How to Reflect Quality Change in the CPI: The Case of Korea

Eunjeong Lee[*]
Department of Price Statistics Division
Korea National Statistical Office
E-mail Leeej@nso.go.kr
Jan 31, 2001

1. Introduction

Rapid technological advances throughout industry, especially remarkable in the sector of information and telecommunications such as personal computers (PCs) and cellular phones, have brought forth new products and those products have continued to be updated at an ever-growing pace. Accordingly, it is not easy at all to find out pure price changes of the products in calculating the Consumer Price Index (CPI). Industrialized nations, in recognition of this difficulty, have already begun to explore new ways of index calculation which can address such difficulty. One of the index calculation methods that are attracting keen attention of many countries despite their limitations in practical application is the hedonic regression model.

The researchers in Korea also have a deep interest in the hedonic model, and have tried to work out a model suitable to Korean reality while keeping an eye on foreign examples. Recently, Korean statisticians have come up with a hedonic model for some items including PC and applied the model to the specifications used in the previous years for quality adjustment purposes. Furthermore, they are comparing the results of quality adjustment and the index calculations using the existing methodology.

This paper describes the outcome of applying the hedonic regression model to PC on a pilot basis. It is believed that the model needs to be supplemented further before the

---

[*] The views expressed in this paper are those of the author and do not necessarily reflect the policies of Korea National Statistical Office.

parameter estimates obtained from the model are used to calculate CPI.

2. Development of Hedonic Regression Model for PCs in Korea CPI

A. Existing CPI calculation methodology

   In Korea, the survey specifications are modified in step with changes in consumption pattern and consumers' taste and preference. At this point, the indices are handled in either of two ways, by the judgement of experts - the staffs of Price Statistics Division: the splicing method and the direct substitution method. The former is used when the new item and the old one differ greatly in quality, while the latter, which reflects a price change directly onto the index, is used in instances when the change only includes slight alterations in packing or weight which can be translated into price value.

   In the case of PC, one of the products that are subject to fast technical improvements and therefore have a very short life cycle, the survey specifications are revised relatively more frequently. For example, the PC survey specifications were changed three times each in 1999 and in 2000, and the 6-time changes involved splicing twice and direct substitution four times. The splicing was conducted when, due to a substantial improvement in the CPU processor and the HDD speed, it was believed that the new survey specifications and the old ones differed significantly in quality. For the instances when the quality change was insignificant or the decrease in price needed to be reflected, the price changes were directly reflected on the index.

B. Hedonic Regression Model

   In order to formulate a hedonic regression model for PCs, data was collected about a total 169 kinds of PCs, most of which were available in the market as of 2000. Some of the items surveyed are not manufactured any more.

The variables which are regarded as affecting the PC price include: type of processor (whether pentium III or celerone); processor speed (MHz); CASH memory size (KB); RAM size (MB); HDD size (GB); CD-ROM speed; presence of DVD; video RAM size (MB); modem or LAN-based connectivity; and brand names (Samsung, Sambo, LG IBM, Hyundai, Daewoo, and Compaq). The reason why the brand name is selected as one of the variables is, that consumers tend to think of after-sale services provided by the manufacturer as one of the deciding factors in purchasing a PC and that the after-sale service cost which is closely related to the brand name is included in the PC price. The kind of sales outlet, although it may be another important variable, is excluded from the list of variables, because of the difficulty in classifying sales outlets into several groups that can be used as a valid variable. For an analysis purpose, in order to rule out any possibility that the type of sales outlet may result in price difference, the consumer prices recommended by manufacturers are adopted as a dependent variable.

With a view to choosing a regression model that properly shows correlations between the variables and PC prices, the linear model and log-linear model have been tested.

In order to identify which of the variables that are expected to affect PC prices are really strong price determinants, the stepwise method was adopted to test the linear model and log-linear model. The result was that, for both the models, processor type, RAM size, DVD presence, video RAM size and brand names (Samsung, Sambo and LG IBM) certainly had a significant influence on PC prices. The comparative analysis showed little difference between the two models, except that the R-squared value (R^2) of the log-linear model was slightly larger than that of the linear model, for which reason the log-linear model was taken up. As the analysis of correlations among the variables revealed a correlation between RAM size and video RAM size, the number of variables was finally reduced to six, excluding video RAM size: processor type, RAM size, DVD presence and 3 brand names (Samsung, Sambo and LG IBM). The following shows a finally formulated model (R^2 is 0.7875 and Adj-R is 0.7796):

$$\text{Log(Price)} = \quad 13.3265 \quad + \quad 0.00395\text{MEM} \quad + \quad 0.27911\text{DVD} \quad +$$
$$0.32644\text{Processor} \quad + \quad 0.19178\text{Sambo} \quad + \quad 0.23209\text{LGIBM} \quad +$$

