Comparison of Hedonic Indices Compiled using Different Types of Weights

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1. Summary / Conclusion

I did this paper on the issue what type of weights should be used for the hedonic regression, being stimulated by Diewert's paper (2003) presented in this meeting. I recompiled chained hedonic indices using expenditure weights and the same formula with Okamoto and Sato (2001) in order to compare with those of quantity weights. In addition, the index compilation using intermediate types of weights is also studied for the Box-Cox test. Conclusions drawn from this empirical study basically corresponds to three suggestions made by Diewert (2003), however there seem points to be noticed in practice as follows:

- From the point of view of the index number theory, expenditure weights are seemingly preferable if the log of the model price is used as the dependent variable. In the case of PCs or digital still cameras, hedonic index compiled using quantity weights does not much differ from that of expenditure weights, while both indices substantially differ from each other in the case of color TVs.

  These results imply that the quantity-weighted or un-weighted hedonic regression may yields price indices sufficiently close to the expenditure-weighted hedonic regression but it should be carefully considered whether price change tend to differ remarkably depending on characteristics and what causes the differences if exists. In the case of color TVs, indices derived from the quantity-weighted and expenditure-weighted hedonic regression do not differ so much if excluding wide-screen models. There is some doubt whether index is really appropriate if including wide-screen models, especially when the expenditure-weighted hedonic regression is applied. In case both indices are substantially different, it should be inquired if a particular reason has effect on the indices, not simply choose the expenditure-weighted hedonic regression. It also should be noted that probably the issue arising in the study of color TVs is not peculiar to the hedonic method in essentials.

- The Box-Cox test was applied to the hedonic regression using intermediate weights and the Box-Cox transformation of the model price as the dependent variable. The test results indicate model price should be log-transformed in all three cases – i.e. PCs, color TVs and digital still cameras.

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[1] The opinions expressed in this paper are those of the author and do not represent official views of either Statistics Bureau, MPHPT, or National Statistics Center IAI.

- The dummy variable adjacent period regression technique (named “two-months method” in this paper) and separate hedonic regression for each of the comparison periods (named “single-month method” in this paper) yield indices close to each other if the log of model price is used as the dependent variable while they yield significantly different indices if model price is not transformed. Probably, single-month method is better when a sufficient number of model prices are available but no significant problem has been found so far about two-months method if the log of model prices is used as the dependent variable.

2. Formula used

2.1 Single-month method, semi-log regression model

(weighted) hedonic regression : $\log p_{t-1} \sim \sum_i \beta_{i,t-1} x_{i,t-1}, \quad \log p_t \sim \sum_i \beta_{i,t} x_{i,t}$

index calculation :

$$\log \hat{I}_{t/t-1} = \sum_i \beta_{i,t}\bar{x}_{i,t-1} - \sum_i \beta_{i,t-1}\bar{x}_{i,t-1}, \quad \log \tilde{I}_{t/t-1} = \sum_i \beta_{i,t}\bar{x}_{i,t} - \sum_i \beta_{i,t-1}\bar{x}_{i,t}$$

$$I_{t/t-1} = \sqrt{\hat{I}_{t/t-1}\tilde{I}_{t/t-1}}$$

$$S_{T/0} = \prod_t I_{t/t-1}$$

where

$\bar{x}_{i,t-1}$: weighted average of charactersitic i in month $t-1$

$\bar{x}_{i,t}$: weighted average of charactersitic i in month t

2.2 Two-month method, semi-log regression model

(weighted) hedonic regression : $\log p_{t \text{ or } t-1} \sim \alpha_{t/t-1}\delta_{t/t-1} + \sum_i \beta_{i,t/t-1} x_{i,t \text{ or } t-1}$

index calculation :

$$I_{t/t-1} = \exp \alpha_{t/t-1}$$

$$D_{T/0} = \prod_t I_{t/t-1}$$

where

$\delta_{t/t-1}$: 0 (period $t-1$), 1 (peirod t)

2.3 Single-month method, non-log regression model

(weighted) hedonic regression : $p_{t-1} \sim \sum_i \beta_{i,t-1} x_{i,t-1}, \quad p_t \sim \sum_i \beta_{i,t} x_{i,t}$

index calculation :

$$\hat{I}_{t/t-1} = \sum_i \beta_{i,t}\bar{x}_{i,t-1} \Big/ \sum_i \beta_{i,t-1}\bar{x}_{i,t-1}, \quad \tilde{I}_{t/t-1} = \sum_i \beta_{i,t}\bar{x}_{i,t} \Big/ \sum_i \beta_{i,t-1}\bar{x}_{i,t}$$

$$I_{t/t-1} = \sqrt{\hat{I}_{t/t-1}\tilde{I}_{t/t-1}}$$

$$S'_{T/0} = \prod_t I_{t/t-1}$$

2.4 Two-month method, non-log regression model

$$\text{(weighted) hedonic regression}: p_{t \text{ or } t-1} \sim \exp[\alpha_{t/t-1}\delta_{t/t-1}]\left(\sum_i \beta_{i,t/t-1} x_{i,t \text{ or } t-1}\right)$$

index calculation :

$$I_{t/t-1} = \exp \alpha_{t/t-1}$$
$$D'_{T/0} = \prod_t I_{t/t-1}$$

As for formula 2.1 – 2.4, hedonic regressions are performed using expenditure weights (= *pq*) or quantity weights (= *q*). An intermediate type of weights (= $p^{1-\lambda}q$) is used for the following formula 2.5.

