Quality adjustment in practice: Case studies in the Corporate Service Price Index (CSPI)

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1. Introduction

The Bank of Japan produces two price indexes for capturing the price movements of goods and services traded among companies: the Corporate Goods Price Index (CGPI), and the Corporate Service Price Index (CSPI). While the CGPI has its own long tradition (since 1897) as the Wholesale Price Index (WPI), the CSPI has been published since 1991, where data have been available since 1985. The present CSPI is calculated based on the weight data of 1995. Nowadays, the CSPI functions as an essential indicator for judging Japan's economic conditions and deflators for the Gross Domestic Products (GDP). Moreover, the CSPI is often used as a standard for price negotiation.

However, with the country's rapid technological development and diversification in service industries, representative transactions are frequently changed and, consequently, prices compiled in the CSPI are continuously required to be replaced from the old samples to new ones. An important issue is that it is difficult to employ quality adjustment in replacing representative samples.

As is well known, quality adjustment for service prices is far more difficult to achieve than that for goods. Conceptually, quality in services like comfort is quite diverse and ambiguous. Practically, even if quality is defined as a certain concept, we can hardly find suitable data for evaluating quality changes that occur continuously.

Nevertheless, to a certain extent, we have endeavored to employ quality adjustment in the CSPI by collecting information from correspondent companies. Our strategy is to do our best with the information we have available.

This paper is organized as follows: Section 2 overviews the methodology of quality adjustment. Section 3 surveys our practical application of quality adjustment in price replacements in 2002. In section 4 we show several examples and explain our experiences of quality adjustments in more detail. Section 5 concludes with some remarks.

2. Overview of the Methodology

The quality adjustment methods we have used are: the direct comparison method, the unit price comparison method, the production cost method, the overlap method, and the hedonic regression method. The imputation method, in which the price information of other similar products is imputed to the price index and the price gap caused by quality differences is eliminated from the price index, has not been used so far.

Direct Comparison Method

When we replace sample prices, it does not necessarily cause a change in quality between the old and new services. If there is no difference in quality, we can use the direct comparison method, which incorporates the prices of new products into

the index by comparing them with those of old products directly. For example, this is often the case when the product numbers have changed but the quality has not. In the sense that we judge whether a quality difference exists, the direct comparison method is regarded as a quality adjustment method. When the direct comparison method is selected as a quality adjustment method for a sample price replacement, there is no practical work to adjust the quality of sample prices.

Unit Price Method

The unit price method adjusts the difference between the prices per same quantity unit when there are changes in price and transaction volume. As in the direct comparison method, quality of the old and new products is treated as unchanged. It should be noted that volume discounts are regarded as changes in quality because there are changes in the transaction condition between the old and new sample prices. In these cases, the unit price method cannot be simply applied.

Production Cost Method

The production cost method adjusts prices on the foundation that the difference between the qualities of old and new products corresponds to the difference in costs to make products. The cost information is obtained from corresponding companies. Thus, although we check the provided information carefully, quality adjustment basically depends on their information. The advantage of the production cost method is that, so long as the data can be obtained from each correspondent company, the information can be incorporated instantly. Therefore, the applied range of this method is broad, even in service prices.

Overlap Method

When the old and new products are sold simultaneously during a certain period of time and when the difference between the two prices is steady, we could apply the overlap method. In this method, we suppose that the price difference between them comes solely from differences in quality, which captures all the quality differences between two sample prices that cannot be specifically extracted by methods such as the production cost and the hedonic regression method. The basic rule is to maintain the level of the new and old price indexes.

Hedonic Regression Method

The hedonic regression method treats products as a collective entity constituted by several functions and degree of performance (both are a part of “characteristics”). Prices in market equilibrium are supposed to be explained by those characteristics under perfect competition. Thus, if a significant regression model explaining the relation between prices and characteristics is obtained using actual data, the theoretical price change corresponding to quality change is calculated based on the volume of the characteristics. So, we can obtain pure price movements by excluding the price change caused by this quality change.

The advantage of the hedonic regression method is that quality adjustment can be

made statistically based on the objective characteristics of a product without relying on subjective judgments about its quality. Besides, this method reduces the burden of reporting firms because they are freed from our inspection of production cost.

3. Price Replacements During 2002

3.1 Practical Application of Quality Adjustment Methods

With the continued development of information technology and the accelerating diversification of services, representative services are changing rapidly. We are forced to replace sample prices continuously. In recent years, the number of cases in which samples need to be replaced has been increasing. Table 1 shows that price replacements made during 2002 for the CSPI totaled 413 among 2,957 sample prices, indicating that the number of replacements of price data comprises 14 percent of the CSPI sample prices in one year.

