COMPARISON OF HEDONIC METHOD AND MATCHED MODELS METHOD USING SCANNER DATA:
THE CASE OF PCs, TVs AND DIGITAL CAMERAS

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In this paper, price indexes measured by the matched models method – month-to-month chaining of average price relatives to the previous month among items sold in the previous month and the observation month both – are compared with hedonic indexes using scanner data for PCs, color television sets and digital (still) cameras[1)] for the purpose of clarifying appropriate methodologies of quality adjustment and elementary index compilation for prices of electric appliances.

Methodology

We use formula (15) – (19) for compiling five kinds of chained indexes using the matched models method while we apply three kinds of chained hedonic indexes. One of the three hedonic methods ('the two-period method') is to apply a regression model containing an indicator d_{t+1} for the later period to the data for two consecutive periods in order to estimate the average price change between the two periods from the indicator coefficient β_t, and chain them up to obtain a chained hedonic index as shown in (1) and (2). The second one ('the single-period method') is to apply a regression model to the data for each period, and estimate the geometric mean of the price relative for the average specification in the former period and that of the later period using the two sets of estimated regression parameters for both periods, and chain them up to obtain a chained hedonic index as shown in (3) – (10). The rest one ('the two-period method with an indicator for new models') is to split an indicator for the later period into two indicators - an indicator e_{t+1} for new models not sold in the former period and an indicator d_{t+1} for the existed models sold in the former period in order to estimate effects of introduction of new models explicitly as shown in (11) and (12). Another difference of 'the two-period method with an indicator for new models' from 'the two-period method' is in that the existed models not sold in the later month are excluded from regression analysis (See Moreau (1996)).

Each item is assigned a weight proportionate to a number of units sold in the relevant period when hedonic regressions are performed. Monthly, quarterly and yearly period are chosen for 'the two-period method' for the purpose of examining effects of period taken. Only monthly period is chosen for the other two methods. All chained indexes calculated as mentioned above are re-based on 1995 annual average.

In the case of PCs, generation indicators for duration from the first appearance on the market are judged significant on average, and incorporated into the regression models (1), (3) and (11). Needless to say, new PCs are introduced in very short cycle. On the other hand, there are many relatively old items on the market unexpectedly although sales volume of each old item is very small. An maker's indicator for items produced by Apple is also incorporated into the regression models (1), (3) and (11). Indicators for other makers are judged not significant stably. Test calculations showed the regression models containing all makers' indicators yield almost the same results with the simpler regression models with an Apple's indicator only. Some features such as built-in CD-ROM drive and pre-installed software, which are supposed to have effect on prices of products to some extent, are excluded from hedonic regression models because test calculations indicate their contribution to price level tends to be insignificant or very week.

In the case of TVs, generation indicators for duration from the first appearance on the market are judged insignificant. All makers' indicators are incorporated into regression models (1), (3) and (11). Although it may be better to categorize TV makers according to their ratings, an indicator is assigned to each individual maker in this paper. One of the reasons is that their ratings possibly have changed recently.

[1)] We used aggregated data provided by GfK Japan. This company collects scanner data from many volume sellers of electric appliances in Japan, and aggregates them by item. In many cases, essentially the same goods, usually different only in color, have different JAN article numbers, which correspond to EAN. Those goods are categorized into a same item in the aggregated data available to us.

As for digital cameras, we only use free sample data for test use, in which a number of models and duration of the observation are limited, we apply a fixed hedonic regression model containing indicators assigned to the observation periods one-to-one ('the single-regression method') to the whole sample data as shown in (13) instead of chained hedonic indexes mentioned above.

- The two-period method

$$\ln(p_t \text{ or } p_{t+1}) = \alpha_t + \beta_t d_{t+1} + \sum_k \chi_{t,k} x_k + \varepsilon \quad (1)$$

$$\text{chained hedonic index} = \prod_t \exp \beta_t \quad (2)$$

where

p_t : average unit price of an individual model in the period t

$d_{t+1} = \begin{cases} 1 & \text{in the case of } p_{t+1} \\ 0 & \text{others} \end{cases}$: indicator for the period $t+1$

x_k : variable for characteristic k

$\alpha_t, \beta_t, \chi_{t,k}$: partial regression coefficient

- The single-period method

$$\ln p_t = \alpha_t + \sum_k \chi_{t,k} x_k + \varepsilon \quad (3)$$

Substitute average spec. $\{\bar{x}_{t,k}\}$ in the period t for variab les $\{x_k\}$ in (3).

$$\ln \bar{p}_t = \alpha_t + \sum_k \chi_{t,k} \bar{x}_{t,k} \quad (4)$$

$$\ln \bar{p}_{t+1} = \alpha_{t+1} + \sum_k \chi_{t+1,k} \bar{x}_{t,k} \quad (5)$$

$$\text{chained hedonic index - average spec. in the earlier period } t = \prod_t \frac{\bar{p}_{t+1}}{\bar{p}_t} \quad (6)$$

Substitute average spec. $\{\bar{x}_{t+1,k}\}$ in the period $t+1$ for variables $\{x_k\}$ in (3).

$$\ln \hat{p}_t = \alpha_t + \sum_k \chi_{t,k} \bar{x}_{t+1,k} \quad (7)$$

$$\ln \hat{p}_{t+1} = \alpha_{t+1} + \sum_k \chi_{t+1,k} \bar{x}_{t+1,k} \quad (8)$$

$$\text{chained hedonic index - average spec. in the later period } t+1 = \prod_t \frac{\hat{p}_{t+1}}{\hat{p}_t} \quad (9)$$

$$\text{chained hedonic index - geometric mean of (6) and (9)} = \prod_t \sqrt{\frac{\bar{p}_{t+1}}{\bar{p}_t} \frac{\hat{p}_{t+1}}{\hat{p}_t}} \quad (10)$$

- The two-period method with an indicator for new models

$$\ln\left(p_t \text{ or } p_{t+1}\right) = \alpha_t + \tilde{\beta}_t \tilde{d}_{t+1} + \gamma_t e_{t+1} + \sum_k \chi_{t,k} x_k + \varepsilon \tag{11}$$

$$\text{chained hedonic index} = \prod_t \exp\left(\frac{1+s_{t+1}}{2}\tilde{\beta}_t + \frac{1-s_{t+1}}{2}\gamma_t\right) \tag{12}$$

where

$$\tilde{d}_{t+1} = \begin{cases} 1 & \text{in the case of } p_{t+1} \text{ of an existed model (sold in the period } t \text{ also)} \\ 0 & \text{others} \end{cases} \quad : \text{indicator for the period } t+1$$

$$e_{t+1} = \begin{cases} 1 & \text{in the case of } p_{t+1} \text{ of a model not sold in the period } t \\ 0 & \text{others} \end{cases} \quad : \text{indicator for new models}$$

s_{t+1} : the existed models' share in the total sales in the later period $t+1$

note that p_ts of models not sold in the later period $t+1$ are excluded.