2.5 Single-month method, (modified) Box-Cox model

$$\text{(weighted) hedonic regression}: \frac{p_{t-1}^{\lambda t-1}}{\lambda_{t-1}} \sim \sum_i \beta_{i,t-1} x_{i,t-1} \quad \cdots\cdots \quad (*)$$

$$\frac{p_t^{\lambda t}}{\lambda_t} \sim \sum_i \beta_{i,t} x_{i,t} \quad \cdots\cdots \quad (**)$$

$$\frac{p_{t-1}^{\lambda t}}{\lambda_t} \sim \sum_i \beta'_{i,t-1} x_{i,t-1}, \quad \frac{p_t^{\lambda t-1}}{\lambda_{t-1}} \sim \sum_i \beta'_{i,t} x_{i,t}$$

index calculation :

$$\hat{I}_{t/t-1} = \left(\sum_i \beta'_{i,t}\bar{x}_{i,t-1} \Big/ \sum_i \beta_{i,t-1}\bar{x}_{i,t-1}\right)^{1/\lambda t-1}, \quad \vec{I}_{t/t-1} = \left(\sum_i \beta'_{i,t}\vec{x}_{i,t} \Big/ \sum_i \beta_{i,t-1}\vec{x}_{i,t}\right)^{1/\lambda t-1}$$

$$\tilde{I}_{t/t-1} = \left(\sum_i \beta_{i,t}\bar{x}_{i,t} \Big/ \sum_i \beta'_{i,t-1}\bar{x}_{i,t}\right)^{1/\lambda t}, \quad \overleftarrow{I}_{t/t-1} = \left(\sum_i \beta_{i,t}\bar{x}_{i,t-1} \Big/ \sum_i \beta'_{i,t-1}\bar{x}_{i,t-1}\right)^{1/\lambda t}$$

$$I_{t/t-1} = \sqrt{\sqrt{\hat{I}_{t/t-1}\vec{I}_{t/t-1}}\sqrt{\tilde{I}_{t/t-1}\overleftarrow{I}_{t/t-1}}}$$

$$B_{T/0} = \prod_t I_{t/t-1}$$

where

$\bar{x}_{i,t}$: average of $x_{i,t}$ with weights $\{p_i^{1-\lambda t} q_i\}$

$\vec{x}_{i,t}$: average of $x_{i,t}$ with weights $\{p_i^{1-\lambda t-1} q_i\}$

$\bar{x}_{i,t-1}$: average of $x_{i,t-1}$ with weights $\{p_{i-1}^{1-\lambda t} q_{i-1}\}$

$$\lambda_{t-1} = \inf_{0<\lambda\le 1}\left[(1-\lambda)\log \bar{p}_{t-1} + \frac{1}{2}\log \hat{\sigma}^2_{\lambda,t-1} - \frac{1}{2}\log \bar{s}_{\lambda,t-1}\right]$$

$$\lambda_t = \inf_{0<\lambda\le 1}\left[(1-\lambda)\log \bar{p}_t + \frac{1}{2}\log \hat{\sigma}^2_{\lambda,t} - \frac{1}{2}\log \bar{s}_{\lambda,t}\right]$$

$\bar{p}_{t-1}, \bar{p}_t$: simple geometric mean of model prices

$\bar{s}_{\lambda,t-1}, \bar{s}_{\lambda,t}$: simple geometric mean of share in weights $\left(= p_\bullet^{1-\lambda} q_\bullet \Big/ \sum p_\bullet^{1-\lambda} q_\bullet\right)$

$\hat{\sigma}^2_{\lambda,t-1}, \hat{\sigma}^2_{\lambda,t}$: estimate of residual variance of regression (*), (**) respectively when λ is given

The intermediate type of weights ($=p^{1-\lambda}q$) seems to be appropriate for the (modified) Box-Cox model mentioned above, taking the following superlative index into consideration.

$$\sqrt{\left[\frac{\sum s_0 I_t^{\lambda}}{\sum s_0}\right]^{1/\lambda}\left[\frac{\sum s_t}{\sum \frac{s_t}{I_t^{\lambda}}}\right]^{1/\lambda}} = \sqrt{\left[\frac{\sum \left(p_0^{1-\lambda}q_0\right)p_t^{\lambda}}{\sum \left(p_0^{1-\lambda}q_0\right)p_0^{\lambda}}\right]^{1/\lambda}\left[\frac{\sum \left(p_t^{1-\lambda}q_t\right)p_t^{\lambda}}{\sum \left(p_t^{1-\lambda}q_t\right)p_0^{\lambda}}\right]^{1/\lambda}}$$

3. Results

Chained hedonic indices are presented in the following Chart 1, Table 1 – 2 and Table A1 – A3 in the appendix.

Chained hedonic indices derived from the "expenditure-weighted semi-log hedonic regression – single month method" are close to the corresponding indices derived from the "quantity-weighted non-log hedonic regression – single month method" as expected in the case of PCs and color TVs (see in Table 1 below, Chart 1 and Table A1 – A2). In the case of digital still cameras, difference between the two indices seems relatively large (see in Table 1 below and Table A3). Although the exact reason is not yet found at present (maybe, some explanatory variables such as pixels and zoom should be appropriately transformed), it may be natural that the difference of the two indices become relatively large since the Box-Cox test shows the appropriate λ is always almost zero as shown in Table A3.

