

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 February 2018 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 1st quarter 2017 to 4th quarter 2017) • Notebook computer: 165 (from 1st quarter 2017 to 4th quarter 2017)
Model selection ⁴	<ul style="list-style-type: none"> • Based on the results of likelihood ratio tests, semi Box-Cox model is selected for desktop computers while double Box-Cox model is selected for notebook computers.
Suggested period of application	<ul style="list-style-type: none"> • From February 2018 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 $\lambda_i = 1$), 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 Desktop Computers

Suggested period of application	This Time Estimation February 2018-	Last Time Estimation August 2017-January 2018
Estimated Model	Semi Box-Cox Model	Semi Box-Cox Model
Box-Cox Parameter of Dependent Variable	0.487	0.540
Intercept	220.111 ***	350.184 ***
CPU Frequency (MHz)	0.027 **	0.039 **
L3 Cache (MB)	12.496 ***	22.302 ***
Main Memory (MB)	6.595E-03 **	8.041E-03 *
GPU Frequency (MHz)	0.078 ***	0.151 ***
Hard Disk Drive (GB)	0.025 **	0.048 ***
Solid State Drive (GB)	0.266 ***	0.638 ***
Dummy Variables		
Monitor		
with a Monitor	84.461 ***	125.433 ***
with a Monitor (23.8 inches and larger)	67.793 ***	122.922 ***
Pre-installed Application		
Microsoft Office Home and Business Premium with an Annual License of Office 365	28.634 *	91.581 ***
Manufacturer		
Manufacturer A	118.198 ***	202.355 ***
Manufacturer B	107.812 ***	219.070 ***
Manufacturer C	107.456 ***	164.229 ***
Period		
4th quarter 2016	--	8.162
1st quarter 2017	--	5.111
2nd quarter 2017	5.039	29.536
3rd quarter 2017	-1.139	--
4th quarter 2017	-7.027	--
R-squared	0.979	0.981
Adjusted R-squared	0.971	0.974
Standard Error of Regression	32.668	47.583
Mean of Dependent Variable	594.282	927.311
Number of Observations	56	56
(release dates)	(from 1Q 2017 to 4Q 2017)	(from 3Q 2016 to 2Q 2017)
Tests for Double Box-Cox Model (H_1 : Double Box-Cox)		
H_0 : Semi Box-Cox ($\lambda_i=1$)	8.257	4.318
H_0 : Log-Linear ($\lambda_0=\lambda_i=0$)	60.581 ***	16.666 **
H_0 : Semi Log-Linear ($\lambda_0=0, \lambda_i=1$)	45.170 ***	35.372 ***
H_0 : Linear ($\lambda_0=\lambda_i=1$)	53.299 ***	26.828 ***

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

Suggested period of application	This Time Estimation February 2018-	Last Time Estimation August 2017-January 2018
Estimated Model	Double Box-Cox Model	Semi Box-Cox Model
Box-Cox Parameter of Dependent Variable	0.553	0.338
Intercept	6.905E+06 *	89.541 ***
CPU Frequency (GHz) x Thread Count	5.396 ***	--
Box-Cox Parameter	1.214	
L3 Cache (MB)	52.473 *	5.464 ***
Box-Cox Parameter	7.601E-06	
Main Memory (MB)	1.318E-11 ***	1.285E-03 ***
Box-Cox Parameter	3.263	
Display Resolution (pixels)	0.353 ***	2.063E-06 **
Box-Cox Parameter	0.373	
Hard Disk Drive (GB)	6.160 ***	--
Box-Cox Parameter	0.331	
Solid State Drive (GB)	73.269 ***	0.031 ***
Box-Cox Parameter	0.093	
Battery Life (minutes)	4.256E-14 ***	7.146E-03 **
Box-Cox Parameter	5.185	
Weight (kg)	-107.136 ***	--
Box-Cox Parameter	-0.681	
Dummy Variables		
CPU Frequency		
2.0 GHz and more	--	7.587 ***
L3 Cache	-6.903E+06 *	--
L4 Cache	79.755 *	--
Disk Drive		
Hard Disk Drive 1 TB and more	--	7.375 ***
SSD	-1,129.198 ***	--
Graphics		
On-board Graphics Memory	--	9.189 ***
Display Type		
Touch Screen Display	85.092 ***	5.844 ***
Optical Drive		
Blu-ray Disc Drive	88.188 ***	--
Security		
Biometric Authentication	73.953 ***	--
Durability		
High Impact Resistance	74.816 ***	9.468 ***
OS		
Windows 10 Pro 64bit	70.394 ***	15.121 ***
Pre-installed Application		
Microsoft Office Home and Business Premium with an Annual License of Office 365	121.726 ***	19.261 ***
Manufacturer		
Manufacturer A	66.891 ***	4.550 *
Manufacturer B	197.460 ***	19.664 ***
Manufacturer C	81.762 ***	--
Manufacturer D	102.136 ***	--
Manufacturer E	181.177 ***	--
Manufacturer F	303.683 ***	--
Manufacturer G	110.477 **	--
Period		
4th quarter 2016	--	-1.075
1st quarter 2017	--	2.376
2nd quarter 2017	35.071 *	1.913
3rd quarter 2017	2.959	--
4th quarter 2017	-39.544 **	--
R-squared	0.967	0.938
Adjusted R-squared	0.961	0.929
Standard Error of Regression	65.090	6.655
Mean of Dependent Variable	1,245.526	160.457
Number of Observations	165	138
(release dates)	(from 1Q 2017 to 4Q 2017)	(from 3Q 2016 to 2Q 2017)
Tests for Double Box-Cox Model		
(H ₁ : Double Box-Cox)		
H ₀ : Semi Box-Cox ($\lambda_i=1$)	50.311 ***	9.096
H ₀ : Log-Linear ($\lambda_0=\lambda_i=0$)	76.235 ***	24.290 ***
H ₀ : Semi Log-Linear ($\lambda_0=0, \lambda_i=1$)	112.720 ***	21.441 ***
H ₀ : Linear ($\lambda_0=\lambda_i=1$)	62.664 ***	42.071 ***

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.