Working Paper Series

Recent Improvements and Prospects of Price Indexes (2)

QUALITY ADJUSTMENT OF SERVICE PRICES

The Results of Quality Adjustment of the Corporate Service Price Index in 2000 and Future Implications for Handling Service Prices

Hiroshi Ugai*

Research and Statistics Department
Bank of Japan

C.P.O BOX 203 TOKYO
100-8630 JAPAN

* e-mail: hiroshi.ugai@boj.or.jp

Working Paper 01-22

This is the second paper in a series of studies on price indexes written amid the rapid progress in the complexity of Japan's economy and in the diversification of pricing behavior of enterprises. I would like to thank Professor Nakajima (Keio University), Professor Nishimura (University of Tokyo), and the many staff of the Bank of Japan for their useful comments. The views expressed here are those of author; they do not necessarily reflect those of the Bank of Japan or the Research and Statistics Department. All errors belong to the author.

QUALITY ADJUSTMENT OF SERVICE PRICES

The Results of Quality Adjustment of the Corporate Service Price Index in 2000 and Future Implications for Handling Service Prices

Hiroshi Ugai[†]

Research and Statistics Department

Bank of Japan

November, 2001

Abstract

The Bank of Japan has published the Corporate Service Price Index (CSPI) since January 1991, and data used in the index has been collected since January 1985. Based on the Bank's ample experiences of compiling the CSPI, this paper has introduced the actual methods of quality adjustment to compile the CSPI and the results of quality adjustment in 2000. The Bank has been endeavoring to adjust the quality as much as possible by using various methods as well as to introduce many newly expanding service items at the time of revising the base year and collect as many samples as possible in compiling the CSPI. The small degree of declines in prices estimated from quality adjustment successfully indicates the features of the services industries—that is, their low productivity.

Still, such quality adjustment has faced many obstacles that are connected to how the output of services should be defined. Technological innovation induced by the progress of information technology and heterogeneity of services accelerated by deregulation and supplemented by information technology have become the two biggest recent changes and these changes have complicated quality adjustment in service prices. These obstacles are not confined to Japan only; rather, they should be considered as applicable to service prices worldwide.

[†] hiroshi.ugai@boj.or.jp

This paper[‡] has drawn out the many limitations involved in capturing the quality of services concretely, and has suggested directions toward expanding varieties of quality adjustment methods. As for services of which output can be determined by the amount of labor inputs and capital inputs, the existing production cost method is still valid, but wider application of the hedonic regression method should be developed. On the other hand, as for services for which it is difficult to use production functions and of which the output is determined by the behavior of demand, inventing econometric models that comprise the concept of saving or consuming time by using services, and utilizing survey data on customer satisfaction should be developed. Furthermore, when the assumption of perfect competition does not hold, inventing other econometric models that take account of the monopolistic behavior of service producers is necessary. Based on the above features of services, all of these new approaches focus on the demand side of services, not the producer side. It is important to continue to develop and utilize quality adjustment methods more positively and to further improve the accuracy of quality adjustment.

(*JEL classification: C43, C81, L15;* keywords: service price, quality adjustment, hedonic approach)

1. *Introduction*

The Bank of Japan has published the Corporate Service Price Index (CSPI)[1] since January 1991, and data used in the index have been collected since January 1985. The CSPI covers about 60 percent of the total transaction values of all inter-corporations services, according to the 1995 I-O Tables. As a result, the actual development of the CSPI is quite consistent with the economic conditions of Japan; it is thus useful as an economic indicator.

[‡] This paper was originally presented to the 16th Meeting of the Voorburg Group on Service Statistics held at Örebro, Sweden, in September 2001 and has been revised thereafter.

[1] For details of this price index, see Research and Statistics Department, Bank of Japan (1999).

