

## Reestimation Results of Hedonic Regression Models in the Corporate Goods Price Index

### — Digital Cameras —

The Bank of Japan reestimates the hedonic regression models of quality adjustment, applied to digital cameras (compact digital cameras, mirrorless interchangeable-lens cameras, and digital single-lens reflex cameras). The reestimation results as of November 2018 are shown in Tables 1 to 3.

The details of data for the estimation are as follows:

Scope of application <sup>1</sup>	<ul style="list-style-type: none"> <li>• Digital cameras classified in “Visual equipment” (Producer Price Index, Export Price Index) and “Digital cameras &amp; video cameras” (Import Price Index)</li> </ul>
Dataset <sup>2</sup>	<p>Source:</p> <ul style="list-style-type: none"> <li>• The retail price (quarterly average price) and specification data are provided with the <i>BCN Ranking</i> by the BCN Inc. Other important specifications unlisted in the database are taken from the specification sheet of each digital camera.</li> </ul> <p>Number of observations (release period):</p> <ul style="list-style-type: none"> <li>• Compact digital camera: 43 (from 4th quarter 2016 to 3rd quarter 2018)</li> <li>• Mirrorless interchangeable-lens camera: 90 (from 4th quarter 2016 to 3rd quarter 2018)</li> <li>• Digital single-lens reflex camera: 53 (from 4th quarter 2015 to 3rd quarter 2018)<sup>3</sup></li> </ul>
Model selection <sup>4</sup>	<ul style="list-style-type: none"> <li>• Based on the results of likelihood ratio tests, Semi Box-Cox Model is selected for compact digital cameras, Semi Log-Linear Model is selected for mirrorless interchangeable-lens cameras and Double Box-Cox Model is selected for digital single-lens reflex cameras.</li> </ul>
Suggested period of application	<ul style="list-style-type: none"> <li>• From November 2018 onward</li> </ul>
Frequency of estimation	<ul style="list-style-type: none"> <li>• Compact digital camera: Every May and November</li> <li>• Mirrorless interchangeable-lens camera and digital single-lens reflex camera: Every November</li> </ul>

<sup>1</sup> The same model is applied to domestic goods, exported goods, and imported goods.

<sup>2</sup> The model is estimated by mixing up price data of both domestic goods and imported goods.

<sup>3</sup> In order to maintain the stability of the estimation, the sample release period for Digital single-lens reflex camera has been extended from eight quarters to twelve quarters.

<sup>4</sup> Hedonic regression model is assumed to be the general function form expressed as follows:

$$\frac{y^{\lambda_0} - 1}{\lambda_0} = \beta_0 + \sum_{i=1}^n \beta_i \frac{x_i^{\lambda_i} - 1}{\lambda_i} + u$$

where  $\lambda$  is the Box-Cox transformation parameter.

When  $\lambda = 0$ , function is logarithmic; When  $\lambda = 1$ , function is linear. The functional form is determined by Box-Cox test (likelihood ratio test) under constraints of each parameter settings, such as in the Double Box-Cox Model, Semi Box-Cox Model (when  $\lambda_i = 1$ ), Log-Linear Model (when  $\lambda_0 = \lambda_i = 0$ ), Semi Log-Linear Model (when  $\lambda_0 = 0, \lambda_i = 1$ ), and Linear Model (when  $\lambda_0 = \lambda_i = 1$ ).

