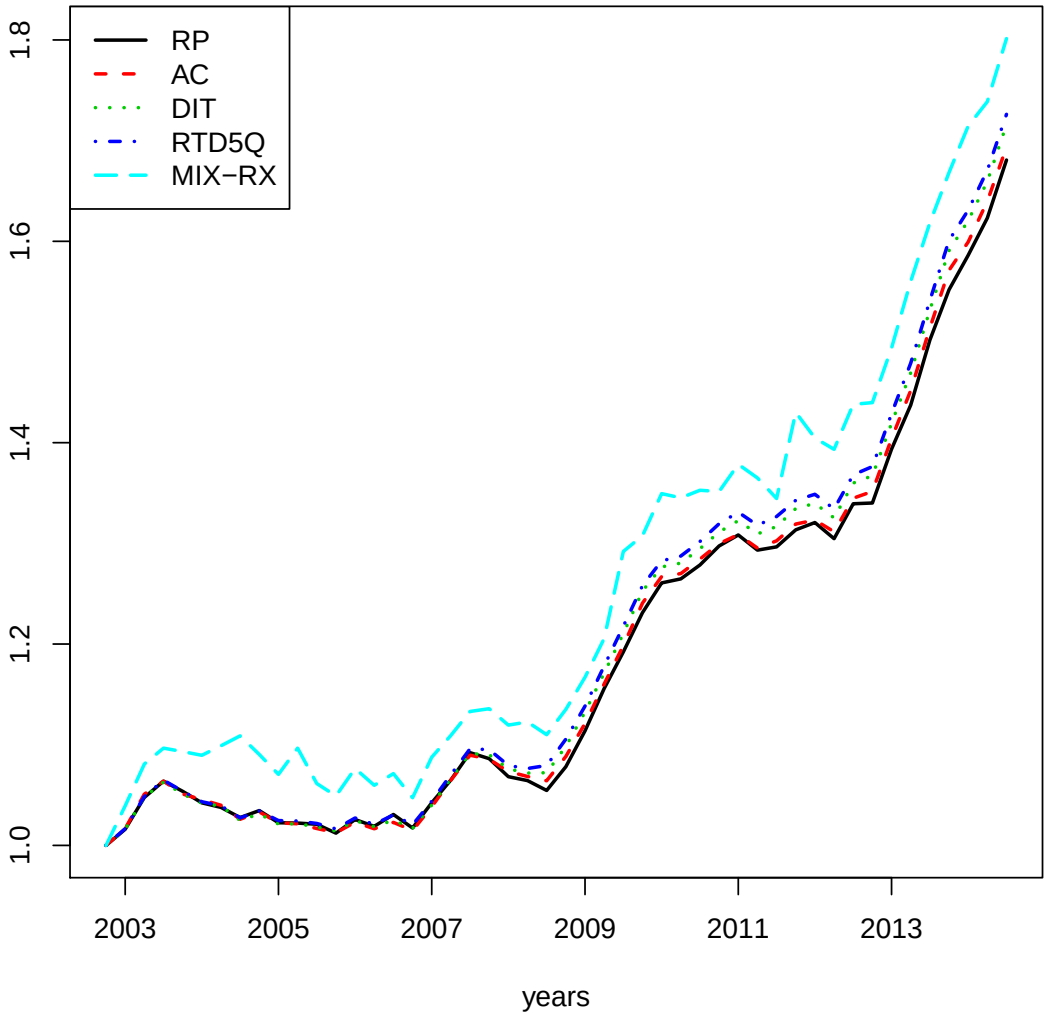

Table 1 : Price Indices for Apartments in Sydney (2003Q1=1)