Our success in compiling the CSPI for such a continued period and in surveying the price developments of services sectors partly stems, in a sense, from the subtle and realistic balance between practical needs and theoretical problems. A typical example of this balance may be seen in dealing with wholesale and retail distribution services and financial services (imputed interest). The trade margins of wholesalers and retailers will depend on the variety of goods sold, the location of shops, the transaction lot, business hours, and many other factors. The margins of various kinds of trading companies in that sense cannot be compared directly. Such services with technical troubles are excluded from the index. To improve the accuracy of the CSPI, it should be studied how the outputs of some services omitted thus far are defined and should be included in the CSPI. In the United States, various leading studies have been done to define the actual output of services.[2] Because it is crucial for us in the long run to capture the trade margins of wholesalers and retailers and financial margins appropriately, we are continuously studying the fundamental issues along with theoretical support from academics.[3] At the same time, in the process of adjusting the quality of price data for more than 10 years, even regarding the service prices already included in the CSPI, we have faced various kinds of theoretical and technical problems that are connected to the difficulties of how prices and outputs of services can be defined. We have tried to lessen the impact of such problems as much as possible, but there are still limitations to be solved. In this paper, I will discuss mainly the latter point and show what areas can be expected to spur further research to adjust the quality in service prices based on our experience.

The rest of the paper is organized as follows: Section 2 discusses recent changes in

---

[2] For example, see the Brookings Institution's workshop on productivity in the services sector and their related papers (2000), Grossman and Helpman (1991), Armknecht and Ginsburg(1992), Gordon (1996) (1999), Diewert and Fox (1998), Levy, Beamish and Murname (2000), Mesenbourg (2001), and Baily and Zitzewitz (2001). There are many other papers related to this matter that I have not introduced.

[3] In Japan, research on productivity in the retail service industry from the viewpoint of consumer demand behavior is now progressing along. This approach defines consumer utility where the service output is the aggregation of variety, abundance, convenience and reception. It estimates the production possibility frontier by applying the DEA (Data Envelopment Analysis) method to micro data. See Nakajima (2001) for further details.

environment surrounding the quality adjustment in service prices. Sections 3 and 4 summarize various quality adjustment methods and usage in practice, and evaluate the effects of quality adjustment in the CSPI conducted in 2000. Section 5 discusses the limitations in measuring service prices and the quality adjustments from the theoretical issues to the actual technical issues from the viewpoint of statistics compilation. Section 6 suggests concrete directions for further research that should, I hope, encourage active discussions about quality adjustment of service prices. I conclude with Section 7, and add some reservations, mostly from the viewpoint of central banks concerned with maintaining price stability.

2. *Environment Surrounding Quality Adjustment in Service Prices*

Until the mid-1990s, the difficulties of quality adjustment had been recognized as twofold. The first mainly concerns the quality improvement of goods as technological innovations. Rapid technological innovations had been seen mostly in the goods market; adjusting quality of goods involved requires capturing the improvement of such quality changes. The second difficulty mainly concerns the heterogeneity of services as many services are made-to-order. Recently, even the first difficulty has become more evident in the services market. For example, technological innovations have appeared rapidly in the telecommunications sector—the speed of innovation in that industry may exceed that of the goods market. Therefore, new services that embody such improvement of quality must be included, and it is also necessary to adjust the quality to reflect changes in the contents of existing services. To deal with this, we have introduced many newly expanding service items at the time of revising the base year in compiling the CSPI. Furthermore, when new services are borne or epoch-making technological improvements are attached within the same item category between the base year revision, the degree of quality change should be evaluated correctly to connect the prices of old and obsolescent samples to those of new samples by taking into account the effects of the newly introduced incomparable characteristics.

As for the latter, one way of coping with this is to collect as many samples as possible. This is our basic stance in compiling the CSPI, and therefore the number of sample prices per item services in the CSPI (around 29) is much larger than that of item commodities in the WPI. Still, if the customized services were not transacted continuously, it is necessary to compare the heterogeneous price data within the same item category by adjusting the quality. In addition, deregulation has recently progressed in many services, i.e. telecommunications, air passenger transportation, and many others, and has forced many companies to diversify their pricing strategies further. Recent progress in information technology has enabled service providers to handle the information of service users and to divide the services markets to segments based on subtle differences in user needs. Thus, to seek for appropriate solutions to limitations in quality adjustment of the service prices based on both technological innovations and heterogeneity is becoming a far more important issue than in the past.[4]

3. *Various Quality Adjustment Methods and Actual Usage in Compiling the CSPI*

Amid such ongoing rapid changes in circumstances of quality adjustment in service prices, the Bank of Japan is endeavoring to adjust the quality as much as possible by using various quality adjustment methods in compiling the CSPI. In general, in adjusting the quality of products, given that the assumption of perfect competition holds, the marginal cost of producers and the marginal value of users (user corporations in case of the CSPI) are equal in equilibrium, indicating that quality adjustment from the supply side is equal to that from the demand side. In other words, adjusting the service price by the production cost of newly attached functions, to stay on the same production possibility curve in terms of characteristics units, is equivalent to shifting back the production isoquant, obtained by the input of a service using the characteristic unit

[4] For overall problems in treating both goods and services prices, see Hayakawa and Yoshida (2001)

measured by the values of user corporations, to the original position. This argument can be generalized into the relationship between producers and consumers. That is, when quality change in services occurs, we have to shift back the utility function to the original level by changing the prices of the services.