## Estimation Result for Compact Digital Cameras

Suggested Period of Application	This Time Estimation November 2018-	Last Time Estimation May 2018-October 2018
Estimated Model	Semi Box-Cox Model	Double Box-Cox Model
Box-Cox Parameter of Dependent Variable	-0.485	0.324
Intercept	2.044 ***	60.178 ***
Optical Zoom (times)	3.162E-05 **	4.389 ***
Box-Cox Parameter	--	0.093
Maximum ISO Sensitivity (including Expanded Sensitivity)	4.355E-08 **	2.214E-16 **
Box-Cox Parameter	--	3.704
F-Number for Wide-angle	-0.002 ***	-0.051 ***
Box-Cox Parameter	--	5.536
Dummy Variables		
4K/2K Video Function	0.002 ***	16.936 ***
Maximum Shutter Speed 1/2,000 second or faster	0.003 ***	6.628 *
Image Sensor Size		
1 inch or larger, and smaller than APS-C	0.004 ***	30.290 ***
APS-C	0.005 ***	53.643 ***
Back-illuminated CMOS Sensor	0.002 ***	--
Optical Image Stabilization Function	0.002 ***	--
LCD Type		
Tilt or Vari-angle	--	10.978 ***
Vari-angle	0.002 *	--
Waterproof	0.003 ***	22.512 ***
Bluetooth Function	--	5.135 *
Manufacturer		
Manufacturer A	0.001 *	--
Manufacturer B	-0.002 ***	--
Manufacturer C	--	-14.864 ***
Manufacturer D	0.003 **	--
Release Period		
2nd quarter 2016	--	12.721 ***
3rd quarter 2016	--	7.442
4th quarter 2016	--	4.764
1st quarter 2017	0.001	1.971
2nd quarter 2017	0.001	-4.495
3rd quarter 2017	0.002 *	14.071 ***
4th quarter 2017	0.003 ***	1.210
1st quarter 2018	4.553E-04	--
2nd quarter 2018	0.002	--
3rd quarter 2018	-0.001	--
R-squared	0.974	0.987
Adjusted R-squared	0.949	0.974
Standard Error of Regression	0.001	4.136
Mean of Dependent Variable	2.049	96.907
Number of Observations (release period)	43 (from 4Q 2016 to 3Q 2018)	36 (from 2Q 2016 to 1Q 2018)
Tests for Double Box-Cox Model ( $H_1$ : Double Box-Cox)		
$H_0$ : Semi Box-Cox ( $\lambda_i=1$ )	0.810	12.544 ***
$H_0$ : Log-Linear ( $\lambda_0=\lambda_i=0$ )	19.190 ***	11.144 **
$H_0$ : Semi Log-Linear ( $\lambda_0=0, \lambda_i=1$ )	11.225 **	14.971 ***
$H_0$ : Linear ( $\lambda_0=\lambda_i=1$ )	70.567 ***	64.980 ***

Notes: 1. \*\*\*, \*\* and \* denote significance at the 1%, 5% and 10% levels, respectively.

2. The specifications of Double/Semi Box-Cox Models are determined based on the result of likelihood ratio test.

The likelihood ratio statistics is distributed as chi-squared with degrees of freedom equal to the number of restraints.

## Estimation Result for Mirrorless Interchangeable-lens Cameras

Suggested Period of Application	This Time Estimation November 2018-	Last Time Estimation November 2017-October 2018
Estimated Model	Semi Log-Linear Model	Double Box-Cox Model
Box-Cox Parameter of Dependent Variable	--	0.166
Intercept	10.510 ***	-9.942E+06 ***
Maximum ISO Sensitivity (Except for Expanded Sensitivity)	5.614E-06 *	1.693E+07 ***
Box-Cox Parameter	--	-1.703
Longest / Shortest Focal Length of Kit Lens	0.021 ***	0.025 *
Box-Cox Parameter	--	1.558
Battery Life (CIPA Standard, pictures)	0.001 *	5.522 ***
Box-Cox Parameter	--	0.004
Image Sensor Size (mm <sup>2</sup> )	0.001 ***	8.013E-07 ***
Box-Cox Parameter	--	2.816
Dummy Variables		
F-Number of Kit Lens for Wide-angle 2.8 or smaller	0.150 *	--
Including Kit Lens	--	1.475 ***
Electronic Viewfinder	0.333 ***	2.736 ***
Maximum Shutter Speed 1/16,000 second or faster	0.197 **	2.768 ***
Waterproof and Dustproof	0.492 ***	3.434 ***
Wi-Fi Function	--	4.064 **
Manufacturer		
Manufacturer A	0.994 ***	5.048 ***
Manufacturer B	--	-5.961 ***
Manufacturer C	--	-3.769 ***
Manufacturer D	-0.249 **	-4.855 ***
Release Period		
1st quarter 2016	--	1.989 ***
2nd quarter 2016	--	3.653 ***
3rd quarter 2016	--	1.364 *
4th quarter 2016	--	1.858 **
1st quarter 2017	0.034	2.813 ***
2nd quarter 2017	0.036	--
3rd quarter 2017	-0.213 *	0.958
4th quarter 2017	-0.064	--
1st quarter 2018	-0.187 *	--
2nd quarter 2018	-0.354 **	--
3rd quarter 2018	-0.188	--
R-squared	0.872	0.902
Adjusted R-squared	0.842	0.860
Standard Error of Regression	0.260	1.026
Mean of Dependent Variable	11.891	35.843
Number of Observations (release period)	90 (from 4Q 2016 to 3Q 2018)	64 (from 4Q 2015 to 3Q 2017)
Tests for Double Box-Cox Model (H <sub>1</sub> : Double Box-Cox)		
H <sub>0</sub> : Semi Box-Cox ( $\lambda_i=1$ )	6.404	9.088 *
H <sub>0</sub> : Log-Linear ( $\lambda_0=\lambda_i=0$ )	10.820 *	14.857 **
H <sub>0</sub> : Semi Log-Linear ( $\lambda_0=0, \lambda_i=1$ )	6.900	10.157 *
H <sub>0</sub> : Linear ( $\lambda_0=\lambda_i=1$ )	92.385 ***	23.536 ***