However, as described before, it is quite difficult to employ proper quality adjustment for service prices. As shown in Table 2, three-quarters of price replacements in the CSPI during 2002 were judged as incomparable cases, where the indexes of new services start in the same level as old ones. Indeed, the number of "difficult to compare" in 2002 was partly inflated due to the special circumstance that the sample prices for real estate services were intensively revised in the latter half of that year.

The direct comparison method was applied to around 10 percent of replacements of sample prices for the CSPI during 2002. It should be borne in mind that this number includes such cases as organizational changes of corresponding companies due to affiliations without any change in service itself or conditions of transaction.

When we adjust substantial quality differences between the old and new services, the production cost method is relatively popular, and comprised 8 percent of all the replacements—one-third of comparable cases in 2002. Although this method depends on the information provided by correspondent companies, it is broadly applicable to various cases.

Under certain conditions, the overlap method is also usable. The number, 14, looks small, but this means that we coped with more than one case a month on average by using the overlap method.

The number of the cases using the hedonic regression method was only three in 2002, all of which were the quality adjustment of computer rental, where we applied the hedonic regression model developed for the quality adjustment of computers in the CGPI to the CSPI.

Other than computer rental, the index of leasing of computers and related equipment is indirectly influenced by the indexes of computers in the CGPI, whose quality changes are adjusted by the hedonic regression method. These cases are not included in Table 1.

3.2 Effect on the CSPI in 2002

Table 3 summarizes the effect of quality adjustments on the year-to-year change in the CSPI by major group. In 2002, quality adjustment had a negative effect on the year-to-year change of the price indexes of leasing and rental, professional services, and other services by 0.1 percent, while in information service, price replacement had a positive effect. In the result, quality adjustment itself was not a factor that moved the total CSPI in 2002. On the other hand, the figures including the effects of quality adjustment of goods related to leasing services show that quality improvement in computers lowered the year-to-year change of the index of leasing and rental by 2.8 percent, and the CSPI total by 0.2 percent.

4. Quality Adjustments in Practice

Compared with quality adjustment in goods, that in the service sectors is admittedly difficult, but we actually adjusted 50 cases in 2002. In the revision plan for the 2000 base CSPI, we will try to improve our methods of quality adjustment. The following section describes our practice and ideas using examples.

4.1 Production Cost Method

In general, the price difference between the old and new products reflects additional costs to produce new ones such as costs of materials, labor expenses, research and development expenses, etc. Consequently, when we employ the production cost method, we need information on all of these costs. However, because services are provided by labor intensive work, changes in the cost corresponding to those of qualities are, to some extent, derived from changes in labor costs. If labor productivity is unchanged, it is not so difficult for correspondent companies to report such changes in labor costs. Therefore, when we face alternations in representative contracts, in particular, of services provided by relatively homogeneous workers, we persistently collect information on cost differences, and compare those differences of the cost and the price change.

Example 1: “Market Research”

In the business of “market research,” a researching firm makes a contract with a customer on certain terms such as the number of items, areas, etc. If those terms of the representative service are changed, we must replace the sample price accordingly. In example 1, while the price was unchanged, the number of items to be researched increased from 95 to 98. The correspondent company reported that the cost for market research was basically in proportion to the number of items, and that price should have been raised by at least three percent. So, we treated the difference between the new price, 23,550 yen, and the quality adjusted price, 24,278.35 (=23,550/(1-0.03)) yen, as the pure price change.

Example 2: “Building Cleaning Service”

The price for building cleaning service is determined by manpower, frequency, and area to be cleaned. In example 2, the correspondent company reported that cleaning frequency defined by the contract decreased from eight times to six times a month and reduced the cost for cleaning by 103,500 yen. Therefore, we treated the difference between the actual new price, 666,000 yen, and the quality adjusted new price, 907,500 (=1,011,000-103,500) yen obtained from the price of old price (1,011,000 yen) minus the decrease in cost (103,000 yen), as the pure price change.

In addition to these examples, we can apply the same approach to the prices of services like facility management services, security services, etc. In applying the cost production cost method to the quality adjustment of services provided by labor-intensive work such as software development services, we should take the price change caused by the improvement of labor productivity into consideration. However, the price change caused by the improvement of labor productivity is not measured by the production cost method in practice due to lack of information.

Moreover, in applying the production cost method, there is the general problem that we do not always obtain the exact cost information corresponding to the quality change by the correspondent companies' reports. As cost information is extremely confidential, we sometimes face the obstacle that, due to correspondent companies' strategies, they cannot provide cost information at all, or may they provide only a part of cost information. In addition, the reporting burden on correspondent companies would increase, in particular, when we survey many sample prices from a certain correspondent company, or we survey services that have briefer product cycles.

On the other hand, we have different types of examples using the production cost method. In "certified social insurance and labor specialist service," we calculate the cost for quality change with a simple regression model.