- The single-regression method

$$\ln p_t = \alpha + \sum_{t \neq 0} \beta_t d_t + \sum_k \chi_k x_k + \varepsilon \tag{13}$$

$$\text{hedonic index} = \exp \beta_t \tag{14}$$

where

p_t : average unit price of a model in the period t

$$d_t = \begin{cases} 1 & \text{in the case of } p_t \\ 0 & \text{others} \end{cases} \quad : \text{indicator for the period } t$$

x_k : variable for characteristic k

$\alpha_t, \beta_t, \chi_k$: partial regression coefficient

- Chained indexes using the matched models method

$$\text{chained Laspeyres} = \prod_m L_m = \prod_m \frac{\sum_i q_{m,i}\,p_{m+1,i}}{\sum_i q_{m,i}\,p_{m,i}} = \prod_m \frac{\sum_i w_{m,i}\left(\dfrac{p_{m+1,i}}{p_{m,i}}\right)}{\sum_i w_{m,i}} = \prod_m \sum_i s_{m,i}\left(\frac{p_{m+1,i}}{p_{m,i}}\right) \quad (15)$$

$$\text{chained Paashe} = \prod_m P_m = \prod_m \frac{\sum_i q_{m+1,i}\,p_{m+1,i}}{\sum_i q_{m+1,i}\,p_{m,i}} = \prod_m \frac{\sum_i w_{m+1,i}}{\sum_i \dfrac{w_{m+1,i}}{\left(\dfrac{p_{m+1,i}}{p_{m,i}}\right)}} = \prod_m \frac{1}{\sum_i \dfrac{s_{m+1,i}}{\left(\dfrac{p_{m+1,i}}{p_{m,i}}\right)}} \quad (16)$$

$$\text{chained Fisher} = \prod_m F_m = \prod_m \sqrt{L_m P_m} \quad (17)$$

$$\text{chained geometric - mean} = \prod_m G_m = \prod_m \prod_i \left(\frac{p_{m+1,i}}{p_{m,i}}\right)^{s_{m,i}} \quad (18)$$

$$\text{chained Tornqvist} = \prod_m T_m = \prod_m \prod_i \left(\frac{p_{m+1,i}}{p_{m,i}}\right)^{\frac{s_{m,i}+s_{m+1,i}}{2}} \quad (19)$$

where

$q_{m,i}$: number of units of model i sold in month m,

$p_{m,i}$: average unit price of model i in month m

$w_{m,i} = q_{m,i}\,p_{m,i}$, $s_{m,i} = \dfrac{w_{m,i}}{\sum_i w_{m,i}}$

note that calculation is performed using all models sold in month m and $m+1$.

Results

Part of hedonic regression parameter estimates is presented in Annex 1 and 2 in the case of PCs, in Annex 3 and 4 in the case of color TVs and in Annex 5 in the case of digital cameras.

- PCs

As shown in Chart 2, three kinds of chained hedonic calculations using monthly data – ‘the two-period method’, ‘the single-period method’ (geometric-mean) and ‘the two-period method with an indicator for new models’ – yield indexes close to each other in the case of PCs. Among those three indexes, index derived from ‘the two-period method’ using monthly data is slightly higher than those of the other two methods. Taking it consideration that index derived from ‘the two-period method with an indicator for new models’ is close to that of ‘the single-period method’, introduction of new models supposedly forces hedonic regression parameters to change from the previous month.

Chained indexes derived from the matched models method fall rapidly similarly to (chained) hedonic indexes as noted by several experts (Turvey (1999), Bascher and Lacroix (1999) and Lowe (1999)). However, the formers seem to be slightly higher than chained hedonic indexes calculated from monthly data as shown in Chart 1 and 2. This fact indicates prices of new models tend to be lower than prices of the quality-equivalent existed models. Comparison between (logarithm of) decrease rates of chained indexes derived from the matched models method and indicator coefficients for new models estimated by ‘the two-period method with an indicator for new models’ also reveals that the later is twice as low as the formers on average as shown in Chart 3. In other words, prices of new models are about the same with those of the quality-equivalent existed models in the next month.

As shown in Chart 3, price level of new models tends to be higher relative to the quality-equivalent existed models before the introduction of Windows98 into the market. At that time, it was said that retailers were unwilling to down prices of new models because sales of PCs fell down, and the existed models remained in stock. Our results coincide with this speculation, and this fact indicates price level of new models depend on market conditions to some extent.

Chart 1. Price indexes for PCs (1995 average = 100)

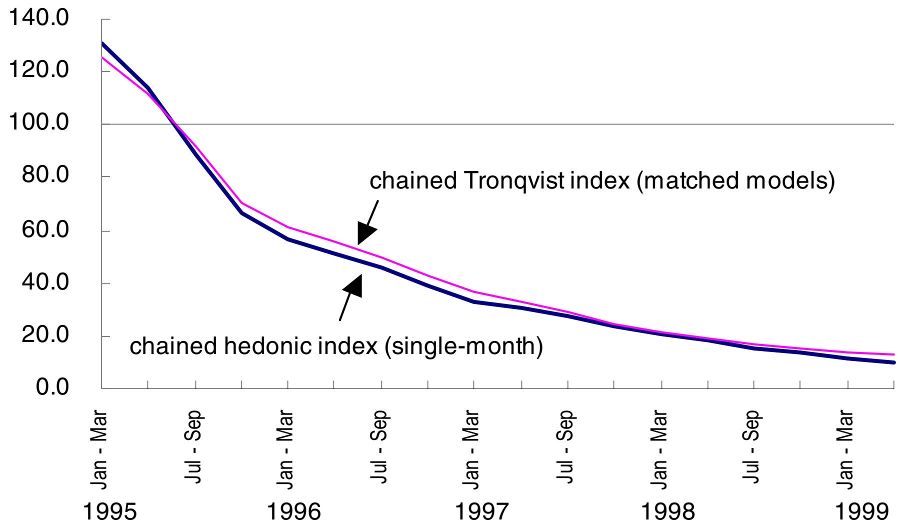
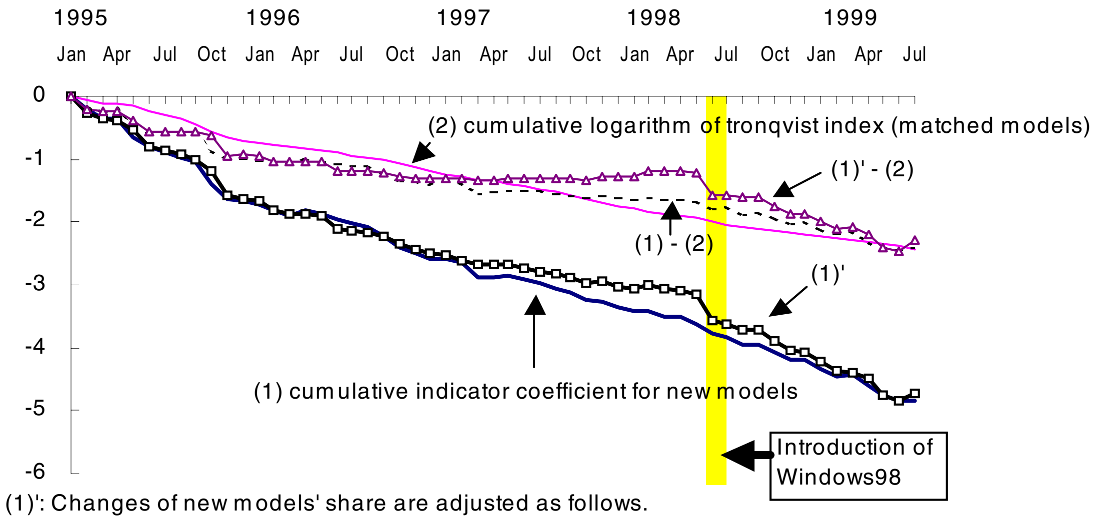