Table 1: Chained hedonic indices compiled using different types of weights

		expenditure Weights		quantity weights			intermediate weights
		semi-log		semi-log		non-log	Box-Cox
		two-months	single-Month	two-months	Single-Month	single-month	single-month
	(Jan. 1995 = 1.00)						
PCs	Jun. 1999	0.07560	0.07213	0.07116	0.06879	0.07276	0.07233
Color TVs	Jun. 1999	0.54641	0.54592	0.61929	0.61913	0.53697	0.55495
	(Jan. 2000 = 1.00)						
Digital Cameras	Dec. 2001	0.61140	0.60934	0.62504	0.62543	0.63477	0.60909

Chained hedonic indices derived from the "quantity-weighted semi-log hedonic regression – single month" are relatively close to "expenditure-weighted semi-log hedonic regression – single month method" in the case of PCs and digital still cameras. However, the two indices substantially differ from each other in the case of color TVs (see Table 1 above, Chart 1 and Table A2). This is mainly due to remarkably different price changes of wide-screen models. If excluding wide-screen models from the hedonic regression and the index compilation, the two indices become relatively close to each other (see Table 2 below and Table A2s). Okamoto and Sato (2001) showed the share of wide-screen models in sales has shrunk, whereas prices of wide-screen models tend to fall down much faster than the basic models (see Chart 2 – 3). "Wide screen" may be a relatively long-lasting but essentially a temporary "boom".

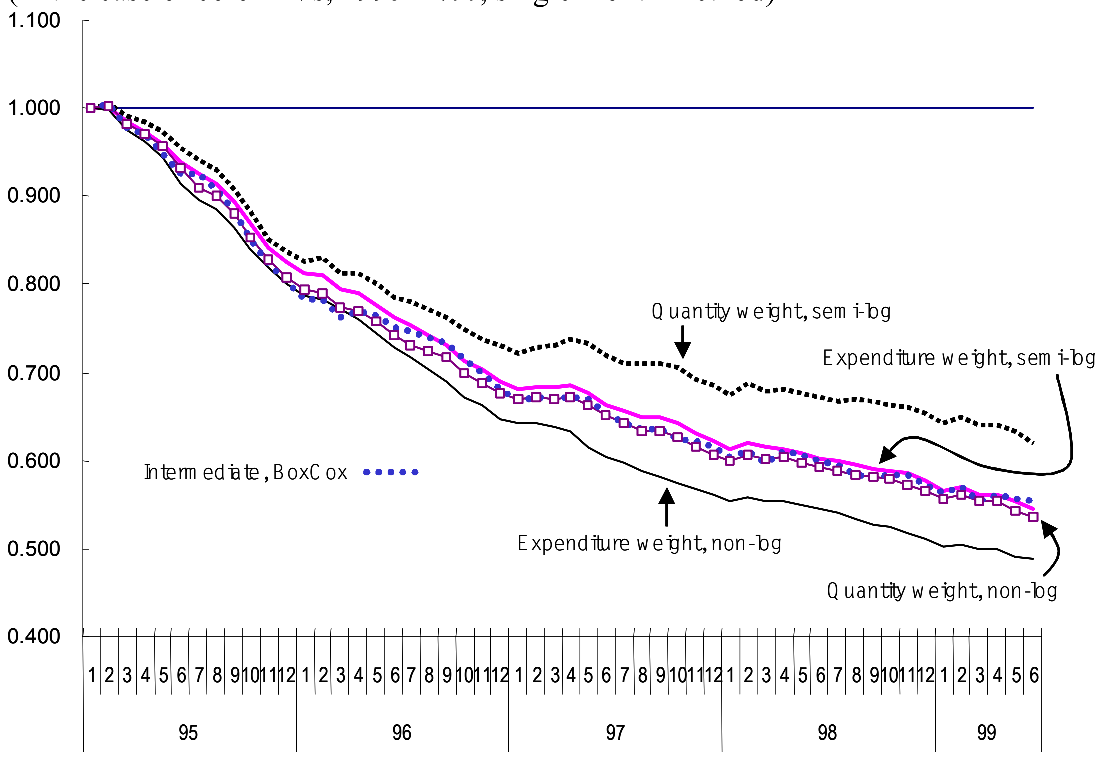
Mysteriously, it took long time for TV sellers to notice consumers do not value “wide screen” in reality. I guess there are certain grounds for a negative view about inclusion of wide-screen models in the hedonic regression and the index compilation.

Table 2: Chained hedonic indices compiled using different types of weights
(in the case of color TVs, excluding wide-screen models)

		expenditure weights		quantity weights	
		semi-log		semi-log	
		two-months	single-month	two-months	single-month
	(Jan. 1995 = 1.00)				
color TVs	Jun. 1999	0.67162	0.67379	0.68209	0.68226

