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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 computers[1]. The reestimation results as of August 2019 are shown in Tables 1 and 2.

The details of data for the estimation are as follows:

Scope of application[2]	・"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]	Source: ・The retail price (quarterly average price) and specification data are provided with the *BCN Ranking* by the BCN Inc. Other important specifications unlisted in the database are taken from the specification sheet of each computer. Number of observations (release period): ・Desktop computer: 180 (from 3rd quarter 2018 to 2nd quarter 2019) ・Notebook computer: 453 (from 3rd quarter 2018 to 2nd quarter 2019)
Model selection[4]	・Based on the results of likelihood ratio tests, Double Box-Cox model is selected for desktop computers and notebook computers.
Suggested period of application	・From August 2019 onward
Frequency of estimation	・Every February and August

[1] Another 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 λ =0, function is logarithmic; When λ=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 λ_i=1), Log-Linear Model (when λ_0=λ_i=0), Semi Log-Linear Model (when λ_0=0, λ_i=1), and Linear Model (when λ_0=λ_i=1).

(Table 1)

Estimation Result for Desktop Computers

Suggested Period of Application	This Time Estimation August 2019-	Last Time Estimation February 2019-July 2019
Estimated Model	Double Box-Cox Model	Double Box-Cox Model
Box-Cox Parameter of Dependent Variable	0.195	0.342
Intercept	164350.216 ***	108.272 ***
Maximum CPU Frequency (MHz)	5.903E-23 ***	--
Box-Cox Parameter	6.450	
CPU Frequency (MHz)	--	8.464E-18 ***
Box-Cox Parameter		5.239
L3 Cache (MB)	0.629 ***	5.184 ***
Box-Cox Parameter	0.142	0.369
Main Memory (MB)	9.528E-06 ***	2.474E-06 ***
Box-Cox Parameter	1.297	1.612
Hard Disk Drive (GB)	1.271E-05 ***	0.229 **
Box-Cox Parameter	7.732E-11	0.322
Solid State Drive (GB)	1.396 ***	0.077 ***
Box-Cox Parameter	8.498E-06	0.899
Monitor Size (inch)	0.020 ***	--
Box-Cox Parameter	1.611	
Display Resolution (pixels)	5.486E-09 ***	--
Box-Cox Parameter	1.261	
Dummy Variables		
Form		
All-in-One Computer	--	12.756 ***
CPU Turbo Function	--	4.655 *
Dual Drive (Hard Disk Drive and Solid State Drive)	-164317.299 ***	-4.743 *
NVIDIA GeForce	2.036 ***	--
Dedicated Graphics Card	--	12.302 ***
4K Display	--	13.461 ***
Blu-ray Disc Drive	2.185 ***	13.668 ***
Pre-installed Application		
Microsoft Office	2.048 ***	10.709 ***
Manufacturer		
Manufacturer A	-1.052 ***	6.434 ***
Manufacturer B	1.311 **	15.897 ***
Manufacturer C	-0.888 **	--
Manufacturer D	-1.155 **	--
Manufacturer E	-0.752 *	--
Manufacturer F	-2.053 ***	--
Manufacturer G	2.590 **	--
Manufacturer H	2.809 ***	--
Manufacturer I	--	14.866 ***
Manufacturer J	--	9.567 ***
Manufacturer K	--	-7.668 ***
Release Period		
2nd quarter 2018	--	-2.783
3rd quarter 2018	--	-0.757
4th quarter 2018	-0.239	-3.361
1st quarter 2019	-0.297	--
2nd quarter 2019	-0.928 **	--
R-squared	0.950	0.921
Adjusted R-squared	0.943	0.909
Standard Error of Regression	1.361	8.418
Mean of Dependent Variable	44.780	152.112
Number of Observations	180	149
(release period)	(from 3Q 2018 to 2Q 2019)	(from 1Q 2018 to 4Q 2018)
Tests for Double Box-Cox Model		
(H_1: Double Box-Cox)		
H_0: Semi Box-Cox (λ_i=1)	90.227 ***	20.612 ***
H_0: Log-Linear (λ_0=λ_i=0)	102.980 ***	41.420 ***
H_0: Semi Log-Linear (λ_0=0,λ_i=1)	128.764 ***	45.855 ***
H_0: Linear (λ_0=λ_i=1)	161.813 ***	51.976 ***

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.