Chart 2. Chained hedonic indexes and chained indexes using matched models (in the case of PCs)

		hedonic (1995 average = 100)							matched models (1995 average = 100)			
		yearly	quarterly	monthly					monthly			
					single-period							
		two-period	two-period	two-period	geometric-mean	average in period t	average in period t+1	two-period with an indicator for new models	chained Fisher	chained Tornqvist	chained Laspeyres	chained geometric-mean
1995	average	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1996	average	73.0	50.8	48.6	48.0	50.9	45.3	48.0	52.0	52.5	53.3	52.2
1997	average	52.1	31.2	28.9	28.6	30.8	26.6	28.1	30.5	30.9	31.7	30.7
1998	average	39.0	19.3	17.2	16.8	18.5	15.3	16.4	17.8	18.1	18.8	18.0
1995	Jan - Mar		129.2	129.9	130.7	128.6	132.7	130.3	125.8	125.7	124.3	125.3
	Apr - Jun		114.0	113.6	114.0	113.7	114.3	113.9	112.2	112.1	111.9	112.3
	Jul - Sep		88.9	89.4	88.9	89.2	88.5	89.1	91.5	91.6	91.7	91.2
	Oct - Dec		67.9	67.1	66.5	68.5	64.4	66.6	70.5	70.7	72.1	71.3
1996	Jan - Mar		58.8	57.1	56.3	59.1	53.7	56.4	60.7	61.2	62.0	61.0
	Apr - Jun		54.5	52.0	51.3	54.1	48.6	51.3	55.5	56.1	57.0	55.9
	Jul - Sep		48.3	46.1	45.6	48.6	42.8	45.5	49.4	49.9	50.5	49.5
	Oct - Dec		41.7	39.4	38.9	41.8	36.2	38.7	42.3	42.7	43.4	42.4
1997	Jan - Mar		36.1	33.6	33.2	35.7	31.0	32.8	36.4	36.8	37.4	36.4
	Apr - Jun		33.3	30.8	30.5	32.7	28.4	29.9	32.8	33.2	34.0	33.0
	Jul - Sep		29.8	27.5	27.3	29.4	25.4	26.7	28.7	29.1	29.8	28.8
	Oct - Dec		25.7	23.6	23.4	25.3	21.6	22.8	24.2	24.6	25.4	24.5
1998	Jan - Mar		22.9	20.8	20.6	22.4	18.9	20.0	21.1	21.4	22.2	21.4
	Apr - Jun		20.8	18.5	18.2	20.0	16.6	17.7	18.8	19.1	20.0	19.2
	Jul - Sep		17.7	15.5	15.1	16.9	13.6	14.8	16.4	16.6	17.3	16.6
	Oct - Dec		15.8	13.7	13.4	14.9	12.0	13.1	14.9	15.2	15.7	15.0
1999	Jan - Mar		14.0	11.8	11.4	12.8	10.2	11.3	13.6	13.8	14.2	13.5
	Apr - Jun		12.8	10.5	10.1	11.4	9.0	10.2	12.6	12.8	13.0	12.3
average R^2		0.7665	0.8803	0.8893	0.8927			0.8924				
average adj. R^2		0.7645	0.8786	0.8871	0.8886			0.8900				
Year-to-year change (in percent)												
1996	average	-27.0	-49.2	-51.4	-52.0	-49.1	-54.7	-52.0	-48.0	-47.5	-46.7	-47.8
1997	average	-28.6	-38.5	-40.6	-40.5	-39.5	-41.4	-41.5	-41.2	-41.1	-40.6	-41.2
1998	average	-25.1	-38.2	-40.6	-41.1	-39.7	-42.5	-41.6	-41.7	-41.5	-40.6	-41.2
1996	Jan - Mar		-54.5	-56.1	-56.9	-54.0	-59.5	-56.7	-51.8	-51.3	-50.1	-51.3
	Apr - Jun		-52.2	-54.3	-55.0	-52.4	-57.4	-55.0	-50.5	-50.0	-49.0	-50.2
	Jul - Sep		-45.7	-48.4	-48.7	-45.5	-51.6	-48.9	-46.0	-45.5	-44.9	-45.7
	Oct - Dec		-38.6	-41.3	-41.5	-39.1	-43.8	-42.0	-40.0	-39.5	-39.8	-40.6
1997	Jan - Mar		-38.7	-41.1	-41.0	-39.6	-42.3	-41.8	-40.1	-39.9	-39.7	-40.3
	Apr - Jun		-38.8	-40.8	-40.6	-39.6	-41.6	-41.6	-40.9	-40.8	-40.4	-41.0
	Jul - Sep		-38.2	-40.3	-40.2	-39.5	-40.8	-41.3	-41.8	-41.7	-41.0	-41.8
	Oct - Dec		-38.3	-40.0	-39.9	-39.4	-40.4	-41.1	-42.7	-42.6	-41.4	-42.1
1998	Jan - Mar		-36.5	-38.0	-38.1	-37.2	-38.9	-39.2	-42.1	-41.9	-40.6	-41.2
	Apr - Jun		-37.5	-39.8	-40.2	-38.8	-41.6	-41.0	-42.6	-42.4	-41.2	-41.8
	Jul - Sep		-40.6	-43.6	-44.5	-42.5	-46.4	-44.7	-43.1	-42.9	-41.8	-42.5
	Oct - Dec		-38.6	-41.9	-42.7	-41.2	-44.2	-42.5	-38.3	-38.1	-38.1	-38.9
1999	Jan - Mar		-39.0	-43.4	-44.4	-42.8	-46.0	-43.4	-35.5	-35.3	-36.2	-36.9
	Apr - Jun		-38.5	-43.2	-44.4	-42.8	-45.9	-42.3	-33.3	-33.2	-34.9	-35.8

Chart 3. Price level of new models relative to the existed models (in the case of PCs)



(1)': Changes of new models' share are adjusted as follows.

$$\begin{matrix}\text{adj. indicator coeff.}\\ \text{for new models}\end{matrix} = \left(\begin{matrix}\text{indicator coeff.}\\ \text{for new models}\end{matrix} - \ln\begin{bmatrix}\text{Tornqvist}\\ \text{index}\end{bmatrix} \right) \cdot \frac{\text{new models' share}}{\text{average new models' share}} + \ln\begin{bmatrix}\text{Tornqvist}\\ \text{index}\end{bmatrix}$$