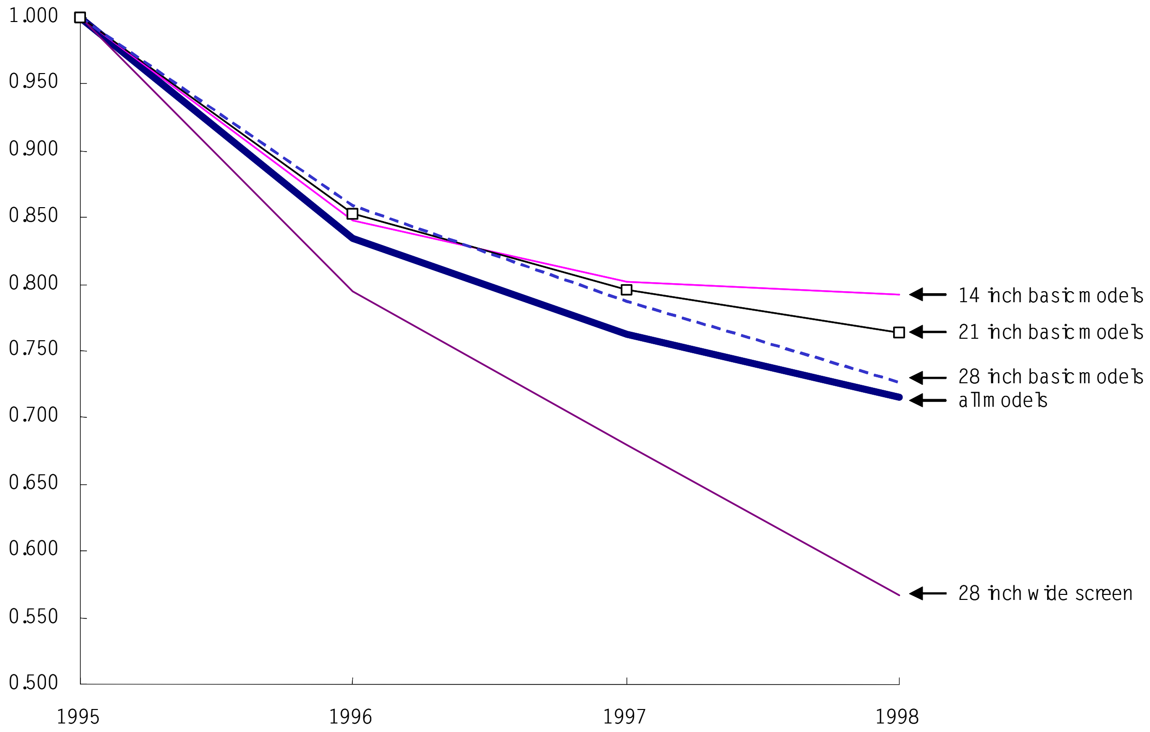
In all three categories, the Box-Cox test shows the appropriate λ is closer to zero rather than one. Chained hedonic indices derived from the hedonic regression using intermediate weights and the appropriate Box-Cox transformation of model prices (“(modified) Box-Cox model – single month method”) are close to the corresponding indices derived from the “expenditure-weighted semi-log hedonic regression – single month method” (see Table 1, Chart 1 and Table A1 – A3). Thus, semi-log regression model is probably preferable. Further study is required to obtain the appropriate transformation of some explanatory variables.

Chart 1: Chained hedonic indices compiled using different types of weights
(in the case of color TVs, 1995=1.00, single month method)



Similar to the quantity-weighted semi-log hedonic regression, the “expenditure-weighted semi-log hedonic regression – two-months method” yields indices close to the corresponding indices obtained from the "expenditure-weighted semi-log hedonic regression – single-month method" in all three categories, while the "quantity-weighted non-log hedonic regression – two-months method" yields indices significantly different from the corresponding indices obtained from the "quantity-weighted non-log hedonic regression – single-month method" (see Table 1 and Table A1 – A3). No specific problem has been found so far about two-month method if the log of model price is used as the dependent variable.

Chart 2: Price indices for the specific types of color TVs estimated from the hedonic regressions



Note. The above chart is drawn using the relevant figures in Table. 8. of Okamoto and Sato (2001)

Chart 3-1: Wide screen TVs, share in the total sales by size

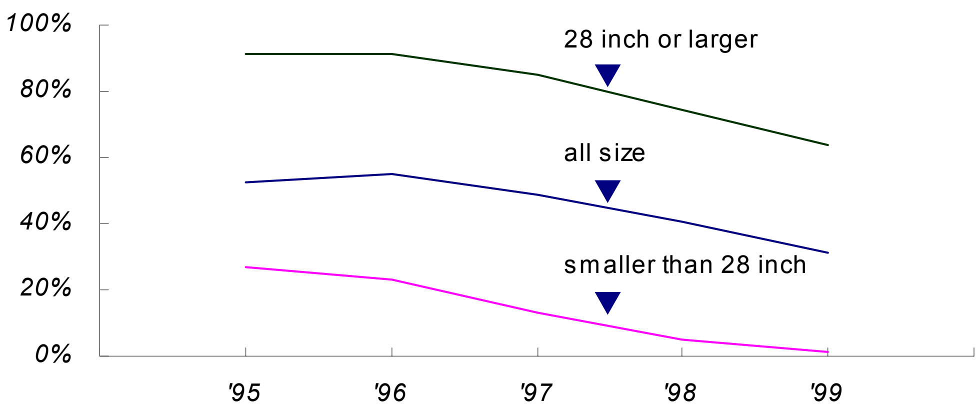
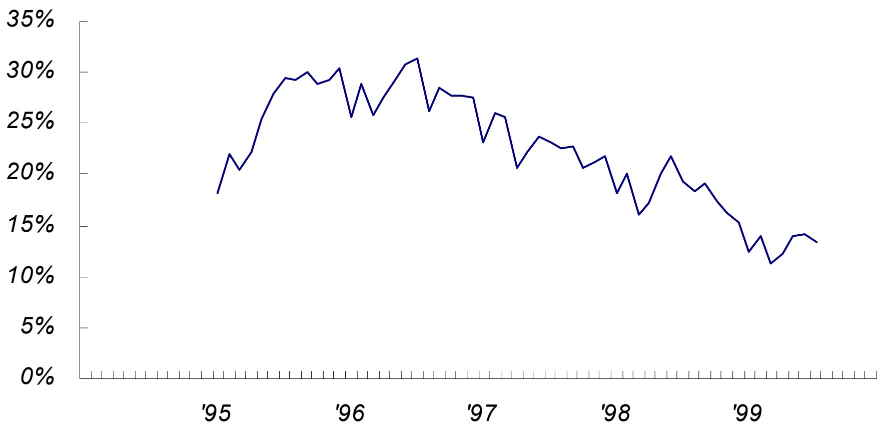


Chart 3-2: Wide screen TVs, share in the total number of units sold



Note. Charts 3-1, 3-2 corresponds to Chart.9-1., 9-2. of Okamoto and Sato (2001) respectively.