	RP1	RP2	AC	DIL	DIP	DIT	RTD2Q	RTD4Q	RTD5Q	MIX-PC	MIX-RX
2003Q1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2003Q2	1.016	1.016	1.017	1.018	1.015	1.016	1.016	1.016	1.017	1.019	1.039
2003Q3	1.048	1.048	1.051	1.046	1.050	1.048	1.048	1.049	1.049	1.050	1.081
2003Q4	1.064	1.064	1.064	1.060	1.066	1.063	1.063	1.065	1.065	1.078	1.097
2004Q1	1.054	1.054	1.051	1.047	1.056	1.051	1.051	1.054	1.054	1.061	1.093
2004Q2	1.042	1.042	1.045	1.037	1.047	1.042	1.042	1.044	1.043	1.075	1.089
2004Q3	1.038	1.038	1.040	1.032	1.046	1.039	1.039	1.040	1.039	1.072	1.099
2004Q4	1.028	1.028	1.026	1.017	1.033	1.025	1.026	1.028	1.027	1.065	1.109
2005Q1	1.035	1.035	1.033	1.023	1.040	1.031	1.031	1.034	1.034	1.067	1.090
2005Q2	1.022	1.022	1.022	1.013	1.029	1.021	1.021	1.025	1.025	1.041	1.071
2005Q3	1.022	1.022	1.021	1.013	1.030	1.022	1.022	1.025	1.024	1.054	1.097
2005Q4	1.021	1.021	1.017	1.009	1.027	1.018	1.018	1.022	1.022	1.040	1.061
2006Q1	1.012	1.012	1.013	1.004	1.024	1.014	1.014	1.018	1.016	1.064	1.049
2006Q2	1.026	1.026	1.023	1.015	1.034	1.025	1.024	1.028	1.027	1.049	1.076
2006Q3	1.019	1.019	1.017	1.008	1.029	1.019	1.019	1.022	1.021	1.034	1.060
2006Q4	1.031	1.031	1.023	1.012	1.038	1.025	1.025	1.031	1.030	1.054	1.071
2007Q1	1.017	1.017	1.015	1.002	1.032	1.017	1.017	1.022	1.020	1.026	1.047
2007Q2	1.042	1.042	1.038	1.025	1.055	1.040	1.040	1.045	1.044	1.063	1.088
2007Q3	1.065	1.065	1.065	1.050	1.083	1.066	1.066	1.071	1.070	1.098	1.109
2007Q4	1.092	1.092	1.090	1.073	1.109	1.091	1.091	1.097	1.096	1.132	1.133
2008Q1	1.086	1.086	1.086	1.070	1.110	1.090	1.090	1.096	1.095	1.109	1.136
2008Q2	1.068	1.070	1.073	1.054	1.098	1.076	1.076	1.080	1.079	1.084	1.119
2008Q3	1.064	1.066	1.068	1.050	1.094	1.072	1.072	1.076	1.076	1.072	1.123
2008Q4	1.055	1.068	1.064	1.048	1.097	1.072	1.072	1.079	1.079	1.088	1.110
2009Q1	1.078	1.095	1.088	1.073	1.125	1.098	1.098	1.105	1.106	1.106	1.135
2009Q2	1.114	1.126	1.121	1.105	1.161	1.132	1.132	1.138	1.138	1.133	1.167
2009Q3	1.156	1.166	1.160	1.142	1.202	1.171	1.170	1.178	1.178	1.170	1.205
2009Q4	1.192	1.198	1.199	1.177	1.245	1.210	1.210	1.218	1.218	1.239	1.292
2010Q1	1.231	1.242	1.241	1.218	1.289	1.253	1.252	1.259	1.258	1.271	1.308
2010Q2	1.261	1.265	1.267	1.241	1.313	1.277	1.275	1.283	1.283	1.296	1.349

Table 2 : Price Indices for Apartments in Sydney (2003Q1=1)