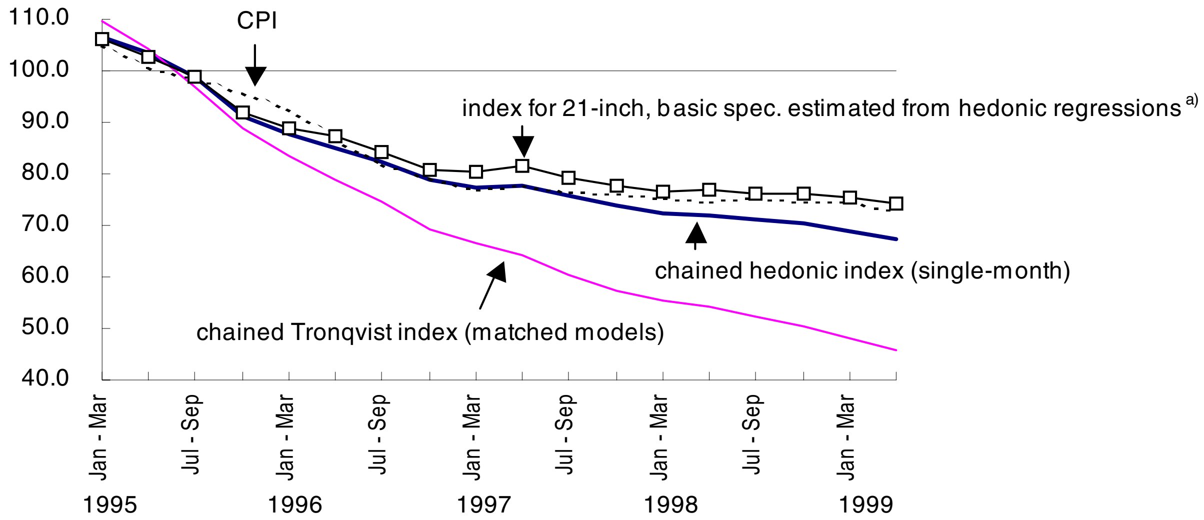
- **TVs**

As shown in Chart 5, three kinds of chained hedonic calculations using monthly data – ‘the two-period method’, ‘the single-period method’ (geometric-mean) and ‘the two-period method with an indicator for new models’ – yield indexes close to each other in the case of color TVs similar to PCs. Furthermore, index derived from ‘the two-period method’ using quarterly data is also very close to those three indexes calculated from monthly data as shown in Chart 5. It implies introduction of new models does not affect hedonic regression parameters significantly.

As shown in Chart 4 and 5, chained indexes derived from the matched models method fall faster than (chained) hedonic indexes in the case of color TVs as noted by Lowe (1999). This fact indicates prices of new models tend to be higher than prices of the quality-equivalent existed models. Chart 6 also shows that indicator coefficients for new models estimated by ‘the two-period method with an indicator for new models’ are about zero or larger than zero, and they tend to be higher than price decrease rates of the existed models on average. In other words, prices of new models are about the same or higher than with those of the quality-equivalent existed models in the previous month.

After all, the results mentioned above may be possibly interpreted as proof of downward bias of the ‘linking’ or ‘splicing’ – an implicit adjustment for quality difference between new models priced in the current month and old models priced in the previous month by leveling price index from the previous month on the assumption that prices did not change from the previous month – in the case of TVs. However, we should carefully investigate it further before drawing a conclusion. As indicated in the case of PCs, price level of new models may depend on market conditions to some extent. In this case, a rise of price level of new models beginning from 1997 may be related with consumers’ strong preference to flat display TVs.

Chart 4. Price indexes for color TVs (1995 average = 100)

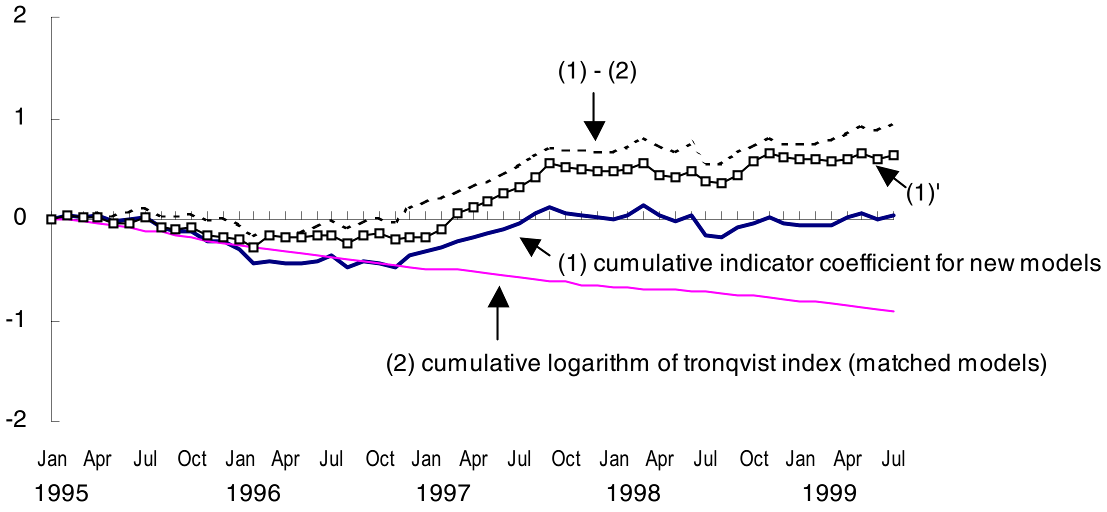


a) See footnotes to Chart 8.

Chart 5. Chained hedonic indexes and chained indexes using matched models (in the case of color TVs)

		hedonic (1995 average = 100)							matched models (1995 average = 100)				CPI
		yearly	quarterly	monthly					monthly				
					single-period			two-period with an indicator for new models					
		two-period	two-period	two-period	geometric-mean	average in period t	average in period t+1		chained Fisher	chained Tornqvist	chained Laspeyres	chained geometric -mean	
1995	average	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1996	average	83.7	83.5	83.5	83.5	84.1	82.9	83.5	76.6	76.6	77.3	76.9	85.2
1997	average	76.8	76.3	76.3	76.2	77.2	75.3	76.2	62.1	62.1	63.2	62.5	76.8
1998	average	72.2	71.5	71.5	71.5	72.7	70.3	71.3	52.9	53.0	54.4	53.6	75.1
1995	Jan - Mar		106.4	106.4	106.4	106.1	106.7	106.4	109.8	109.8	109.4	109.6	105.2
	Apr - Jun		103.5	103.5	103.5	103.4	103.6	103.5	104.2	104.2	104.1	104.2	100.6
	Jul - Sep		98.7	98.7	98.8	98.9	98.7	98.7	97.1	97.1	97.2	97.1	98.6
	Oct - Dec		91.3	91.3	91.3	91.6	91.1	91.3	88.9	88.9	89.2	89.0	95.7
1996	Jan - Mar		87.6	87.7	87.7	88.1	87.3	87.7	83.6	83.6	84.2	83.8	92.7
	Apr - Jun		85.2	85.2	85.1	85.7	84.6	85.2	79.0	79.0	79.7	79.3	87.1
	Jul - Sep		82.4	82.4	82.3	82.9	81.6	82.4	74.5	74.5	75.2	74.7	81.7
	Oct - Dec		78.8	78.9	78.8	79.5	78.0	78.8	69.3	69.3	70.1	69.5	79.4
1997	Jan - Mar		77.5	77.6	77.5	78.3	76.6	77.5	66.4	66.5	67.6	67.0	76.8
	Apr - Jun		77.9	77.9	77.8	78.7	76.9	77.7	64.3	64.3	65.4	64.7	77.7
	Jul - Sep		75.8	75.8	75.8	76.8	74.8	75.6	60.4	60.4	61.5	60.7	76.6
	Oct - Dec		74.0	74.0	74.0	75.0	72.9	73.8	57.3	57.3	58.5	57.7	76.2
1998	Jan - Mar		72.5	72.5	72.5	73.6	71.4	72.3	55.2	55.2	56.5	55.7	75.4
	Apr - Jun		72.1	72.1	72.1	73.3	70.9	71.9	54.1	54.1	55.5	54.6	74.7
	Jul - Sep		71.1	71.2	71.2	72.4	70.0	70.9	52.3	52.4	53.9	53.0	75.4
	Oct - Dec		70.2	70.3	70.2	71.5	68.9	69.9	50.1	50.3	51.8	50.9	74.8
1999	Jan - Mar		68.7	68.7	68.7	70.1	67.3	68.3	47.8	47.9	49.5	48.6	74.6
	Apr - Jun		67.2	67.2	67.2	68.7	65.8	66.9	45.6	45.7	47.3	46.4	72.7
average R^2		0.9810	0.9813	0.9807	0.9809			0.9809					
average adj. R^2		0.9807	0.9809	0.9801	0.9797			0.9802					