References

Diewert, W. E. (2003), "Hedonic Regressions: A Review of Some Unresolved Issues", the 7th Meeting of the International Working Group (Ottawa Group), Paris, May 27-29, 2003.

Okamoto, M. and Sato, T. (2000), "Comparison of Hedonic Method and Matched Models Method using Scanner Data: The Case of PCs, color TVs and Digital Cameras", the 6th Meeting of the International Working Group (Ottawa Group), Canberra, April 2-6, 2001.

Appendix

Table A1: Chained hedonic indices compiled using different types of weights (in the case of PCs, Jan. 1995 = 1.00)

		expenditure weight			quantity weight				intermediate weight		
		semi-log		non-log	semi-log		non-log		Box-Cox*	Box-Cox	
		two-months	single-month	single-month	two-months	single-month	two-months	single-month	single-month	single-month	λ
95	1	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	0.215
	2	0.91303	0.91282	0.92409	0.90639	0.90849	0.92797	0.92268	0.91727	0.91539	0.389
	3	0.87544	0.87497	0.88327	0.87390	0.87570	0.89148	0.88425	0.87925	0.87746	0.153
	4	0.85986	0.85953	0.85947	0.85992	0.86180	0.87072	0.86364	0.86101	0.86115	0.134
	5	0.83132	0.83033	0.82857	0.83439	0.83535	0.84101	0.83541	0.83251	0.83211	0.100
	6	0.73739	0.72776	0.72244	0.74151	0.73649	0.74969	0.73429	0.73046	0.72938	0.051
	7	0.68188	0.67170	0.66644	0.68538	0.67956	0.70101	0.67959	0.67476	0.67331	0.246
	8	0.64646	0.63662	0.64166	0.64371	0.63755	0.67566	0.65036	0.64243	0.63957	0.260
	9	0.59883	0.58994	0.59924	0.58714	0.58179	0.62922	0.60163	0.59411	0.59208	0.119
	10	0.54162	0.53355	0.54369	0.52625	0.52171	0.57341	0.54271	0.53636	0.53529	0.074
	11	0.48522	0.47480	0.48349	0.47299	0.46655	0.51443	0.48892	0.47967	0.47750	0.446
	12	0.45952	0.44985	0.45803	0.44296	0.43647	0.49006	0.46146	0.45319	0.45133	0.373
96	1	0.44877	0.43937	0.44657	0.43231	0.42602	0.47712	0.44946	0.44201	0.44043	0.244
	2	0.42022	0.41133	0.41858	0.40317	0.39725	0.44831	0.42148	0.41396	0.41234	0.129
	3	0.40895	0.40023	0.40800	0.39082	0.38516	0.43968	0.41106	0.40297	0.40122	0.156
	4	0.40271	0.39443	0.39958	0.38647	0.38146	0.43168	0.40232	0.39608	0.39527	0.009
	5	0.39395	0.38586	0.39102	0.37864	0.37377	0.42307	0.39323	0.38742	0.38668	0.001
	6	0.36970	0.36183	0.36563	0.35444	0.34979	0.39711	0.36900	0.36324	0.36250	0.001
	7	0.35675	0.34928	0.35151	0.34261	0.33848	0.38326	0.35536	0.35028	0.35000	0.001
	8	0.34643	0.33918	0.34128	0.33237	0.32844	0.37224	0.34478	0.34000	0.33990	0.001
	9	0.33115	0.32420	0.32791	0.31677	0.31300	0.35744	0.33050	0.32545	0.32490	0.001
	10	0.31640	0.30935	0.31087	0.30400	0.30011	0.33966	0.31449	0.31013	0.31010	0.001