	RP1	RP2	AC	DIL	DIP	DIT	RTD2Q	RTD4Q	RTD5Q	MIX-PC	MIX-RX
2010Q3	1.265	1.269	1.270	1.244	1.318	1.280	1.279	1.287	1.287	1.296	1.345
2010Q4	1.279	1.282	1.284	1.259	1.332	1.295	1.294	1.302	1.302	1.311	1.353
2011Q1	1.297	1.300	1.300	1.274	1.349	1.311	1.310	1.319	1.319	1.324	1.351
2011Q2	1.308	1.315	1.309	1.283	1.363	1.323	1.321	1.330	1.331	1.316	1.379
2011Q3	1.293	1.300	1.295	1.268	1.352	1.309	1.308	1.317	1.318	1.320	1.365
2011Q4	1.297	1.313	1.303	1.274	1.361	1.317	1.315	1.325	1.327	1.307	1.345
2012Q1	1.313	1.316	1.319	1.289	1.382	1.335	1.333	1.342	1.343	1.358	1.430
2012Q2	1.321	1.325	1.323	1.293	1.388	1.340	1.339	1.348	1.349	1.361	1.405
2012Q3	1.305	1.314	1.311	1.277	1.375	1.325	1.324	1.333	1.334	1.346	1.393
2012Q4	1.339	1.341	1.345	1.311	1.411	1.360	1.359	1.367	1.368	1.388	1.438
2013Q1	1.340	1.353	1.352	1.317	1.420	1.367	1.366	1.375	1.376	1.412	1.440
2013Q2	1.394	1.404	1.404	1.367	1.474	1.419	1.418	1.427	1.429	1.462	1.494
2013Q3	1.437	1.453	1.452	1.415	1.526	1.469	1.469	1.478	1.479	1.500	1.560
2013Q4	1.502	1.513	1.514	1.476	1.589	1.532	1.531	1.540	1.541	1.584	1.618
2014Q1	1.552	1.573	1.571	1.533	1.651	1.591	1.590	1.600	1.601	1.627	1.668
2014Q2	1.586	1.603	1.599	1.561	1.682	1.621	1.620	1.630	1.631	1.669	1.714
2014Q3	1.623	1.641	1.640	1.598	1.723	1.660	1.659	1.670	1.671	1.675	1.739
2014Q4	1.681	1.693	1.694	1.653	1.781	1.716	1.715	1.726	1.726	1.767	1.801

Target is about 1.72 (i.e., DIT, RTD2Q, RTD4Q, RTD5Q)

Results for Tokyo

Micro-level asking price data for Tokyo for 1986-2016 from RECRUIT. Co.

237 190 apartment asking prices

Hedonic model:
log price = constant + log floor area + age (quadratic) + time to nearest station + time to Tokyo central station (quadratic) + ward

Note: ward is a location dummy of which there are 23

Estimate hedonic model for all apartments and for new apartments (defined as less than three years old)

Figure 3 : Price Indices for Apartments in Tokyo (1986Q1=1)