Chart 6. Price level of new models relative to the existed models (in the case of color TVs)



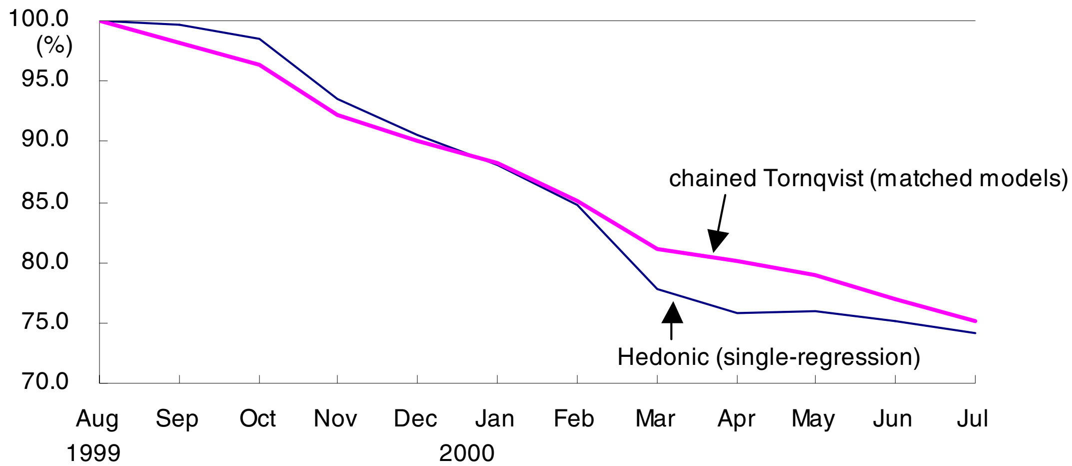
See footnote to Chart 3.

- Digital cameras

Although we suppose chained indexes derived from the matched models method usually tend to fall faster than hedonic indexes in the cases of electric appliances, which have already spread to consumers, the case of digital cameras implies some new products have similarities with PCs with respect to quality changes as noted by Turvey (1999).

Chart 7 indicates a possibility that chained indexes derived from the matched models method are almost equal to hedonic indexes, or slightly higher. At present, it is difficult to draw a conclusion because we only use free sample data for test use, in which a number of models and duration of the observation are limited.

Chart 7. Price indexes for digital cameras (Aug. 1999 = 100)



Price change by models of different quality

According to the hedonic parameter estimation, the value or 'price' of various features of electric appliances changes differently. In the case of color TVs, the 'price' of wide screen (aspect ratio is 16:9) decreased by about 30 percent relative to standard screen (aspect ratio is 4:3) in four years, and the 'price' of built-in videocassette recorder decreased by about 10 percent in the same period while the 'price' of flat display rose by about 30 percent relative to non flat display from 1997 through 1999 seemingly (See Annex 3 and 4). The 'price' hike in the last example may result from unexpectedly strong consumers' preference for flat display TVs.

The faster decline of the 'price' of wide screen contributed to relatively rapid fall of prices of the relevant models as shown in Chart 8. It also contributed to price fall of models with 28 inch or larger size display because wide screen is usually adopted for large-size display.

Those findings indicate difficulties in choices of the survey specifications. Obviously, choice of standard screen yields price indexes closer to hedonic indexes than that of wide screen between 1995 and 1999. Furthermore, as shown in Chart 9-1 and Chart 9-2, wide screen TVs did not expand their share in the total sales, or in the total number of units sold either although they were in the majority of the total sales in 1995 and 96. Thus, it is not wrong to exclude wide screen from the survey specification if we need to choose either of the two. In order to obtain a price index much closer to hedonic indexes, we need to know changes of the 'price' of each feature and changes of the share gained by the relevant models in the total sales. It probably means use of scanner data containing price and quantity of each model, and hedonic calculation using scanner data are desirable for compiling more accurate price index whether direct or indirect use.

In the 2000 Japanese CPI revision, price index for the new category 'PCs' will be compiled using scanner data. We are still examining the methodology of index compilation for PCs. Although we intended to adopt the (chained) matched models method if price indexes derived from this method are sufficiently close to the hedonic indexes, our study indicates a possibility that the former tends to fall slower than the latter in the long run. The results presented in this paper also imply use of the overlap method yields price indexes higher than the hedonic indexes even if we can collect a price of the prescribed old and new models at each sample outlet at the same time by the traditional retail price survey.

As for TVs, we consider our study shows the appropriateness of the present methodology – a kind of combination of direct comparison and overlap – on the whole. However, we need to study further supposing the good choice of the survey specification will be more difficult in the future when features of TVs will be more diversified. We are also planning to continue our study for prices of digital cameras for the possible addition to the CPI basket in the near future.

Chart 8. Chained indexes using matched models, unit price indexes and chained indexes estimated from hedonic regressions (in the case of color TVs, 1995 annual average = 100)

	all items	14 inch	21 inch	of which, models with a basic spec. [a]				
	matched sample	matched sample	matched sample	matched sample	unit price index			
	chained Fisher	chained Fisher	chained Fisher	chained Fisher	simple [d] average of unit price	simple [d] average of unit price (geometric-mean)	weighted [d] average of unit price	weighted [d] average of unit price (geometric-mean)
1995	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1996	76.6	81.9	83.3	80.9	87.3	85.3	85.8	85.9
1997	62.1	72.1	72.7	68.3	78.8	77.8	82.8	83.1
1998	52.9	65.5	64.9	60.6	75.9	75.7	79.0	79.3

	28 inch	of which, models with wide screen and BS/CS tuner [c]				
	matched sample	matched sample	unit price index			
	chained Fisher	chained Fisher	simple [d] average of unit price	simple [d] average of unit price (geometric-mean)	weighted [d] average of unit price	weighted [d] average of unit price (geometric-mean)
1995	100.0	100.0	100.0	100.0	100.0	100.0
1996	69.7	65.7	74.9	74.7	77.4	77.3
1997	51.5	48.1	63.5	62.8	61.3	61.4
1998	40.7	38.6	54.0	53.8	50.4	50.6

	index estimated from hedonic regressions [e]								
	All items	14 inch		21 inch		28 inch			
	all spec.	basic spec. [a]		basic spec. [a]		basic spec. [a]		wide [b] screen	wide screen [c] and BS/CS tuner
	actual [g] makers' shares and coeff.	fixed [f] makers' shares and coeff.	actual [g] makers' shares and coeff.	fixed [f] makers' shares and coeff.	actual [g] makers' shares and coeff.	fixed [f] makers' shares and coeff.	actual [g] makers' shares and coeff.	fixed [f] makers' shares and coeff.	actual [g] makers' shares and coeff.
1995	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1996	83.5	84.2	84.8	84.7	85.3	85.3	85.9	79.4	79.9
1997	76.2	79.2	80.2	78.6	79.6	77.8	78.8	67.9	67.7
1998	71.5	75.1	79.2	72.4	76.4	68.8	72.6	56.7	57.4

a) Non-flat standard screen CRT (aspect ratio 4:3) with multiplex transmission broadcasting tuner, no other functions.
b) Non-flat wide screen CRT (aspect ratio 16:9) with multiplex transmission broadcasting tuner, no other functions.
c) Non-flat wide screen CRT (aspect ratio 16:9) with multiplex transmission broadcasting tuner, BS or BS/CS tuner, no other functions.
d) In the same way as chained indexes, monthly unit price indexes are rebased on 1995 annual average.
e) Chained price index estiamted by substituting the relevant values for the average of variables in the hedonic regression models derived from the single-month method shown in (3) - (10). Hedonic regression parameters are estimated using all models.
f) Excluding change of makers' shares and coefficients of maker's indicators from the calculations.
g) Including change of makers' shares and coefficients of maker's indicators in the calculations.

