

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 2019 are shown in Tables 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: 149 (from 1st quarter 2018 to 4th quarter 2018) • Notebook computer: 383 (from 1st quarter 2018 to 4th quarter 2018)
Model selection ⁴	<ul style="list-style-type: none"> • Based on the results of likelihood ratio tests, Double Box-Cox model is selected for desktop computers and notebook computers.
Suggested period of application	<ul style="list-style-type: none"> • From February 2019 onward
Frequency of estimation	<ul style="list-style-type: none"> • 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 $\lambda = 0$, 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

Suggested Period of Application	This Time Estimation February 2019-	Last Time Estimation August 2018-January 2019
Estimated Model	Double Box-Cox Model	Double Box-Cox Model
Box-Cox Parameter of Dependent Variable	0.342	0.295
Intercept	108.272 ***	74.506 ***
CPU Frequency (MHz)	8.464E-18 ***	1.623E-28 ***
Box-Cox Parameter	5.239	8.263
L3 Cache (MB)	5.184 ***	1.359 ***
Box-Cox Parameter	0.369	0.244
Main Memory (MB)	2.474E-06 ***	--
Box-Cox Parameter	1.612	
GPU Frequency (MHz)	--	6.316E-06 ***
Box-Cox Parameter		2.078
Hard Disk Drive (GB)	0.229 **	0.160 **
Box-Cox Parameter	0.322	0.320
Solid State Drive (GB)	0.077 ***	0.207 *
Box-Cox Parameter	0.899	0.385
Monitor Size (inch)	--	0.002 ***
Box-Cox Parameter		3.099
Dummy Variables		
Main Memory		
16 (GB)	--	11.281 ***
32 (GB)	--	25.980 ***
Form		
All-in-One Computer	12.756 ***	--
Stick Computer	--	-16.514 ***
CPU Turbo Function	4.655 *	8.176 ***
Dual Drive (Hard Disk Drive and Solid State Drive)	-4.743 *	--
Dedicated Graphics Card	12.302 ***	--
4K Display	13.461 ***	--
Blu-ray Disc Drive	13.668 ***	--
Pre-installed Application		
Microsoft Office Home and Business Premium or Personal Premium with an Annual License of Office 365	--	6.043 ***
Microsoft Office	10.709 ***	--
Manufacturer		
Manufacturer A	6.434 ***	15.050 ***
Manufacturer B	14.866 ***	10.911 ***
Manufacturer C	--	8.788 ***
Manufacturer D	9.567 ***	--
Manufacturer E	15.897 ***	--
Manufacturer F	-7.668 ***	--
Release Period		
4th quarter 2017	--	-2.144
1st quarter 2018	--	-4.557 **
2nd quarter 2018	-2.783	0.718
3rd quarter 2018	-0.757	--
4th quarter 2018	-3.361	--
R-squared	0.921	0.948
Adjusted R-squared	0.909	0.933
Standard Error of Regression	8.418	4.636
Mean of Dependent Variable	152.112	101.729
Number of Observations (release period)	149 (from 1Q 2018 to 4Q 2018)	78 (from 3Q 2017 to 2Q 2018)
Tests for Double Box-Cox Model (H_1 : Double Box-Cox)		
H_0 : Semi Box-Cox ($\lambda_i=1$)	20.612 ***	21.830 ***
H_0 : Log-Linear ($\lambda_0=\lambda_i=0$)	41.420 ***	31.244 ***
H_0 : Semi Log-Linear ($\lambda_0=0, \lambda_i=1$)	45.855 ***	29.859 ***
H_0 : Linear ($\lambda_0=\lambda_i=1$)	51.976 ***	51.563 ***

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.

Estimation Result for Notebook Computers

Suggested Period of Application	This Time Estimation February 2019-	Last Time Estimation August 2018-January 2019
Estimated Model	Double Box-Cox Model	Double Box-Cox Model
Box-Cox Parameter of Dependent Variable	0.370	0.463
Intercept	130.981 ***	-2.322E+05 ***
CPU Frequency (GHz)	--	2.543 **
Box-Cox Parameter		2.941
Maximum CPU Frequency (GHz)	1.772 ***	--
Box-Cox Parameter	1.943	
Thread Count	21.253 **	5.714 ***
Box-Cox Parameter	-0.728	1.070
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)	1.284E-04 ***	4.459E-12 ***
Box-Cox Parameter	1.267	3.255
Display Resolution (pixels)	0.003 ***	1.279E+05 ***
Box-Cox Parameter	0.537	-0.550
Hard Disk Drive (GB)	3.055 ***	--
Box-Cox Parameter	0.050	
Solid State Drive (GB)	5.900 ***	0.513 ***
Box-Cox Parameter	0.165	0.801
Battery Runtime (minutes)	0.026 ***	7.713E-10 ***
Box-Cox Parameter	0.959	3.582
Weight (kg)	-6.283 ***	--
Box-Cox Parameter	-0.287	
Dummy Variables		
Disk Drive		
Dual Drive (Hard Disk Drive and Solid State Drive)	-79.160 ***	--
Hard Disk Drive 1TB or more	--	31.573 ***
CPU 6 Cores or more	28.567 ***	--
L3 Cache	--	45.151 ***
Dedicated Graphics Card	8.392 ***	24.658 ***
Touch Screen Display	7.967 ***	23.593 ***
Blu-ray Disc Drive	13.506 ***	25.850 ***
Biometric Authentication	--	21.036 ***
Pre-installed Application		
Microsoft Office Home and Business Premium with an Annual License of Office 365	--	44.914 ***
Microsoft Office	14.850 ***	--
Manufacturer		
Manufacturer A	37.867 ***	--
Manufacturer B	21.282 ***	--
Manufacturer C	19.510 ***	38.094 ***
Manufacturer D	24.349 ***	66.535 ***
Manufacturer E	28.407 ***	71.889 ***
Manufacturer F	47.647 ***	155.996 ***
Manufacturer G	7.450 **	18.758 *
Manufacturer H	--	-17.541 ***
Manufacturer I	--	-37.070 ***
Manufacturer J	--	-48.310 *
Release Period		
4th quarter 2017	--	-14.108 ***
1st quarter 2018	--	-12.513 *
2nd quarter 2018	-3.847 **	-29.899 ***
3rd quarter 2018	-7.499 ***	--
4th quarter 2018	-7.580 ***	--
R-squared	0.916	0.946
Adjusted R-squared	0.910	0.940
Standard Error of Regression	12.119	27.801
Mean of Dependent Variable	208.159	518.631
Number of Observations (release period)	383 (from 1Q 2018 to 4Q 2018)	260 (from 3Q 2017 to 2Q 2018)
Tests for Double Box-Cox Model (H_1 : Double Box-Cox)		
H_0 : Semi Box-Cox ($\lambda_i=1$)	43.582 ***	57.742 ***
H_0 : Log-Linear ($\lambda_0=\lambda_i=0$)	96.009 ***	139.111 ***
H_0 : Semi Log-Linear ($\lambda_0=0, \lambda_i=1$)	130.406 ***	105.167 ***
H_0 : Linear ($\lambda_0=\lambda_i=1$)	145.706 ***	112.656 ***

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.