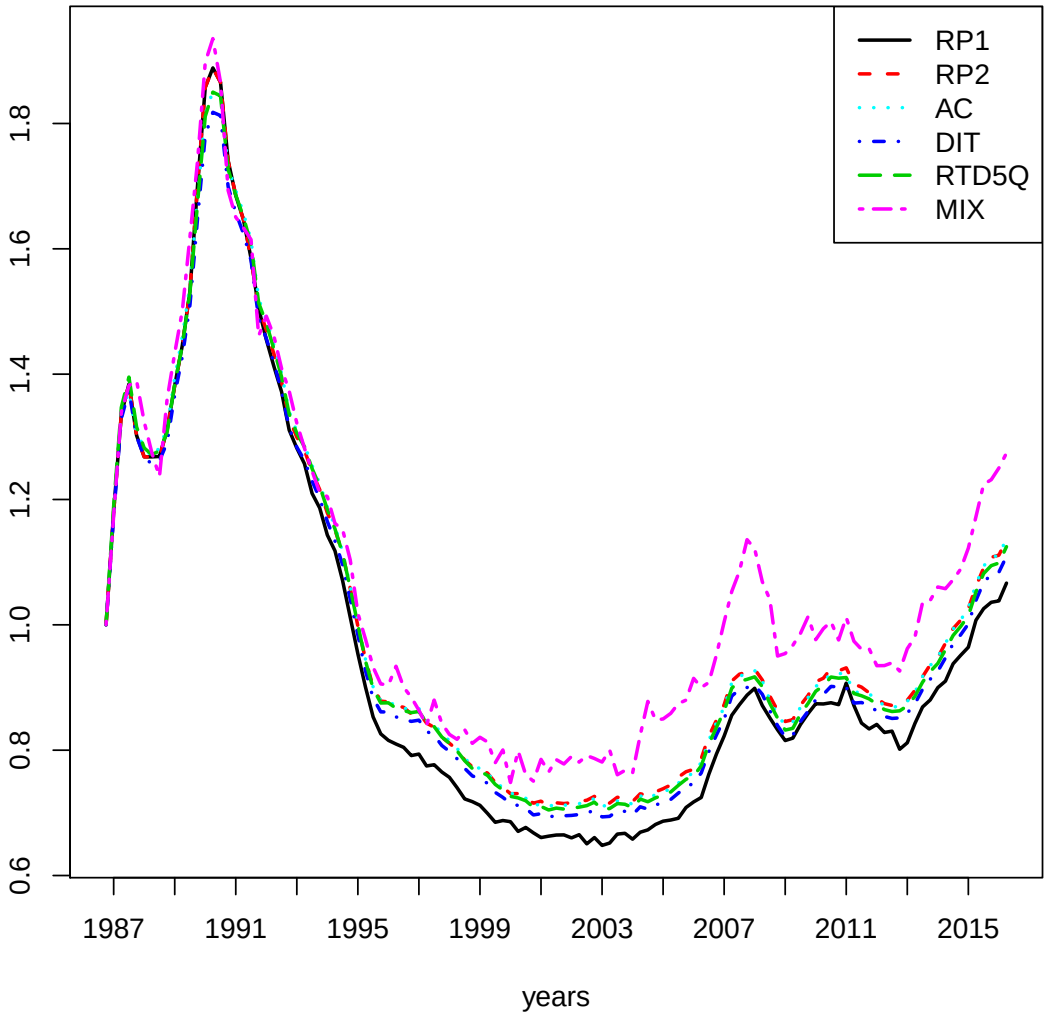

Table 3 : Price Indices for Apartments in Tokyo (1986Q4=1)

	RP1	RP1 (lin)	RP2	AC	DIL	DIP	DIT	RTD2Q	RTD4Q	RTD5Q	MIX
1986Q4	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2015Q1	0.850	0.964	1.026	1.027	0.980	1.024	1.002	1.002	1.016	1.014	1.122
2015Q2	0.895	1.007	1.061	1.065	1.017	1.062	1.039	1.039	1.054	1.053	1.173
2015Q3	0.908	1.026	1.091	1.094	1.044	1.092	1.068	1.068	1.083	1.082	1.224
2015Q4	0.918	1.036	1.108	1.107	1.057	1.104	1.080	1.081	1.096	1.094	1.232
2016Q1	0.924	1.038	1.111	1.111	1.060	1.108	1.084	1.084	1.100	1.099	1.250
2016Q2	0.947	1.067	1.136	1.138	1.085	1.134	1.109	1.110	1.125	1.125	1.274

We have most confidence in RTD4Q and RTD5Q (i.e., prices rose by about 12 percent).

Here we have on average slightly less than 2 000 observations per quarter.

DIT and RTD2Q seem to drift slightly for Tokyo.

Figure 4 : Price Indices for New Apartments in Tokyo (1986Q1=1)