	11	0.29298	0.28677	0.28658	0.28094	0.27753	0.31211	0.28977	0.28655	0.28738	0.001
	12	0.27682	0.27095	0.27049	0.26494	0.26175	0.29578	0.27341	0.27048	0.27138	0.001
97	1	0.26459	0.25941	0.25932	0.25230	0.24962	0.28330	0.26119	0.25866	0.25983	0.001
	2	0.25271	0.24839	0.24709	0.24154	0.23952	0.27060	0.24914	0.24722	0.24898	0.001
	3	0.24219	0.23817	0.23572	0.23193	0.23014	0.25928	0.23851	0.23680	0.23867	0.001
	4	0.23737	0.23351	0.23014	0.22772	0.22608	0.25387	0.23291	0.23174	0.23403	0.001
	5	0.23216	0.22846	0.22481	0.22306	0.22151	0.24867	0.22803	0.22679	0.22889	0.001
	6	0.22268	0.21916	0.21584	0.21395	0.21248	0.23958	0.21940	0.21786	0.21958	0.001
	7	0.21439	0.21100	0.20776	0.20602	0.20459	0.23086	0.21122	0.20974	0.21140	0.001
	8	0.20665	0.20338	0.20025	0.19860	0.19722	0.22260	0.20354	0.20215	0.20377	0.001
	9	0.19762	0.19445	0.19221	0.18950	0.18812	0.21355	0.19492	0.19344	0.19481	0.001
	10	0.18486	0.18190	0.17810	0.17828	0.17707	0.19879	0.18146	0.18057	0.18218	0.001
	11	0.17633	0.17309	0.16895	0.16989	0.16849	0.18971	0.17247	0.17168	0.17343	0.001
	12	0.16800	0.16498	0.16060	0.16222	0.16094	0.18097	0.16441	0.16362	0.16534	0.001
98	1	0.16185	0.15893	0.15475	0.15603	0.15480	0.17453	0.15820	0.15752	0.15926	0.001
	2	0.15468	0.15143	0.14725	0.14924	0.14779	0.16661	0.15094	0.15017	0.15178	0.001
	3	0.14961	0.14648	0.14208	0.14438	0.14298	0.16128	0.14592	0.14520	0.14674	0.001
	4	0.14759	0.14450	0.13985	0.14257	0.14119	0.15900	0.14384	0.14318	0.14476	0.001
	5	0.14104	0.13806	0.13356	0.13600	0.13466	0.15185	0.13737	0.13676	0.13837	0.001
	6	0.12725	0.12292	0.12027	0.12202	0.11949	0.13866	0.12389	0.12254	0.12325	0.107
	7	0.11936	0.11527	0.11254	0.11449	0.11211	0.13027	0.11608	0.11485	0.11561	0.001
	8	0.11618	0.11207	0.10904	0.11148	0.10898	0.12696	0.11266	0.11156	0.11237	0.001
	9	0.11424	0.11019	0.10744	0.10944	0.10697	0.12514	0.11077	0.10972	0.11046	0.001
	10	0.10893	0.10504	0.10227	0.10445	0.10206	0.11923	0.10557	0.10457	0.10527	0.001
	11	0.10134	0.09771	0.09444	0.09705	0.09501	0.11130	0.09818	0.09720	0.09800	0.001
	12	0.09943	0.09586	0.09247	0.09531	0.09329	0.10933	0.09635	0.09536	0.09608	0.001
99	1	0.09502	0.09158	0.08858	0.09059	0.08861	0.10472	0.09197	0.09106	0.09184	0.001
	2	0.08707	0.08325	0.08111	0.08273	0.08029	0.09679	0.08422	0.08309	0.08345	0.001
	3	0.08590	0.08242	0.08000	0.08160	0.07939	0.09573	0.08316	0.08205	0.08262	0.001
	4	0.08468	0.08119	0.07883	0.08009	0.07780	0.09453	0.08170	0.08071	0.08135	0.288
	5	0.08060	0.07722	0.07494	0.07629	0.07406	0.08990	0.07776	0.07680	0.07740	0.293
	6	0.07560	0.07213	0.07028	0.07116	0.06879	0.08469	0.07276	0.07181	0.07233	0.144