Chart 9-1. Wide screen TVs, share in the total sales by size

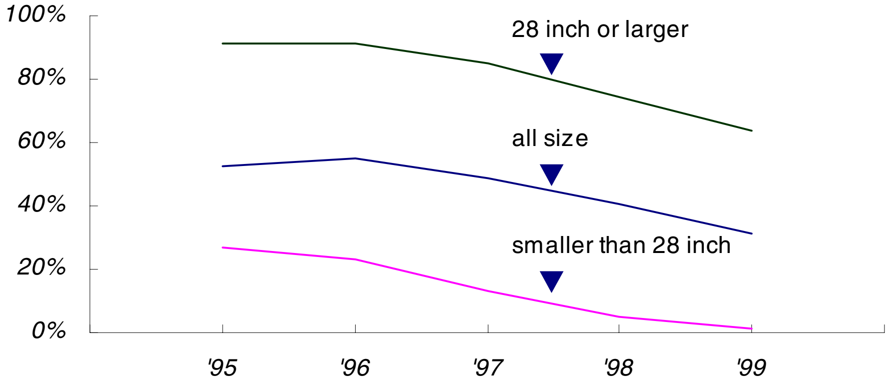
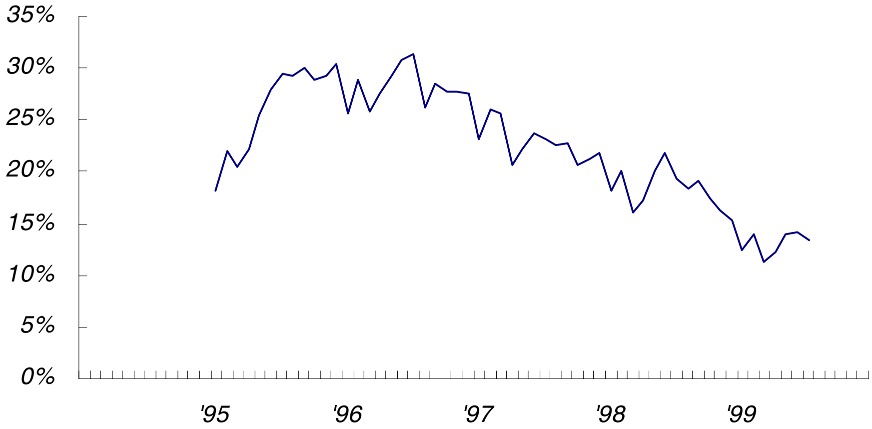


Chart 9-2. Wide screen TVs, share in the total number of units sold



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Annex 1. Hedonic regression parameter estimates (in the case of PCs*, the single-month method)

objective variable : log-transformed average unit price, weight : number of goods sold

				Jan, 1995		Jan, 1996		Jan, 1997		Jan, 1998		Jan, 1999	
				coefficient	t-value	coefficient	t-value	coefficient	t-value	coefficient	t-value	coefficient	t-value
intercept				10.492172	44.66	10.443451	170.49	10.585638	249.86	10.540375	250.02	10.376439	96.28
maker	Apple			-0.382258	-3.84	0.141523	3.01	0.233582	2.16	0.193030	6.80	0.194024	11.61
square of display size (inch^2)				0.005246	6.72	0.002721	9.93	0.002219	11.63	0.001922	14.88	0.002421	19.30
built-in TV tuner				0.360132	8.76	0.136702	6.86	0.153671	10.25	-0.089750	-4.60	0.054766	1.26
HDD (MB)				0.000768	5.78	0.000425	12.52	0.000146	8.96	0.000074676	9.13	0.000031533	7.93
main memory (MB)				0.031872	3.74	0.026353	13.20	0.008930	12.51	0.007985	9.40	0.003153	9.94
CPU clock freq. (MHz)				0.006136	5.83	0.004321	9.14	0.003728	12.59	0.002593	10.78	0.002328	15.75
built-in modem				0.075360	1.50	0.064667	4.15	0.082401	5.33	0.035892	2.49	-0.030765	-1.59
type	desktop	LCD	STN							0.248186	5.05	0.382583	3.38
base: desktop, CRT			TFT, built-in					0.294748	4.62	0.550852	11.63	0.432037	12.50
			TFT, separate							0.715169	6.42	0.412559	33.24
		no monitor		1.106083	6.11	0.590914	8.69	0.634085	11.92	0.360829	9.99	0.561426	13.77
	note	LCD	STN	1.190185	9.57	0.762911	17.57	0.701770	28.53	0.560549	32.48	0.562518	16.30
			TFT	1.389366	10.69	1.015271	26.07	0.877322	35.72	0.751886	46.47	0.721508	42.31
			other LCD	0.824586	6.62	0.358520	4.83	0.318696	1.90	0.559559	1.13	-0.178919	-0.22
CPU		486 or lower rank		-0.301485	-3.14	-0.205138	-8.33	-0.383129	-9.54	-0.655320	-6.20	-0.445527	-0.91
base: Pentium		Pentium II								0.251557	10.80	0.141138	1.40
		Pentium III											
		Pentium Pro						0.108097	1.36	0.134124	1.20		
		MMX Pentium						-0.003702	-0.07	0.162680	10.34	0.033351	0.33
		Celeron										0.102368	1.01
		others				-0.179343	-4.06	-0.132690	-1.23	0.133409	4.65	0.002135	0.21
elapsed time from the period of introduction		a year		0.049855	0.99	-0.269355	-6.27	-0.143414	-4.24	-0.099276	-4.98	-0.124559	-4.54
base: less than a year		two years or more		-0.376650	-4.02	-0.322594	-3.12	0.003013	0.02	-0.183423	-1.93	-0.338750	-3.46
R^2				0.8347		0.8943		0.8898		0.9012		0.9038	
adj. R^2				0.8213		0.8910		0.8862		0.8980		0.9012	
number of items				186		494		569		673		805	

* Excluding PDAs and palmtop PCs.
Estimates for other months are omited from the table.

