

## Reestimation Result of Hedonic Regression Model in the Corporate Goods Price Index — Passenger Cars —

The Bank of Japan reestimates the hedonic regression model of quality adjustment, applied to gasoline cars, hybrid vehicles and plug-in hybrid electric vehicles (sedans, station wagons, minivans, SUVs, and hatchbacks). The reestimation result as of October 2018 is shown in the Table.

The details of data for the estimation are as follows:

Scope of application <sup>1</sup>	<ul style="list-style-type: none"> <li>• Gasoline cars, hybrid vehicles and plug-in hybrid electric vehicles (sedans, station wagons, minivans, SUVs, and hatchbacks), classified in the commodity class “Passenger cars” in Producer Price Index (PPI), Export Price Index (EPI), and Import Price Index (IPI)<sup>2</sup></li> </ul>
Dataset <sup>3</sup>	<p>Source:</p> <ul style="list-style-type: none"> <li>• The retail price data are provided with the <i>Goo-net</i> by the PROTO CORPORATION and the average discount rates are provided with the <i>Monthly Car Magazine JIKAYOSHA</i> by the Naigai Publishing Corp. The price data on passenger cars are compiled by multiplying the retail prices and average discount rates.</li> <li>• The specification data are provided with the <i>Goo-net</i> as well. Other important specifications unlisted in the database are taken from the specification sheet of each passenger car.</li> </ul> <p>Number of observations (release period):</p> <ul style="list-style-type: none"> <li>• 1,155 (from 3rd quarter 2016 to 2nd quarter 2018)</li> </ul>
Model selection <sup>4</sup>	<ul style="list-style-type: none"> <li>• Based on the results of likelihood ratio tests, the double Box-Cox model is selected.</li> </ul>
Suggested period of application	<ul style="list-style-type: none"> <li>• From October 2018 onward</li> </ul>
Frequency of estimation	<ul style="list-style-type: none"> <li>• Every October</li> </ul>

<sup>1</sup> The same model is applied to domestic goods, exported goods, and imported goods.

<sup>2</sup> Mini passenger cars, etc. are excluded from observations.

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

<sup>4</sup> 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  $\lambda$  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 Passenger Cars

Suggested Period of Application		This Time Estimation October 2018-	Last Time Estimation October 2017-September 2018
Estimated Model		Double Box-Cox Model	Double Box-Cox Model
Box-Cox Parameter of Dependent Variable		-0.280	0.150
Intercept		3,472.763 ***	1,664.131 ***
Room Space (m <sup>3</sup> )	Sedans & Station Wagons	--	2.433 ***
	Box-Cox Parameter	--	1.066
	Minivans	1.360E-05 ***	0.039 ***
	Box-Cox Parameter	3.400	2.770
Fuel Efficiency JC08 (km/l) ×Equivalent Inertia Weight (kg)	Sedans & Station Wagons	2.543E-09 ***	9.512E-08 ***
	Box-Cox Parameter	1.372	1.637
	Minivans	1.606E-09 ***	1.754E-09 ***
	Box-Cox Parameter	1.455	2.097
	SUVs	6.841E-09 ***	3.147 ***
	Box-Cox Parameter	1.330	0.002
Horsepower (PS)	Hatchbacks	7.152E-18 ***	1.951E-26 ***
	Box-Cox Parameter	3.351	5.773
	Sedans & Station Wagons	2.846E-04 ***	5.993 ***
	Box-Cox Parameter	0.647	0.003
	Minivans	0.007 ***	3.825E-07 ***
	Box-Cox Parameter	6.240E-06	3.384
SUVs	Box-Cox Parameter	5.880E-06 ***	3.243 ***
	Box-Cox Parameter	1.337	0.040
	Hatchbacks	0.008 ***	4.408 ***
Box-Cox Parameter	3.621E-06	0.018	
Dummy Variables			
Car Configuration			
Minivans		-1,162.565 ***	2,275.621 ***
SUVs		0.006 ***	819.239 ***
Hatchbacks		-2,306.764 ***	2,019.161 ***
Motor			
Hybrid Vehicles		--	0.393 ***
Plug-in Hybrid Electric Vehicles		--	2.137 ***
Powertrain			
AWD (Full time or Part time)		0.002 ***	0.846 ***
FR (Front-engine, rear-wheel-drive)		0.002 ***	--
Standard Equipment			
Leather Seats		0.001 ***	1.003 ***
Side Airbags		4.504E-04 **	0.559 ***
Power Seats		0.002 ***	0.869 ***
Aluminum Wheel		0.002 ***	--
LED Headlamp		0.001 ***	--
Privacy Glass		--	0.782 ***
Limited Slip Differential (LSD)		0.002 ***	0.630 ***
Advanced Emergency Braking System (AEBS)		--	0.358 ***
Adaptive Cruise Control (ACC)		--	0.405 ***
Adaptive Cruise Control (ACC) <No speed limitation>		0.001 ***	--
Lane Departure Warning System (LDWS)		0.001 ***	0.184 **
Adaptive Front-Lighting System (AFS)		0.001 ***	0.624 ***
Parking Assist		0.001 ***	--
Brand			
Brand A		-0.002 ***	-1.557 ***
Brand B		-0.003 ***	-1.353 ***
Brand C		--	-0.523 ***
Brand D		--	-1.803 ***
Brand E		-0.001 ***	-1.237 ***
Brand F		0.004 ***	2.648 ***
Brand G		0.003 ***	-0.896 ***
Brand H		--	-0.611 ***
Brand I		0.006 ***	2.987 ***
Brand J		0.008 ***	4.723 ***
Brand K		0.006 ***	3.825 ***
R-squared		0.957	0.962
Adjusted R-squared		0.956	0.961
Standard Error of Regression		0.002	0.792
Mean of Dependent Variable		3.509	52.810
Number of Observations		1,155	994
(release period)		(from 3Q 2016 to 2Q 2018)	(from 3Q 2015 to 2Q 2017)
Tests for Double Box-Cox Model			
(H <sub>1</sub> : Double Box-Cox)			
H <sub>0</sub> : Semi Box-Cox ( $\lambda_i=1$ )		85.560 ***	220.310 ***
H <sub>0</sub> : Log Linear ( $\lambda_0=\lambda_i=0$ )		273.705 ***	158.589 ***
H <sub>0</sub> : Semi Log Linear ( $\lambda_0=0, \lambda_i=1$ )		130.257 ***	238.038 ***
H <sub>0</sub> : Linear ( $\lambda_0=\lambda_i=1$ )		1,905.192 ***	641.781 ***

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

2. The specification of Double Box-Cox Model is 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. The intercept terms of the vehicle model dummy variables and continuous variables are used as explanatory variables in the model estimation.

4. The equivalent inertia weight of a vehicle is measured as its curb weight with an additional 110kg of weight to a vehicle, which is set to chassis dynamometer while measuring its fuel efficiency under JC08 emission test cycle.

5. Sedans & Station Wagons are set to the baseline of the car configuration dummy variable.

6. In addition to the explanatory variables listed above, the model includes release period dummy variables.