* λ is fixed at 0.5.

Table A2 : Chained hedonic indices compiled using different types of weights (in the case of color TVs, Jan. 1995 = 1.00)

		expenditure weight			quantity weight				intermediate weight		
		semi-log		non-log	semi-log		non-log		Box-Cox*	Box-Cox	
		two-months	single-month	single-month	two-months	single-month	two-months	single-month	single-month	single-month	λ
95	1	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	0.096
	2	0.99946	0.99942	0.99895	1.00444	1.00446	1.00393	1.00214	1.00083	1.00592	0.074
	3	0.98393	0.98395	0.97630	0.99133	0.99133	0.97924	0.98194	0.98286	0.97718	0.106
	4	0.97286	0.97278	0.96182	0.98426	0.98414	0.96390	0.97121	0.97150	0.97110	0.101
	5	0.95896	0.95904	0.94438	0.97396	0.97383	0.94844	0.95715	0.95751	0.94906	0.096
	6	0.93898	0.93963	0.91518	0.95497	0.95497	0.92465	0.93145	0.93446	0.92590	0.081
	7	0.92409	0.92470	0.89561	0.94157	0.94158	0.90348	0.90909	0.91593	0.92592	0.042
	8	0.91393	0.91460	0.88570	0.92949	0.92953	0.89439	0.89974	0.90637	0.90855	0.037
	9	0.89428	0.89481	0.86430	0.90846	0.90842	0.87214	0.87928	0.88635	0.88353	0.028
	10	0.86791	0.86844	0.83942	0.88252	0.88246	0.84422	0.85237	0.85975	0.85025	0.028
	11	0.84179	0.84237	0.81833	0.85139	0.85127	0.82342	0.82795	0.83451	0.82272	0.031
	12	0.82636	0.82692	0.80008	0.83701	0.83688	0.80756	0.80786	0.81663	0.80358	0.008
96	1	0.81081	0.81137	0.78664	0.82655	0.82642	0.78600	0.79401	0.80228	0.78270	0.010
	2	0.80933	0.80993	0.78343	0.82945	0.82937	0.78532	0.78991	0.79979	0.78381	0.001
	3	0.79400	0.79463	0.77107	0.81335	0.81330	0.76952	0.77447	0.78466	0.76280	0.001
	4	0.78787	0.78861	0.76100	0.81148	0.81146	0.76182	0.77031	0.77931	0.76856	0.001
	5	0.77524	0.77588	0.74364	0.80117	0.80052	0.74672	0.75703	0.76611	0.76578	0.001
	6	0.76250	0.76200	0.72765	0.78563	0.78473	0.73360	0.74139	0.75130	0.75035	0.028
	7	0.75429	0.75378	0.71736	0.78239	0.78156	0.72358	0.73179	0.74277	0.74608	0.004
	8	0.74239	0.74153	0.70361	0.77340	0.77248	0.70901	0.72431	0.73307	0.73981	0.001
	9	0.73149	0.73064	0.69082	0.76345	0.76253	0.69740	0.71697	0.72386	0.73392	0.001
	10	0.71385	0.71306	0.67126	0.74928	0.74841	0.67818	0.69945	0.70655	0.71473	0.001
	11	0.70351	0.70279	0.66178	0.73858	0.73771	0.66859	0.68878	0.69606	0.69866	0.020
	12	0.69123	0.69060	0.64769	0.73181	0.73097	0.65366	0.67567	0.68324	0.68071	0.026
97	1	0.68190	0.68130	0.64348	0.72312	0.72232	0.64371	0.66952	0.67576	0.66783	0.010
	2	0.68480	0.68421	0.64263	0.72863	0.72787	0.64647	0.67174	0.67808	0.67128	0.001
	3	0.68462	0.68406	0.63728	0.73180	0.73108	0.64095	0.67002	0.67709	0.66855	0.001
	4	0.68540	0.68489	0.63236	0.73898	0.73827	0.63199	0.67113	0.67783	0.67089	0.001
	5	0.67581	0.67538	0.61592	0.73284	0.73216	0.61990	0.66302	0.66889	0.66928	0.010
	6	0.66341	0.66288	0.60420	0.72012	0.71951	0.60608	0.65127	0.65697	0.65482	0.001
	7	0.65584	0.65526	0.59822	0.71170	0.71108	0.59997	0.64212	0.64888	0.64298	0.001
	8	0.65079	0.65021	0.58783	0.71083	0.71026	0.59058	0.63440	0.64243	0.63541	0.001
	9	0.64916	0.64856	0.58180	0.71191	0.71132	0.58788	0.63294	0.64088	0.63627	0.001
	10	0.64334	0.64276	0.57525	0.70599	0.70541	0.58195	0.62686	0.63504	0.62511	0.025
	11	0.63103	0.63045	0.56672	0.69184	0.69133	0.57644	0.61541	0.62343	0.62183	0.060
	12	0.62320	0.62264	0.56019	0.68540	0.68495	0.57065	0.60689	0.61539	0.61481	0.062
98	1	0.61281	0.61222	0.55394	0.67455	0.67406	0.55966	0.59956	0.60683	0.60353	0.052
	2	0.62133	0.62075	0.55787	0.68756	0.68712	0.56547	0.60699	0.61486	0.61052	0.050
	3	0.61492	0.61438	0.55388	0.67985	0.67946	0.55732	0.60166	0.60919	0.59670	0.021
	4	0.61411	0.61361	0.55354	0.68147	0.68105	0.55862	0.60302	0.60950	0.61014	0.027
	5	0.60826	0.60773	0.54851	0.67702	0.67663	0.55782	0.59738	0.60407	0.60519	0.103
	6	0.60261	0.60213	0.54388	0.67165	0.67128	0.55490	0.59231	0.59906	0.60004	0.130
	7	0.59921	0.59873	0.54054	0.66803	0.66766	0.55147	0.58892	0.59557	0.59378	0.108
	8	0.59529	0.59481	0.53397	0.66891	0.66856	0.54485	0.58458	0.59168	0.58370	0.096
	9	0.59024	0.58948	0.52683	0.66694	0.66654	0.53933	0.58202	0.58782	0.58145	0.113
	10	0.58855	0.58773	0.52388	0.66320	0.66268	0.53693	0.57928	0.58557	0.58457	0.168
	11	0.58600	0.58527	0.51786	0.66084	0.66039	0.53249	0.57313	0.58118	0.58260	0.182
	12	0.57787	0.57720	0.51200	0.65372	0.65343	0.52823	0.56511	0.57336	0.57136	0.153
99	1	0.56616	0.56550	0.50125	0.64212	0.64181	0.51490	0.55576	0.56280	0.56246	0.167
	2	0.57043	0.56977	0.50442	0.65041	0.65021	0.51669	0.56067	0.56759	0.56962	0.122
	3	0.56113	0.56054	0.49956	0.64101	0.64085	0.50804	0.55385	0.55972	0.55409	0.125
	4	0.56109	0.56055	0.50027	0.64002	0.63987	0.50910	0.55410	0.55971	0.56113	0.097
	5	0.55392	0.55341	0.49037	0.63365	0.63351	0.49970	0.54380	0.55094	0.55522	0.034
	6	0.54641	0.54592	0.48828	0.61929	0.61913	0.49737	0.53697	0.54371	0.55495	0.014

* λ is fixed at 0.5.

Table A2s: Chained hedonic indices compiled using different types of weights (in the case of color TVs, excluding wide-screen models, Jan. 1995 = 1.00)