Since there is no difference in the degree of quality adjustment from the supply side and the demand side as far as the above assumption holds, the criteria of selecting methods are: deciding which method has the most reliable information, and determining the extent to which other conceptual limitations concerning each method described in this section can be overcome.

Let me begin by surveying the actual usage of quality adjustment methods in 2000. First, the frequency of quality adjustment is high. Quality adjustments made during 2000 for the CSPI totaled 361 among 2,957 items, indicating that the number of replacements of price data comprises more than 10 percent of the CSPI in one year (Chart 1), slightly less than that of the Wholesale Price Index (WPI) (Chart 2). The quality adjustment methods the Bank used are: the direct comparison method, the unit price comparison method, the overlap method, and the production cost method. The hedonic regression method is used for compiling the WPI, but is used only indirectly for the CSPI. The imputation method has not been used for either index so far. When none of the methods can be applied, the Bank reluctantly classes the case as "difficult to compare" so that the index level does not move. The Bank tries to avoid "difficult to compare" cases, but 40 percent of these cases were observed for the CSPI.

Below are concrete examples of applying each method.[5] Overall, services to which methods of quality adjustment are applied are limited to: 1) items in which quality can be captured directly, 2) items in which quality can be captured by volume, 3) items whose price change can reflect quality difference, and 4) items in which changes in quality can be grasped from changes in production costs.

---

and Sen (1982).

[5] Further details on the quality adjustment methods and the actual application are explained in Price

A. *Direct Comparison Method*

When no quality difference exists between old and new products, the direct comparison method—which incorporates the prices of new products into the index by comparing them with those of old products directly—can be used. This was typical for cases in which the product numbers have changed but not the quality itself, or for cases in which the reporting company has changed due to affiliations and the service in transaction and the company itself or conditions of transaction remain the same. It was applied to around 40 percent of replacements of price data for the CSPI during 2000. The number of cases subject to this method has a tendency to increase in line with corporate restructuring and reorganization of businesses.

B. *Unit Price Comparison Method*

This method is applied when there are changes in the transaction volume while the actual quality of products remains unchanged. The difference between these prices per same quantity unit is considered as either an increase or decrease of prices. This is the same way of thinking as the direct comparison method in the sense that it regards the quality of old and new products as unchanged in quality-adjusted terms. It was applied to only 5 percent of replacements of price data for the CSPI during 2000. Caution should be taken so as not to confuse the quality difference with volume discounts; thus confirmation should be made to the surveyed companies on whether there are changes in the transaction condition between old and new prices. An actual example from 2000 follows.

Example 1

Among "fire insurance" of "finance and insurance," the price data (damage

---

Statistics Division, Bank of Japan (2001).

insurance premium) of normal fire insurance was changed. The price of the surveyed product is the selling price from agents to firms and is the insurance per insurance unit of storage. With respect to the contents of the price data, the insurance unit was changed from 170 million yen to 100 million yen, but the insurance rate and the content of service were unchanged. Therefore, the CSPI also remained the same.

C. *Overlap Method*

When old and new products are sold simultaneously during a certain period of time and when the difference between the two prices is steady, this method judges that the price difference between them comes solely from differences in quality. Under this judgment, the basic rule is to maintain the level of the new and old price indexes. This is considered a rational method when the two products are transacted simultaneously and the transaction volume of both products is stable. This method was applied to around 1 percent of cases in the CSPI. An actual and rare example of high-tech products from 2000 is described below.

Example 2

Among the price data of "software development" in "information services" of the CSPI, some products adopt the unit price by the required programming language as "software development." In this example, as the quality of computers has been improving, the demand for assembly languages has decreased. Programs written in assembly languages are relatively small in terms of program size, but the mechanic language must be rearranged using ideographical match-marking. In contrast, demand for programs written in the high-tech but easy-to-understand C Programming Language, despite its large size, is increasing, and has become mainstream. Consequently, price data were switched to those written in C Programming Language. The same company has simultaneously been providing both services, and the prices of the two products were almost parallel. Thus, the index was unchanged based on the overlap method.

