

Reestimation Results of Hedonic Regression Models in the Corporate Goods Price Index and the Services Producer Price Index — Desktop and Notebook Computers —

The Bank of Japan reestimates the hedonic regression models of quality adjustment, applied to desktop and notebook computers¹. The reestimation results as of August 2017 are shown in Appendices 1 and 2.

The details of data for the estimation are as follows:

Scope of application ²	<ul style="list-style-type: none"> • “Desktop computers” (Producer Price Index, Import Price Index) and “Notebook computers” (Producer Price Index, Export Price Index, Import Price Index) • Rental desktop and notebook computers classified in “Computer rental” (Services Producer Price Index)
Dataset ³	<p>Source:</p> <ul style="list-style-type: none"> • 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 computer. <p>Number of observations (release period):</p> <ul style="list-style-type: none"> • Desktop computer: 56 (from 3rd quarter 2016 to 2nd quarter 2017) • Notebook computer: 138 (from 3rd quarter 2016 to 2nd quarter 2017)
Model selection ⁴	<ul style="list-style-type: none"> • Based on the results of likelihood ratio tests, semi Box-Cox models are selected for desktop computers and notebook computers.
Suggested period of application	<ul style="list-style-type: none"> • From August 2017 onward
Frequency of estimation	<ul style="list-style-type: none"> • Every February and August

¹ Other hedonic regression model is estimated for tablet computers.

² The same model is applied to domestic goods, exported goods, and imported goods.

³ The model is estimated by mixing up price data of both domestic goods and imported goods.

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 $\lambda_1 = 1$), Log-Linear Model (when $\lambda_0 = \lambda_1 = 0$), Semi Log-Linear Model (when $\lambda_0 = 0, \lambda_1 = 1$), and Linear Model (when $\lambda_0 = \lambda_1 = 1$).

Estimation Result for Desktop Computers

Period of Application	This Time Estimation August 2017-	Last Time Estimation February 2017-July 2017
Estimated Model	Semi Box-Cox Model	Semi Box-Cox Model
Box-Cox Parameter of Dependent Variable	0.540	0.757
Intercept	350.184 ***	1,702.911 ***
CPU Frequency (MHz)	0.039 **	--
L3 Cache (MB)	22.302 ***	336.924 ***
Main Memory (MB)	8.041E-03 *	0.136 ***
GPU Frequency (MHz)	0.151 ***	4.163 ***
Hard Disk Drive (GB)	0.048 ***	--
Solid State Drive (GB)	0.638 ***	--
Dummy Variables		
CPU		
2.0 GHz and more	--	535.951 **
Solid State Drive		
128 GB and more	--	1,451.900 ***
Monitor		
with a Monitor	125.433 ***	1,282.929 ***
with a Monitor (23.8 inches and larger)	122.922 ***	611.885 *
Pre-installed Application		
Microsoft Office Home and Business Premium with an Annual License of Office 365	91.581 ***	1,653.116 ***
Manufacturer		
Manufacturer A	202.355 ***	4,095.919 ***
Manufacturer B	219.070 ***	3,914.813 ***
Manufacturer C	164.229 ***	--
Manufacturer D	--	2,515.252 ***
Period		
2nd quarter 2016	--	409.747 **
3rd quarter 2016	--	-1.819
4th quarter 2016	8.162	-962.603 ***
1st quarter 2017	5.111	--
2nd quarter 2017	29.536	--
R-squared	0.981	0.985
Adjusted R-squared	0.974	0.980
Standard Error of Regression	47.583	498.253
Mean of Dependent Variable	927.311	8,986.418
Number of Observations (release dates)	56 (from 3Q 2016 to 2Q 2017)	58 (from 1Q 2016 to 4Q 2016)
Tests for Double Box-Cox Model (H_1 : Double Box-Cox)		
H_0 : Semi Box-Cox ($\lambda_i=1$)	4.318	0.418
H_0 : Log-Linear ($\lambda_0=\lambda_i=0$)	16.666 **	60.128 ***
H_0 : Semi Log-Linear ($\lambda_0=0, \lambda_i=1$)	35.372 ***	71.632 ***
H_0 : Linear ($\lambda_0=\lambda_i=1$)	26.828 ***	10.336 **

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

2. The specifications of 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 Notebook Computers

Period of Application	This Time Estimation August 2017-	Last Time Estimation February 2017-July 2017
Estimated Model	Semi Box-Cox Model	Double Box-Cox Model
Box-Cox Parameter of Dependent Variable	0.338	0.675
Intercept	89.541 ***	-599.262
Display Resolution (pixels) Box-Cox Parameter	2.063E-06 **	--
L3 Cache (MB) Box-Cox Parameter	5.464 ***	122.609 ***
Main Memory (MB) Box-Cox Parameter	1.285E-03 ***	0.302 ***
Solid State Drive (GB) Box-Cox Parameter	0.031 ***	24.951 ***
Battery Life (minutes) Box-Cox Parameter	7.146E-03 **	39.628 ***
CPU Frequency (MHz) Box-Cox Parameter	--	95.908 **
Hard Disk Drive (GB) Box-Cox Parameter	--	12.420 ***
Dummy Variables		
CPU Frequency 2.0 GHz and more	7.587 ***	--
Hard Disk Drive 1 TB and more	7.375 ***	--
Display Resolution higher than Full HD and lower than WUXGA	--	220.404 *
higher than WUXGA and lower than 4K UHD TV	--	444.265 ***
4K UHD TV and higher	--	698.173 ***
Graphics On-board Graphics Memory	9.189 ***	415.874 ***
Display Type IPS Display	--	237.060 ***
IGZO Display	--	388.590 **
Touch Screen Display with Stylus Pen	--	390.060 ***
Touch Screen Display without Stylus Pen	--	196.647 **
Touch Screen Display	5.844 ***	--
Durability High Impact Resistance	9.468 ***	--
Optical Drive Blu-ray Disc Drive	--	348.349 ***
OS Windows 10 Pro 64bit	15.121 ***	310.238 ***
Pre-installed Application Microsoft Office Home and Business Premium with an Annual License of Office 365	19.261 ***	718.674 ***
Manufacturer Manufacturer A	4.550 *	-228.929 *
Manufacturer B	19.664 ***	--
Manufacturer C	--	728.847 ***
Manufacturer D	--	-355.367 ***
Period 2nd quarter 2016	--	70.895
3rd quarter 2016	--	-233.172 **
4th quarter 2016	-1.075	-292.924 ***
1st quarter 2017	2.376	--
2nd quarter 2017	1.913	--
R-squared	0.938	0.957
Adjusted R-squared	0.929	0.949
Standard Error of Regression	6.655	312.296
Mean of Dependent Variable	160.457	4,577.568
Number of Observations (release dates)	138 (from 3Q 2016 to 2Q 2017)	140 (from 1Q 2016 to 4Q 2016)
Tests for Double Box-Cox Model (H_1 : Double Box-Cox)		
H_0 : Semi Box-Cox ($\lambda_1=1$)	9.096	12.557 *
H_0 : Log-Linear ($\lambda_0=\lambda_1=0$)	24.290 ***	93.312 ***
H_0 : Semi Log-Linear ($\lambda_0=0, \lambda_1=1$)	21.441 ***	85.701 ***
H_0 : Linear ($\lambda_0=\lambda_1=1$)	42.071 ***	16.204 **

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.

3. "High Impact Resistance" dummy is applied if a device is able to withstand drop and pressure testing, or is made of high durability materials.