0.33841Samsung

MEM : RAM size (unit: MB)

DVD : dummy variable ('1' for the cases when DVD is present, and '0' for the other cases)

Processor : dummy variable ('1' for pentium III processor and '0' for celeron processor)

Sambo : dummy variable ('1' for Sambo, and '0' for the other brands)

LGIBM : dummy variable ('1' for LG IBM, and '0' for the other brands)

Samsung : dummy variable ('1' for Samsung, and '0' for the other brands)

C. Index outcome

As the data on the PC products of the past years was hardly accessible, the analysis was largely confined to pentium-grade PCs. Accordingly, the hedonic model was applied to the modified PC survey specifications and PC price observations made only in 1999 and 2000. The table below shows the specification changes and PC indices when the hedonic model is applied. During the two years, PC specifications had been modified 6 times in total. Out of the 6-time modifications, there were 2 occasions when significant quality improvements led to changes in specification: direct substitution was adopted for one occasion, and index splicing, for the other. However, it has turned out that the quality improvement had not been fully reflected onto the index in either of the cases.

	PC before application of hedonic model		PC after application		Additional remarks
	Index	Increase	Index	Increase	
1999.1	56.7		56.7		
1999.2	56.6	-0.18	56.6	-0.18	
1999.3	56.6	0.00	56.6	0.00	
1999.4	56.6	0.00	56.6	0.00	
1999.5	56.6	0.00	53.6	-5.30	Specification changed[1]
1999.6	56.3	-0.53	53.3	-0.56	
1999.7	56.3	0.00	53.3	0.00	
1999.8	55.1	-2.13	52.2	-2.06	Specification changed
1999.9	55.0	-0.18	52.1	-0.19	
1999.10	54.4	-1.09	51.5	-1.15	
1999.11	54.4	0.00	51.5	0.00	
1999.12	49.7	-8.64	45.4	-11.84	Specification changed[2]
2000.1	49.5	-0.40	45.2	-0.44	
2000.2	49.3	-0.40	45.0	-0.44	
2000.3	49.1	-0.41	44.9	-0.22	
2000.4	49.1	0.00	44.9	0.00	
2000.5	49.1	0.00	44.9	0.00	
2000.6	48.8	-0.61	43.6	-2.90	Specification changed[3]
2000.7	48.5	-0.61	43.3	-0.69	
2000.8	47.4	-2.27	42.3	-2.31	
2000.9	47.1	-0.63	42.1	-0.47	Specification changed
2000.1	46.8	-0.64	41.8	-0.71	
2000.11	46.5	-0.64	41.5	-0.72	
2000.12	45.6	-1.94	40.7	-1.93	Specification changed

[1]Significant changes were not made in variables, but index splicing was adopted

[2]Significant changes were made in variables, but direct substitution method was adopted.

[3]Significant changes were made in variables and index splicing was adopted.

The PC indices, which previously recorded annual decreases of 2.8% and 13.2%, respectively in 1999 and 2000, dropped further by 6.5% and 18.6% when the hedonic model was applied. This can be translated into 0.0088%p and 0.0109%p fall of average annual CPI in 1999 and 2000, compared to the indices before application of the hedonic model. In other words, the PC indices currently in use for the year 2000 have an upward bias of 0.0109%p, because a proper quality adjustment was not made at the time of PC specification change in 2000.

3. Conclusion

With rapid technical improvements and the resultant short life cycle of products, statisticians and researchers are struggling with the ever-growing difficulty in reflecting the price change in products with the same quality onto the CPI. The previously used methods for index calculation cannot address these radical changes any more. Therefore, alternative methodologies, including the hedonic regression model which is intended to estimate quality changes, are being examined in an effort to work out as accurate CPI as possible. Korea is not an exception to this global effort. The statisticians in korea also have studied a range of methods that may fully consider the quality change between the new and old observations. At the moment, the hedonic regression approach is drawing much attention as a possible solution.

It is admitted that several factors, including a vast volume of data set, high costs of data collection and continuous emergence of new technologies, make it difficult to adopt the hedonic model immediately. Nevertheless, the concept of translating quality changes into prices is very inspiring.

Korean researchers are planning to conducting research into extending the use of hedonic regression models for quality adjustment purposes to additional items, such as automobile, within the CPI.