

Reestimation Result of Hedonic Regression Model in the Corporate Goods Price Index

— Smartphones —

The Bank of Japan reestimates the hedonic regression model of quality adjustment, applied to smartphones. The reestimation result as of September 2019 is shown in the Table.

The details of data for the estimation are as follows:

Scope of application ¹	<ul style="list-style-type: none"> Smartphones classified in both “Cellular phones” (Producer Price Index, Import Price Index) and “Fixed & mobile radio communications equipment” (Export Price Index)
Dataset ²	<p>Source:</p> <ul style="list-style-type: none"> The price data are provided with the <i>K-tai Watch</i> by the Impress Corporation³ and the 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 smartphone. <p>Number of observations (release periods):</p> <ul style="list-style-type: none"> 247 (from 3rd quarter 2017 to 2nd quarter 2019)
Model selection ⁴	<ul style="list-style-type: none"> Based on the results of likelihood ratio tests, the Double Box-Cox model is selected.
Suggested period of application	<ul style="list-style-type: none"> From September 2019 onward
Frequency of estimation	<ul style="list-style-type: none"> Every March and September

¹ The same model is applied to domestic goods, exported goods, and imported goods.

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

³ Cash sales prices for new subscription without speech plan are used for SIM free phones.

⁴ 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 λ 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 Smartphones

Suggested Period of Application	This Time Estimation September 2019-	Last Time Estimation March 2019-August 2019
Estimated Model	Double Box-Cox Model	Double Box-Cox Model
Box-Cox Parameter of Dependent Variable	0.924	1.065
Intercept	-7.865E+09 ***	-3.809E+10 ***
Main Memory (GB)	560.955 ***	327.773 ***
Box-Cox Parameter	1.915	3.133
CPU Frequency (GHz)	3.186E+03 ***	5.094E+04 ***
Box-Cox Parameter	2.460	0.978
Storage (GB)	119.423 ***	512.333 ***
Box-Cox Parameter	0.787	0.826
Rear Camera Resolution (ten thousand pixels)	8.125E-04 ***	1.694E-09 ***
Box-Cox Parameter	2.006	3.868
Number of Rear Cameras	6.692E+03 **	-
Box-Cox Parameter	-2.765	-
Front Camera Resolution (ten thousand pixels)	2.056E+10 ***	1.135E+11 ***
Box-Cox Parameter	-2.614	-2.977
Battery Capacity (mAh)	2.067E+03 ***	8.350E+05 ***
Box-Cox Parameter	0.193	-0.304
Bezel-to-Body Ratio (%)	-8.278E+05 **	-3.954E+07 **
Box-Cox Parameter	-1.726	-2.360
Dummy Variables		
Mobile Carrier		
Carrier A	2.330E+03 ***	9.538E+03 **
Carrier B	-3.539E+03 ***	-1.776E+04 ***
Other Functions		
OLED Display	5.962E+03 ***	2.666E+04 ***
Waterproof	2.745E+03 **	1.724E+04 ***
Iris Scanner	1.423E+04 ***	4.013E+04 ***
Manufacturer		
Manufacturer A	1.292E+04 ***	8.037E+04 ***
Manufacturer B	-1.741E+04 ***	-3.591E+04 ***
Manufacturer C	-	1.734E+04 ***
Manufacturer D	-1.424E+04 ***	-4.855E+04 ***
Manufacturer E	-1.365E+04 ***	-4.695E+04 ***
Manufacturer F	-9.196E+03 ***	-3.104E+04 ***
Manufacturer G	-1.696E+04 ***	-6.502E+04 ***
Manufacturer H	-1.061E+04 ***	-3.496E+04 ***
Manufacturer I	-	2.902E+04 **
Manufacturer J	-	-2.764E+04 ***
Manufacturer K	-3.638E+03 ***	-
Manufacturer L	-8.257E+03 ***	-
Manufacturer M	-6.866E+03 ***	-
Manufacturer N	2.357E+04 ***	-
Manufacturer O	-7.488E+03 ***	-
Manufacturer P	-2.802E+03 *	-
Manufacturer Q	-1.569E+04 ***	-
Manufacturer R	-4.364E+04 ***	-
Manufacturer S	1.586E+04 ***	-
Release Period		
2nd quarter 2017	-	-3.780E+03
3rd quarter 2017	-	-4.077E+03
4th quarter 2017	-1.239E+03	-1.344E+04 **
1st quarter 2018	-3.346E+03 **	-2.001E+04 **
2nd quarter 2018	-4.738E+03 ***	-3.307E+04 ***
3rd quarter 2018	-3.793E+03 **	-2.155E+04 **
4th quarter 2018	-5.861E+03 ***	-4.559E+04 ***
1st quarter 2019	-5.971E+03 ***	-
2nd quarter 2019	-1.004E+04 ***	-
R-squared	0.957	0.941
Adjusted R-squared	0.950	0.933
Standard Error of Regression	3.983E+03	2.208E+04
Mean of Dependent Variable	3.608E+04	1.514E+05
Number of Observations (release period)	247 (from 3Q 2017 to 2Q 2019)	265 (from 1Q 2017 to 4Q 2018)
Tests for Double Box-Cox Model (H_1 : Double Box-Cox)		
H_0 : Semi Box-Cox ($\lambda_i=1$)	21.485 ***	34.724 ***
H_0 : Log-Linear ($\lambda_0=\lambda_i=0$)	149.619 ***	164.286 ***
H_0 : Semi Log-Linear ($\lambda_0=0, \lambda_i=1$)	139.257 ***	172.246 ***
H_0 : Linear ($\lambda_0=\lambda_i=1$)	22.419 ***	35.015 ***

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. "Waterproof" dummy is applied to devices that receive a rating of IPX8.