Annex 2. Hedonic regression parameter estimates (in the case of PCs*, the two-month method with an indicator for new models)

objective variable : log-transformed average unit price, weight : number of goods sold

			Jan, 1995 = 0 Feb, 1995 = 1		Jan, 1996 = 0 Feb, 1996 = 1		Jan, 1997 = 0 Feb, 1997 = 1		Jan, 1998 = 0 Feb, 1998 = 1		Jan, 1999 = 0 Feb, 1999 = 1	
			coefficient	t-value	coefficient	t-value	coefficient	t-value	coefficient	t-value	coefficient	t-value
intercept			10.617438	66.04	10.419734	224.42	10.645784	315.74	10.617924	356.68	10.310191	128.61
later month, models sold in earlier month also			-0.033359	-1.90	-0.027481	-3.28	-0.055024	-8.68	-0.041203	-9.05	-0.041894	-9.60
later month, models not sold in earlier month			-0.333172	-4.36	-0.060394	-1.27	-0.000534	-0.02	-0.062028	-1.70	-0.164967	-14.90
maker	Apple		-0.382361	-5.78	0.126917	3.75	0.266886	3.14	0.179046	8.90	0.265893	22.09
square of display size (inch ^{2})			0.004983	9.36	0.002789	13.58	0.002302	15.95	0.001920	20.85	0.002215	24.22
built-in TV tuner			0.371105	13.63	0.148033	10.38	0.134286	12.69	-0.081469	-5.67	0.103664	3.85
HDD (MB)			0.000677	7.46	0.000450	18.27	0.000135	11.39	0.000078382	13.53	0.000033312	12.26
main memory (MB)			0.026514	4.33	0.026579	18.36	0.008392	16.11	0.006204	11.22	0.002235	9.34
CPU clock freq. (MHz)			0.006197	8.42	0.004520	13.20	0.003879	17.94	0.002714	15.95	0.002722	25.73
built-in modem			0.072383	2.15	0.055417	4.88	0.071128	6.20	0.036945	3.67	-0.001336	-0.10
type	desktop	LCD STN							0.266858	7.49	0.285316	3.52
base: desktop, CRT		TFT, built-in					0.305230	6.39	0.551794	15.10	0.437361	16.36
		TFT, separate							0.699602	7.67	0.403440	46.38
		no monitor	1.099815	8.99	0.614722	12.14	0.593584	14.73	0.372288	14.40	0.576319	19.53
	note	LCD STN	1.138177	13.52	0.762211	23.72	0.678823	35.40	0.568516	45.78	0.596607	24.75
		TFT	1.329917	15.09	1.003735	34.99	0.848951	46.23	0.749780	63.96	0.752617	59.85
		other LCD	0.773419	9.17	0.325898	6.06	0.153663	1.33	0.595872	1.19	-0.200695	-0.24
CPU		486 or lower rank	-0.278056	-4.29	-0.176259	-10.06	-0.324129	-11.79	-6.766490	-8.15	-0.390450	-0.88
base: Pentium		Pentium II							0.220797	13.61	0.177723	2.35
		Pentium III										
		Pentium Pro					0.088117	1.58	0.109002	1.13		
		MMX Pentium					-0.036118	-0.55	0.152033	14.41	0.069430	0.93
		Celeron									0.154264	2.04
		others			-0.174682	-5.48	-0.130032	-1.54	0.099030	4.87	0.089899	1.19
elapsed time from the period of introduction		a year	0.036251	1.00	-0.242763	-8.14	-0.133340	-5.54	-0.092311	-6.55	-0.109217	-5.65
base: less than a year		two years or more	-0.412320	-5.50	-0.337418	-4.58	-0.010907	-0.09	-0.215079	-2.79	-0.233219	-2.94
R^2			0.8165		0.8947		0.8873		0.9008		0.9037	
adj. R^2			0.8077		0.8927		0.8851		0.8989		0.9021	
number of items per month			174		460		515		616		710	

* See footnotes to Annex 1.

Annex 3. Hedonic regression parameter estimates (in the case of color TVs*, the single-month method)
object variable : log-transformed average unit price, weight : number of goods sold

		Jan, 1995		Jan, 1996		Jan, 1997		Jan, 1998		Jan, 1999	
		coefficient	t-value	coefficient	t-value	coefficient	t-value	coefficient	t-value	coefficient	t-value
intercept		9.605823	367.30	9.390221	380.72	9.319001	390.23	9.334565	390.98	9.368059	338.54
maker	Sony	0.258705	10.31	0.236728	11.47	0.212837	10.76	0.270561	17.01	0.262584	16.50
base: Aiwa	Panasonic	0.254843	9.93	0.172048	8.74	0.203779	10.14	0.209485	12.05	0.218389	12.50
	Japan Victor	0.158148	5.47	0.167104	6.39	0.099504	4.32	0.207068	9.59	0.180947	8.47
	Toshiba	0.151595	5.32	0.119463	4.91	0.116449	5.10	0.171340	8.44	0.178473	8.18
	Mitsubishi	0.140226	4.96	0.087697	3.49	0.079313	3.30	0.099810	4.17	0.167550	7.05
	Hitachi	0.042056	1.42	0.064620	2.77	0.064712	2.64	0.104522	5.42	0.127275	4.56
	Sanyo	0.028038	1.07	0.051098	2.38	0.078341	3.25	0.088811	3.98	0.082280	4.08
	Sharp	0.032126	1.26	0.055379	2.85	0.058376	2.95	0.097982	5.42	0.133291	6.81
	NEC	-0.025052	-0.95	-0.016342	-0.74	-0.016108	-0.74	0.031662	1.30	0.139051	0.42
	Funai	-0.096483	-3.34	-0.142585	-4.48	-0.176518	-6.72	-0.199472	-9.81	-0.209694	-9.41
	Sansei	-0.336899	-10.58	-0.176032	-5.26	-0.184406	-6.32	-0.036974	-0.72	-0.118378	-2.87
	Orion	-0.145189	-3.73	-0.254426	-8.25	-0.105480	-2.00				
	Maruman	-0.316705	-7.76	-0.204617	-2.86						
	LG	-0.240208	-6.66	-0.329942	-11.44	-0.238424	-8.33	-0.088380	-1.28	-0.264741	-6.86
	Daiu					-0.223773	-4.35	-0.240808	-9.62	-0.285098	-11.18
	Yupitel	-0.238687	-2.61	-0.273076	-5.13						
LCD				1.798749	13.77	1.700991	10.75	1.648851	10.99	1.854288	13.78
square of screen size (inch ^{2})		0.001521	37.44	0.001505	39.28	0.001496	41.65	0.001389	42.10	0.001272	38.36
wide screen		0.436755	29.60	0.364408	25.86	0.295097	19.48	0.209154	13.28	0.096760	4.78
EDTV				0.166701	5.14	0.063862	1.93	0.028199	0.82	-0.037311	-0.66
HDTV		0.692077	4.56	0.684012	6.30	0.692197	12.37	0.613933	13.13	0.441939	7.19
flat display						0.078356	0.68	0.241608	9.31	0.341605	16.90
multiplex transmission broadcasting		0.181467	11.50	0.177756	12.00	0.165471	11.26	0.139236	10.25	0.175582	12.64
BS or CS/BS tuner		0.095123	3.40	0.042458	1.63	0.066780	2.76	0.099002	3.84	0.141401	4.80
teletext decorder		0.267355	5.47	0.148705	4.78	0.157342	4.43	0.173544	3.82	0.240911	5.04
input for external digital satelitte broadcasting tuner								0.350136	1.33	0.205558	0.32
no. of TV tuners		0.075133	3.61	0.135551	7.22	0.106218	5.89	0.084685	4.34	0.055514	2.39
picture-in-picture		0.080565	1.37	-0.002326	-0.05	0.112996	3.57	0.111905	3.64	0.076761	2.06
MUSE-NTSC converter		0.143457	0.93	0.240962	1.86	0.156548	3.53	0.140827	3.96	0.192720	5.79
built-in VCR (VHS)		0.663438	36.66	0.622523	39.54	0.615408	39.44	0.549169	33.89	0.551028	26.36
built-in internet access						0.571851	2.30	0.118754	0.28	0.019766	0.04
R^2		0.9806		0.9807		0.9796		0.9803		0.9812	
adj. R^2		0.9795		0.9795		0.9783		0.9790		0.9800	
number of items		442		477		496		515		475	

* Excluding projection TVs and portable TVs with screen size less than 10 inch
Estimates for other months are omited from the table.