		expenditure weight semi-log		quantity weight semi-log	
		two-months	single-month	two-months	single-month
95	1	1.00000	1.00000	1.00000	1.00000
	2	1.00574	1.00572	1.00707	1.00713
	3	0.99179	0.99177	0.99502	0.99501
	4	0.98392	0.98376	0.98975	0.98953
	5	0.97785	0.97772	0.98267	0.98236
	6	0.96037	0.96021	0.96504	0.96467
	7	0.94823	0.94791	0.95474	0.95435
	8	0.94043	0.94015	0.94386	0.94349
	9	0.92055	0.92023	0.92165	0.92121
	10	0.89761	0.89730	0.89854	0.89814
	11	0.86698	0.86667	0.86426	0.86376
	12	0.85464	0.85432	0.85167	0.85115
96	1	0.84115	0.84085	0.84397	0.84351
	2	0.84680	0.84653	0.85257	0.85214
	3	0.83322	0.83300	0.83682	0.83644
	4	0.83551	0.83525	0.83976	0.83933
	5	0.82726	0.82675	0.83118	0.82982
	6	0.81145	0.81092	0.81272	0.81133
	7	0.80626	0.80574	0.81109	0.80982
	8	0.79993	0.79944	0.80390	0.80263
	9	0.79314	0.79265	0.79493	0.79366
	10	0.77765	0.77714	0.78224	0.78099
	11	0.76750	0.76706	0.77204	0.77079
	12	0.76079	0.76036	0.76863	0.76736
97	1	0.75384	0.75343	0.76205	0.76083
	2	0.76011	0.75973	0.76912	0.76797
	3	0.76573	0.76537	0.77470	0.77359
	4	0.77446	0.77412	0.78604	0.78496
	5	0.77180	0.77149	0.78153	0.78046
	6	0.75991	0.75961	0.76923	0.76819
	7	0.75015	0.74982	0.76004	0.75899
	8	0.74960	0.74928	0.76149	0.76051
	9	0.75295	0.75396	0.76471	0.76417
	10	0.74902	0.74986	0.75912	0.75853
	11	0.73565	0.73648	0.74413	0.74362
	12	0.72664	0.72749	0.73807	0.73764
98	1	0.71617	0.71700	0.72678	0.72632
	2	0.72967	0.73051	0.74267	0.74226
	3	0.72360	0.72449	0.73473	0.73440
	4	0.72607	0.72693	0.73822	0.73782
	5	0.72343	0.72428	0.73502	0.73462
	6	0.71948	0.72035	0.72948	0.72908
	7	0.71768	0.71856	0.72665	0.72624
	8	0.71788	0.71878	0.72973	0.72935
	9	0.71699	0.71789	0.72889	0.72851
	10	0.71892	0.72090	0.72526	0.72501
	11	0.71988	0.72203	0.72445	0.72429
	12	0.70885	0.71102	0.71714	0.71717
99	1	0.69626	0.69839	0.70509	0.70509
	2	0.70490	0.70706	0.71613	0.71625
	3	0.69558	0.69772	0.70696	0.70712
	4	0.69603	0.69825	0.70656	0.70674
	5	0.68759	0.68982	0.70039	0.70059
	6	0.67162	0.67379	0.68209	0.68226

Table A3: Chained hedonic indices compiled using different types of weights (in the case of digital cameras, Jan. 1995 = 1.00)

		expenditure weight			quantity weight				intermediate weight		
		semi-log		non-log	semi-log		non-log		Box-Cox*	Box-Cox	
		two-months	single-month	single-month	two-months	single-month	two-months	single-month	single-month	single-month	λ
00	1	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	0.001
	2	0.97448	0.97434	0.97378	0.97243	0.97231	0.97717	0.98046	0.97737	0.97376	0.001
	3	0.92672	0.92432	0.94919	0.93415	0.93470	0.95484	0.95443	0.93988	0.92421	0.001
	4	0.90835	0.90622	0.93712	0.91838	0.91899	0.94433	0.94321	0.92499	0.90548	0.001
	5	0.89318	0.89099	0.91597	0.90809	0.90871	0.92185	0.92339	0.90730	0.89064	0.001
	6	0.86411	0.86233	0.88827	0.88349	0.88412	0.89456	0.89772	0.88030	0.86211	0.001
	7	0.87019	0.86937	0.88665	0.89094	0.89210	0.89281	0.89792	0.88451	0.86944	0.001
	8	0.87049	0.86973	0.88650	0.88741	0.88857	0.89300	0.89619	0.88397	0.86968	0.001
	9	0.84062	0.83979	0.84965	0.86025	0.86132	0.85413	0.86275	0.85206	0.83937	0.001
	10	0.81273	0.81162	0.83579	0.83290	0.83406	0.83282	0.84203	0.82743	0.81170	0.001
	11	0.78466	0.78367	0.80891	0.81405	0.81547	0.80705	0.81927	0.80184	0.78340	0.001
	12	0.77121	0.77031	0.79023	0.80345	0.80501	0.78919	0.80438	0.78780	0.76979	0.001
01	1	0.75725	0.75637	0.77812	0.78903	0.79056	0.77439	0.78934	0.77335	0.75591	0.001
	2	0.73495	0.73410	0.75926	0.76351	0.76499	0.75446	0.76477	0.75011	0.73370	0.001
	3	0.70955	0.70873	0.74484	0.72357	0.72496	0.72937	0.73157	0.72142	0.70813	0.001
	4	0.70399	0.70217	0.73049	0.72326	0.72384	0.72474	0.73068	0.71675	0.70159	0.001
	5	0.69440	0.69174	0.72275	0.71409	0.71461	0.71852	0.72027	0.70689	0.69134	0.001
	6	0.68386	0.68109	0.71793	0.69833	0.69883	0.71644	0.71091	0.69740	0.68056	0.001
	7	0.68605	0.68341	0.71325	0.70661	0.70710	0.71376	0.71174	0.69914	0.68340	0.001
	8	0.69028	0.68760	0.71270	0.71328	0.71376	0.71606	0.71638	0.70344	0.68734	0.001
	9	0.66627	0.66368	0.69267	0.68009	0.68056	0.69524	0.68990	0.67848	0.66327	0.001
	10	0.64242	0.63985	0.67111	0.65751	0.65788	0.67870	0.66985	0.65632	0.63991	0.001
	11	0.62835	0.62584	0.65799	0.64240	0.64275	0.66461	0.65405	0.64121	0.62572	0.001
	12	0.61140	0.60934	0.64984	0.62504	0.62543	0.65290	0.63477	0.62307	0.60909	0.001

* λ is fixed at 0.5.