(Table 2)

Estimation Result for Notebook Computers

Suggested Period of Application	This Time Estimation August 2019-	Last Time Estimation February 2019-July 2019
Estimated Model	Double Box-Cox Model	Double Box-Cox Model
Box-Cox Parameter of Dependent Variable	0.113	0.370
Intercept	15.795 ***	130.981 ***
Maximum CPU Frequency (GHz)	11.442 ***	1.772 ***
Box-Cox Parameter	-2.621	1.943
Thread Count	0.007 ***	21.253 **
Box-Cox Parameter	2.537	-0.728
L3 Cache (MB)	--	3.482 ***
Box-Cox Parameter		0.215
L2 Cache when L3 Cache not installed (MB)	--	2.688 **
Box-Cox Parameter		1.155
Main Memory (MB)	0.002 ***	1.284E-04 ***
Box-Cox Parameter	0.685	1.267
Display Resolution (pixels)	4.365E-04 ***	0.003 ***
Box-Cox Parameter	0.491	0.537
Hard Disk Drive (GB)	0.016 **	3.055 ***
Box-Cox Parameter	0.056	0.050
Solid State Drive (GB)	0.008 ***	5.900 ***
Box-Cox Parameter	0.746	0.165
Battery Runtime (minutes)	0.001 ***	0.026 ***
Box-Cox Parameter	0.905	0.959
Weight (kg)	-1.184 ***	-6.283 ***
Box-Cox Parameter	-1.752	-0.287
Dummy Variables		
Disk Drive		
Dual Drive (Hard Disk Drive and Solid State Drive)	--	-79.160 ***
CPU 6 Cores or more	--	28.567 ***
L3 Cache	1.008 ***	--
NVIDIA GeForce	0.406 **	--
Dedicated Graphics Card	--	8.392 ***
Touch Screen Display	0.480 ***	7.967 ***
Blu-ray Disc Drive	0.448 **	13.506 ***
LTE	0.533 **	--
Pre-installed Application		
Microsoft Office	0.947 ***	14.850 ***
Manufacturer		
Manufacturer A	0.344 **	24.349 ***
Manufacturer B	0.869 ***	47.647 ***
Manufacturer C	-0.790 ***	--
Manufacturer D	-1.037 ***	--
Manufacturer E	-0.472 ***	--
Manufacturer F	0.907 ***	37.867 ***
Manufacturer G	-0.599 ***	--
Manufacturer H	1.096 ***	21.282 ***
Manufacturer I	-2.667 ***	--
Manufacturer J	-0.856 ***	--
Manufacturer K	-1.523 ***	--
Manufacturer L	-1.302 ***	--
Manufacturer M	-1.773 ***	--
Manufacturer N	-2.315 ***	--
Manufacturer O	--	28.407 ***
Manufacturer P	--	19.510 ***
Manufacturer Q	--	7.450 **
Release Period		
2nd quarter 2018	--	-3.847 **
3rd quarter 2018	--	-7.499 ***
4th quarter 2018	-0.052	-7.580 ***
1st quarter 2019	0.022	--
2nd quarter 2019	-0.263 *	--
R-squared	0.861	0.916
Adjusted R-squared	0.851	0.910
Standard Error of Regression	0.808	12.119
Mean of Dependent Variable	24.762	208.159
Number of Observations (release period)	453 (from 3Q 2018 to 2Q 2019)	383 (from 1Q 2018 to 4Q 2018)
Tests for Double Box-Cox Model (H_1: Double Box-Cox)		
H_0: Semi Box-Cox (λ_i=1)	36.017 ***	43.582 ***
H_0: Log-Linear (λ_0=λ_i=0)	104.163 ***	96.009 ***
H_0: Semi Log-Linear (λ_0=0,λ_i=1)	41.668 ***	130.406 ***
H_0: Linear (λ_0=λ_i=1)	221.979 ***	145.706 ***

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.