Example 3: "Certified Social Insurance and Labor Specialist Service"

"Certified social insurance and labor specialist service" is a consulting service for a company's labor management. Basically the costs for consulting correspond to the number of employees to be managed in customer's company. Thus, if we identify this relation statistically, we can apply the production cost method to the change in the contract about the number of employees.

At present we use a tariff table of monthly consulting fees, with 14 ranks set by the number of employees of customer's company ranging from "from one to less than five" to "from 400 to less than 500." So, even if the number of employees is beyond this range, we obtain theoretical prices based on consulting costs for any case from a simple regression function between monthly fees and the number of employees.

In example 3, the prices of old and new services were defined as consulting fees with employees ranging at "from 1800 to 1899" and "from 2300 to 2399" respectively. In this case, putting medians of employees, 1849.5 and 2349.5,

into the regression model, we calculated the theoretical increase rate of price based on the consulting cost corresponding to the quality change, which was 26.2 percent. Consequently, we obtained the quality adjusted price of the new service 1,009,600 (=800,000*1.262) yen by multiplying the price of the old services (800,000 yen) by the rate of price change due to the quality change (1.262). The price difference of the minus 129,600 (=880,000-1,009,600) yen derived from the price of new services (880,000 yen) minus the quality adjusted price of the new services (1,009,600 yen) is counted as the pure price change.

Another problem in the production cost method is that sometimes reported cost information includes not only the additional cost for the change in quality to be adjusted, but also that for other factors due to the limitation of information provided by the correspondent companies. It is difficult to extract the exact cost for quality change.

Under such circumstances, to conduct quality adjustment of sample prices, we use available information as much as possible. In the CSPI of 2000 base, we will try to apply the production cost method to the newly introduced index for packaged software. Since the packaged software is produced by relatively small firms, if a responding firm specializes in the products to be sampled and develop a new series of these products, it is relatively easy for us to collect the accurate cost information of the new products. This is because we can regard that the total cost of the company is equal to the cost of the products produced.

4.2 Unit Price Method

The unit price method is applicable as long as the quality per unit is kept in the same between the old and new samples. Since it is used for only one case in the replacements of samples implemented during 2002, we will explain two examples, one of which was reported in 2001.

Example 4: “Taxis”

In taxi services, quality in terms of transportation is not supposed to change significantly although there might be slight differences in ride quality like comfort. Therefore, when faced with the price change in taxi services, we compare the unit price, such as a price per meter. In example 4, the driving distance benchmark for counting fees was changed from 273 meters to 292 meters. Since our sample price was set at the fee for the driving distance benchmark, the theoretically adjusted price for new driving distance benchmark, 292 meters, was 855.68 (=800 *292/273) yen by multiplying the price of the old services (800 yen) by the rate of change in the driving distance benchmark (292/273). Thus we regarded the price difference to be minus 155.68 (=700-855.68) yen, which was derived from the price of new driving distance benchmark (700 yen) minus the adjusted unit price of the old services (855.68 yen), and is counted as the pure price change.

Example 5: “Newspaper Advertising”

In “newspaper advertising,” size is an important factor that determines the price of advertising. In other words, when the size of representative newspaper advertising changes, as long as other conditions are the same, prices per unit size between the old and new advertising are comparable because quality of the same unit is the same. In example 5, while the size of advertisement was changed from 36.85 square centimeters (=5.5 by 6.7 centimeters) to 44.28 (=5.4 by 8.2 centimeters), the price increased from 840.1 yen to 1088.9. However, unit price per 1 square centimeter (22.8 yen) remains almost the same. Taking into account that other qualities remained unchanged, we apply the unit price method and made the index level remain unchanged.

The idea of the unit price method is quite simple. However, as mentioned before, we should be cautious about the volume discount effect on price. If the unit price is determined by the volume of services, differing amounts of services are not comparable.

4.3 Overlap Method

Example 6: “Outdoor Advertising”

In “outdoor advertising” we collect advertisement rates of specified contracts that are defined by location and size. If one of those contracts expired, we replace it with another. In this case we often use the overlap method because the new sample coexists with the old one. In example 6, although the price of the new sample is much higher than the old one, the responding firm told us that the price difference had been stable in the past. So, regarding the price difference as that of quality, we applied the overlap method and kept the same index level as before.

This is considered a rational method when the two services coexist simultaneously, the transaction volume of both products is stable, and those prices move in parallel. However, actual application of this method is limited, because this does not usually occur in services facing relentless technological innovation and diversification. In general, old services rapidly lose their attraction within the market due to the introduction of new ones. Furthermore, if new services are priced strategically to increase their market share, the assumption that the price gap reflects the quality difference does not hold.