Annex 4. Hedonic regression parameter estimates (in the case of color TVs*, the two-month method with an indicator for new models)

object variable : log-transformed average unit price, weight : number of goods sold

		Jan, 1995 = 0 Feb, 1995 = 1		Jan, 1996 = 0 Feb, 1996 = 1		Jan, 1997 = 0 Feb, 1997 = 1		Jan, 1998 = 0 Feb, 1998 = 1		Jan, 1999 = 0 Feb, 1999 = 1	
		coefficient	t-value	coefficient	t-value	coefficient	t-value	coefficient	t-value	coefficient	t-value
intercept		9.642611	516.74	9.407944	506.85	9.333999	540.10	9.358528	520.74	9.381928	458.05
later month, models sold in earlier month also		-0.023025	-3.88	-0.012559	-2.03	-0.012295	-2.04	-0.016079	-2.78	-0.018030	-2.92
later month, models not sold in earlier month		0.013745	0.26	-0.076867	-0.43	0.040766	0.63	-0.005753	-0.07	-0.022900	-0.29
maker	Sony	0.249818	14.23	0.236570	15.54	0.214038	15.28	0.260561	22.67	0.262400	22.87
base: Aiwa	Panasonic	0.250659	14.00	0.170710	11.72	0.210837	14.81	0.212650	16.83	0.224712	17.63
	Japan Victor	0.173263	8.60	0.168937	9.04	0.112022	7.03	0.201621	13.34	0.184686	12.30
	Toshiba	0.149026	7.62	0.116198	6.66	0.122371	7.70	0.170040	11.71	0.180617	11.51
	Mitsubishi	0.131444	6.78	0.081427	4.45	0.075714	4.49	0.099574	5.81	0.164568	9.72
	Hitachi	0.034597	1.74	0.054006	3.14	0.065383	3.77	0.096723	6.84	0.104480	5.64
	Sanyo	0.033123	1.81	0.048187	3.02	0.073709	4.37	0.083636	5.17	0.094644	6.19
	Sharp	0.021016	1.19	0.041087	2.86	0.057309	4.09	0.090967	6.95	0.129196	9.24
	NEC	-0.027104	-1.47	-0.017691	-1.08	-0.021917	-1.42	0.023271	1.36	0.065587	0.34
	Funai	-0.105781	-5.08	-0.136724	-5.66	-0.176893	-9.15	-0.211051	-14.04	-0.207831	-12.77
	Sansei	-0.324105	-13.95	-0.261776	-10.97	-0.172774	-8.30	-0.067168	-1.88	-0.115505	-3.74
	Orion	-0.172356	-6.44	-0.317739	-14.61	-0.170144	-4.84				
	Maruman	-0.336140	-12.03	-0.205775	-4.13						
	LG	-0.238001	-9.25	-0.346881	-15.49	-0.270433	-12.95	-0.115063	-2.38	-0.246762	-8.09
	Daiu					-0.245347	-6.03	-0.246879	-13.54	-0.295166	-15.86
	Yupitel	-0.274416	-5.31	-0.328495	-7.85						
LCD				1.871131	20.61	1.699215	15.12	1.654273	15.37	1.862137	19.07
square of screen size (inch ^{2})		0.001530	55.91	0.001516	55.72	0.001490	59.98	0.001403	61.07	0.001269	54.49
wide screen		0.441096	45.46	0.366981	37.14	0.304293	29.39	0.209974	19.39	0.099188	7.15
EDTV				0.168640	7.74	0.081188	3.65	0.040432	1.78	-0.025805	-0.66
HDTV		0.706540	7.44	0.684407	10.37	0.677360	20.04	0.620251	20.95	0.446395	10.89
flat display						0.108056	1.34	0.245443	14.04	0.345061	25.01
multiplex transmission broadcasting		0.172086	16.20	0.172649	16.19	0.164169	16.02	0.133236	13.87	0.169485	17.00
BS or CS/BS tuner		0.112733	6.10	0.047366	2.56	0.065499	3.95	0.107237	5.81	0.141216	6.72
teletext decorder		0.265380	8.57	0.153295	7.17	0.145492	6.27	0.192592	6.32	0.240130	7.55
input for external digital satelitte broadcasting tuner								0.369340	1.99	0.199199	0.42
no. of TV tuners		0.063773	4.70	0.133717	9.89	0.105023	8.41	0.077060	5.35	0.061920	3.64
picture-in-picture		0.096680	2.60	-0.006619	-0.22	0.109999	5.17	0.114362	5.32	0.066183	2.54
MUSE-NTSC converter		0.138498	1.46	0.211188	2.59	0.143617	5.06	0.125485	5.39	0.189742	8.63
built-in VCR (VHS)		0.668161	54.65	0.629930	54.87	0.616076	54.77	0.559141	46.16	0.544350	35.63
built-in internet access						0.631152	3.77	0.077374	0.27	0.095948	0.25
R^2		0.9834		0.9816		0.9816		0.9819		0.9823	
adj. R^2		0.9828		0.9810		0.9810		0.9812		0.9817	
number of items per month		426		460		476		490		451	

* See footnotes to Annex 3.

Annex 5. Hedonic regression parameter estimates
(in the case of digital cameras[a)], the single-regression mthod)

object variable : log-transformed average unit price, weight : number of units sold

		coefficient	t-value
intercept		9.4737414	162.48
period	Sep., 1999	-0.0038251	-0.14
base:	Oct., 1999	-0.0148182	-0.54
Aug., 1999	Nov., 1999	-0.0663859	-2.42
	Dec., 1999	-0.0989191	-3.60
	Jan., 2000	-0.1279325	-4.65
	Feb., 2000	-0.1647113	-5.98
	Mar., 2000	-0.2512356	-9.08
	Apr., 2000	-0.2765524	-9.91
	May, 2000	-0.2751019	-9.89
	Jun., 2000	-0.2861912	-10.22
	Jul., 2000	-0.2989695	-10.53
maker	Group A [b)]	0.3226572	10.63
base: Casio	Group B [c)]	0.4540487	15.00
pixel (10 thousand)		0.0036708	31.33
square of LCD size (inch ^{2})		0.0700221	5.55
interchangable lens		1.3676337	2.46
optical magnifying power		0.0869477	19.22
reciprocal of the highest shutter speed (1/sec.)		0.0000241	5.98
fixed focus		-0.1305377	-3.39
movie		0.1716435	9.22
printer		0.3103983	2.94
coefficient of determination		0.8887	
adjusted for the degrees of freedom		0.8830	
number of items per month		36	

a) Excluding wrist-watch types and the lowest-grade.
b) Group A : Minolta, Ricoh, Sanyo, Sony, Toshiba
c) Group B : Canon, Epson, Fuji Film, Kodak, Olympus, Sharp