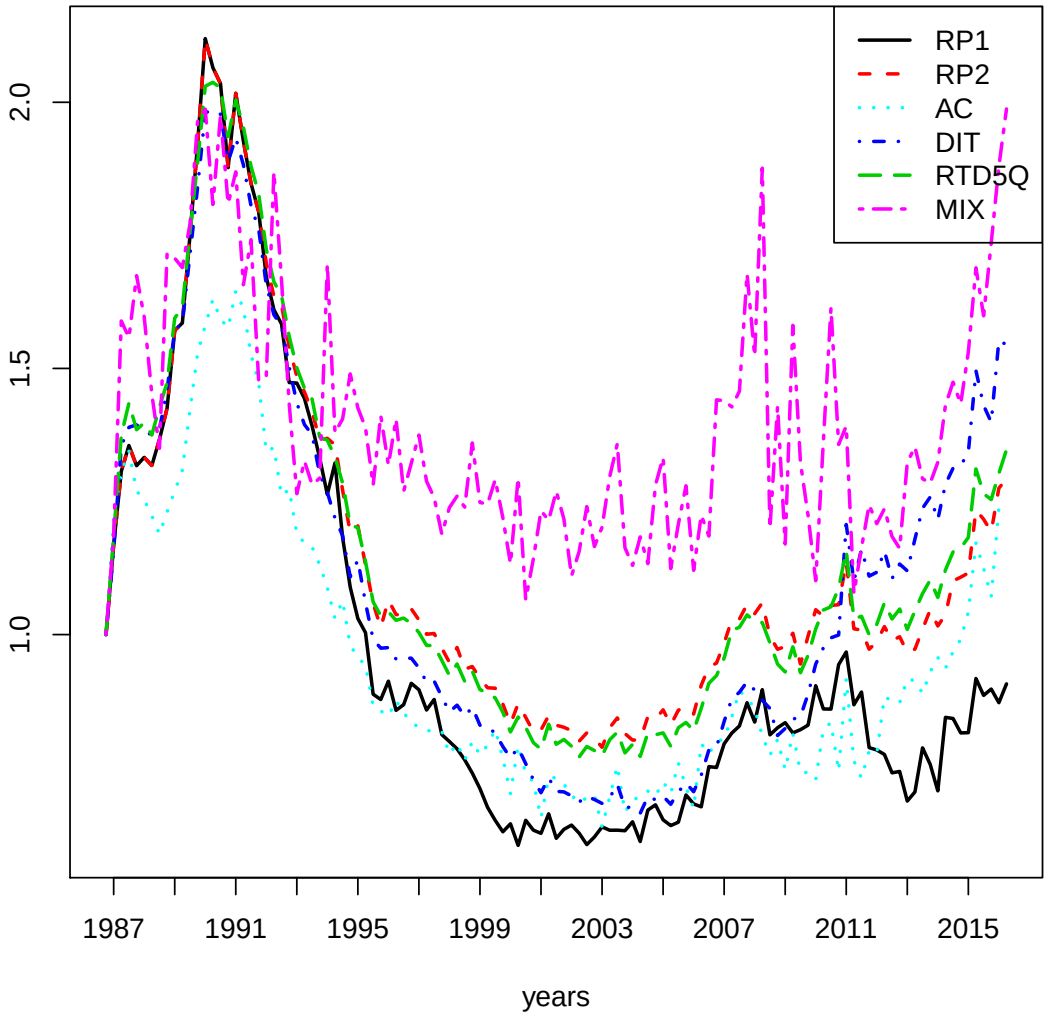

Table 4 : Price Indices for Apartments in Tokyo (1986Q4=1)

	RP1	RP2	AC	DIL	DIP	DIT	RTD2Q	RTD4Q	RTD5Q	MIX
1986Q4	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2014Q3	0.842	1.101	0.968	1.027	1.678	1.313	1.203	1.201	1.155	1.474
2014Q4	0.815	1.108	0.991	1.015	1.710	1.317	1.209	1.209	1.163	1.434
2015Q1	0.816	1.116	1.043	1.023	1.761	1.342	1.225	1.230	1.183	1.531
2015Q2	0.918	1.234	1.172	1.137	1.967	1.496	1.363	1.368	1.311	1.689
2015Q3	0.886	1.217	1.125	1.077	1.900	1.430	1.307	1.319	1.265	1.599
2015Q4	0.898	1.193	1.071	1.045	1.873	1.399	1.280	1.304	1.254	1.736
2016Q1	0.872	1.275	1.238	1.240	1.943	1.553	1.339	1.348	1.303	1.879
2016Q2	0.907	1.292	1.241	1.265	1.886	1.545	1.361	1.379	1.347	1.988

There is drift again in the DIL and DIP results.

We have most confidence here in the RTD results (i.e., prices of new builds rose by about 36 percent).

Conclusion

- The price indices seem to be quite robust to the choice of hedonic method.
- The double imputation Paasche and Lasepyres (DIP and DIL) indices for apartments in Sydney and new builds in Tokyo are subject to drift. Fortunately, no NSIs are using either of these methods.
- The repricing method does not perform that badly, even when the same reference shadow prices are used for many years. But there is a slight downward bias.
- Using repricing is risky. For example, the quadratic terms in the functional form for Tokyo cause problems. The functional form should be kept simple when repricing is used.

- We recommend NSIs using repricing switch to average characteristics, DIT, or RTD, or at least update the reference repricing shadow prices every five years.
- Where possible mix-adjusted indices should be avoided. In both our data sets, the mix-adjusted indices are somewhat erratic and rise faster than the hedonic indices.
- It is much more difficult to construct a quality-adjusted price index for new builds. RTD4Q or RTD5Q are recommended when there is a shortage of data points.
- For the HPI we recommend not splitting new and existing dwellings. It is better to combine them in the same hedonic model.
- Houses and apartments should be estimated using separate hedonic models, and then combined using the standard Eurostat method for combining strata.