One of the applicable prices for the overlap method seems to be airfares, where various kinds of discount tickets are sold and replaced, reflecting recent deregulation in the airline industry. We are sure that there are quality differences between normal tickets and discount tickets. However, it is not so simple to incorporate quality adjustment in air passenger transportation. Let us discuss the issue using our future plan of the CSPI.

Example 7: “Domestic Air Passenger Transportation”

In the 2000 base CSPI, we are planning to expand the variety of discount tickets in "domestic air passenger transportation." This will reflect the actual price movements more accurately, but we will have to cope with the lack of term- providing services of seasonal discount tickets. In Japan there are several seasonal discount tickets that are sold only in off-peak seasons. These discount tickets have several conditions such as no cancellation, no reservation change, purchase in advance, etc. In this sense their quality is obviously inferior to normal tickets.

The point is whether the price difference is regarded as the quality difference between discount seasonal tickets and normal tickets. If it is true, we can apply the overlap method to the price replacement whenever each season ends. In the price index there is no jump between seasons.

However, we decided not to adopt this way of quality adjustment in the 2000 base CSPI. The reasons are following two points. First, the price difference does not seem to reflect that of quality. In other words, the price difference is too large, despite satisfying the basic service of transporting a person to his or her destination. This is partly because airline companies could control their oligopolistic prices in Japan. Second, the possibility of purchase, which is one factor of quality of services changes depending on the timing of ticket purchase. For example, when customers purchase normal tickets during peak season, they must reserve them in advance and cannot change their plan freely just before traveling because they have little chance to purchase other tickets. This means that customers never enjoy the quality of normal tickets in peak season. Therefore, we cannot simply define the price difference in air passenger transportation as differences in quality.

4.4 Hedonic Regression Method

The hedonic regression method is applied only to "computer rental." We apply our hedonic regression model used in the CGPI to the CSPI as a substitute. This is because we regard the quality change in services of computer rental equal to the quality change in computer products.

Example 8: "Computer Rental"

The index of "computer rental" is compiled by rental fees of representative computers, which rapidly and continuously change in line with technological development. Therefore, we apply our hedonic regression model used in the CGPI to the CSPI. In example 8, our sample price was a rental fee of a notebook computer for six months, and the spec of the representative computer changed in main memory, from 384MB to 768MB, and clock frequency, from 1.0GHz to 1.6GHz. Then, using the parameter of the hedonic regression model for the CGPI, we obtained the rate of the change corresponding to the quality improvement of the representative notebook computer, 48.7 percent. Since we assumed that quality of computer rental service was defined by the computer to be rented, the level of the theoretical

price corresponding to the quality of the new rental service was 39,702.9 yen (=26,700*1.487). Consequently, the difference between this theoretical price (39,702.9 yen) and the actual price (38,900 yen) was treated as a price decrease in the CSPI.

In the indexes of "leasing of computers and related equipment," the effect of quality adjustment using the hedonic regression method is indirectly influenced. Leasing service prices are usually calculated by multiplying the prices of products to be leased by the commission rate for leasing services. In the CSPI, sample prices of leasing services are compiled by multiplying the commission rate for leasing services collected from corresponding companies by the prices of products to be leased. As prices of products to be leased, we selected the corresponding index series from the CGPI—what we call "inflator." As for "leasing of computers and related equipment," the inflator is the index of personal computers or electronic computers and computer equipment in the CGPI. Therefore, whenever quality adjustment using the hedonic regression method occurs in these indexes of the CGPI, it has some effects on leasing of computers and related equipment in the CSPI.

As described above, the hedonic regression method has the advantage in objectively quantifying quality. However, there are various issues to be solved in practice. First, the possibility of specifying the principle characteristics representing the quality of each product must be secured before using this method. Second, these characteristics need to be shown quantitatively. Third, to obtain a stable estimation, a vast amount of data on prices and characteristics must be collected within a short period. These restrictions prevent us from applying this method to various items in the CSPI.

5. Concluding Remarks

This paper explains our practical experiences and ideas in employing quality adjustments in the CSPI. While intensive discussion on the methodology about quality adjustment is progressing, we are struggling to adjust quality change as much as possible by using available data and information. Our practical approach might look simple in the sense that it does not necessarily rely on complex calculations. However, under the circumstance that representative services alternate continuously, it is essential for us to manage various price replacements for adjusting the quality differences between the old and new services without judging it to be "difficult to compare." Otherwise, the CSPI will be seriously distorted and we will not grasp the real situation in service sectors. Therefore, we will continue to make efforts to improve the accuracy of quality adjustment by collecting as much information as possible. The most important point is to keep close contact with correspondent companies. Practical success in quality adjustment depends on statistics compilers' back-to-basics mindsets and actions.