Notes: 1. \*\*\*, \*\* and \* denote significance at the 1%, 5% and 10% levels, respectively.

2. The specifications of Double Box-Cox/Semi Log-Linear Models are determined based on the result of likelihood ratio test.

The likelihood ratio statistics is distributed as chi-squared with degrees of freedom equal to the number of restraints.

## Estimation Result for Digital Single-lens Reflex Cameras

Suggested Period of Application	This Time Estimation November 2018-	Last Time Estimation November 2017-October 2018
Estimated Model	Double Box-Cox Model	Double Box-Cox Model
Box-Cox Parameter of Dependent Variable	0.202	-0.111
Intercept	27.127 ***	5.100 ***
AF Sensor (points)	1.761 ***	4.834E-03 ***
Box-Cox Parameter	0.103	0.735
Battery Life (pictures)	--	0.015 **
Box-Cox Parameter	--	0.175
Maximum ISO Sensitivity (Except for Expanded Sensitivity)	0.460 ***	0.260 ***
Box-Cox Parameter	0.099	-0.207
Longest / Shortest Focal Length of Kit Lens	0.489 ***	--
Box-Cox Parameter	0.454	
Maximum Continuous Shooting Speed (frames/second)	2.527E-04 ***	--
Box-Cox Parameter	4.427	
Dummy Variables		
Image Sensor Size		
Full Frame	8.470 ***	0.133 ***
Maximum Shutter Speed		
1/8,000 second or faster	--	0.041 **
Image Stabilization Function	--	0.028 **
4K/2K Video Function	3.998 ***	0.106 ***
Quiet Shutter Function	--	0.085 ***
Longest / Shortest Focal Length of Kit Lens		
7 or more	--	0.073 ***
F-Number of Kit Lens for Wide-angle		
2.8 or smaller	1.745 **	--
Waterproof and Dustproof	2.292 ***	--
Manufacturer		
Manufacturer A	--	-0.186 ***
Manufacturer B	--	-0.390 ***
Manufacturer C	3.814 ***	--
Release Period		
2nd quarter 2016	-5.568 ***	-0.100 ***
3rd quarter 2016	1.356 *	-0.009
4th quarter 2016	-1.778 **	0.022
1st quarter 2017	-1.156	-0.015
2nd quarter 2017	-1.504 **	-0.013
3rd quarter 2017	-0.671	-0.023
1st quarter 2018	-2.468 ***	--
3rd quarter 2018	0.609	--
R-squared	0.990	0.985
Adjusted R-squared	0.985	0.977
Standard Error of Regression	1.025	0.029
Mean of Dependent Variable	49.944	6.606
Number of Observations (release period)	53 (from 4Q 2015 to 3Q 2018)	48 (from 4Q 2015 to 3Q 2017)
Tests for Double Box-Cox Model ( $H_1$ : Double Box-Cox)		
$H_0$ : Semi Box-Cox ( $\lambda_i=1$ )	25.722 ***	9.584 **
$H_0$ : Log-Linear ( $\lambda_0=\lambda_i=0$ )	10.072 *	13.001 **
$H_0$ : Semi Log-Linear ( $\lambda_0=0, \lambda_i=1$ )	30.140 ***	9.603 **
$H_0$ : Linear ( $\lambda_0=\lambda_i=1$ )	100.533 ***	85.203 ***

Notes: 1. \*\*\*, \*\* and \* denote significance at the 1%, 5% and 10% levels, respectively.

2. The specifications of Double Box-Cox Models are determined based on the result of likelihood ratio test.

The likelihood ratio statistics is distributed as chi-squared with degrees of freedom equal to the number of restraints.

3. "Quiet Shutter Function" dummy is applied if the device is capable of shooting in quiet.