However, actual application of this method is limited, because this situation does not usually occur in products facing relentless technological innovation. For products facing technological innovation, old products rapidly lose their attraction within the market due to the introduction of new products. Furthermore, if new products are priced with strategy to increase their market share, the assumption that the price gap reflects the quality difference does not hold. The overlap method has the disadvantage that it is hard to apply to high-tech products.

D. *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 produce that difference. The advantage of the production cost method is that as long as data can be obtained from each surveyed firm, the information can be incorporated easily. This indicates that the application range of this method can be broad. The Bank constantly exchanges information with firms and uses the obtained information after judging whether any bias exists regarding the cost information on quality changes. This method is applied to more than 10 percent of replacements of price data for the CSPI during 2000. An actual example from 2000 of the CSPI follows.

Example 3

As for “motor vehicle maintenance” among “motor vehicle and machinery maintenance,” the checklist of motor vehicle inspections was reduced due to the revisions of the Road Trucking Vehicle Law (which came into effect in May 2000). While costs were reduced from this viewpoint, the duration of compulsory motor vehicle inspection for motor vehicles lengthened, which increased the cost per inspection. Overall, when the nominal price increases only slightly, prices in quality-adjusted terms is evaluated to be flat and unchanged. In fact, however, since there was a rebound in the recent decrease in prices due to negotiations with users, an almost 20 percent increase in quality-adjusted terms was applied to the

index.

However, various restrictions exist when using this method. First, it is difficult to evaluate characteristics such as designs and brands in terms of costs. Second, it is insufficient to use this method if technological change saves the cost of producing services. Third, if functional changes corresponding to the increase or decrease in quality are diversified, the burden of calculating the cost changes by surveyed companies cannot be ignored.

E. *Hedonic Regression Method*

The hedonic regression method regards products as a collective entity constituted by several functions and degree of performance (both are a part of "characteristics"). As for the old and new products, the theoretical prices are calculated based on the volume of the characteristics; the figure obtained is the difference due to quality change within the price gap between old and new products. The difference excluding this quality change is considered purely as a price movement. The greatest advantage in using this method is that a quality adjustment can be made statistically based on objective characteristics of a product without relying on subjective judgments about its quality. Moreover, quality adjustment of products can be easily conducted as long as related data are collected, so that it is advantageous for products with drastic innovations and short product cycles.

The hedonic regression method is thus an excellent method. However, there are various issues to be solved in practice. First, the possibility to specify 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 should be collected during a short period. These restrictions are particularly evident in the service prices. This is currently applied to personal computers, digital cameras, and camcorders in the WPI. Yet, as for the CSPI, only the prices of personal computers

evaluated by the hedonic regression method are utilized to compile the leasing services index,[6] while this method is not used directly for service prices themselves. The possibility to extend this method to the CSPI will be discussed later in this paper.

4. *Effects of Quality Adjustment in the CSPI*

In Japan, technological innovation has exerted downward pressure on prices through increases in productivity and the rightward shift of the aggregated supply curve.[7] The price decline caused by the increase in productivity is realized through a decrease in nominal prices and through price reduction in quality-adjusted terms brought on by improvements in quality. Chart 3 calculates the movements of price indexes prior to quality adjustment on the so-called "nominal basis" for the CSPI and shows the degree of decline in the percentage change of price indexes due to quality adjustment. For comparison, the estimation about the WPI is shown in Chart 4. According to the charts, even by including the effects of quality adjustment of goods related to leasing services, there is just a small difference (-0.2% at maximum) in the percentage change of the CSPI before and after quality adjustment, while relatively large difference (-0.4%) exists in case of the WPI in 2000. Because the increase in productivity originally appears in both price changes on a nominal basis and degree of decline in price indexes caused by quality adjustment, it is insufficient to draw a firm conclusion on productivity growth only from this difference. Especially the increase in productivity due to the recent streamlining of distribution channels appears not in quality adjustment but in the nominal price decline. Nevertheless, this difference indicates the general tendency of productivity growth of the related industries. In fact, these estimation results of the quality adjustment effects are generally consistent with

---

[6] Leasing index is compiled by multiplying leasing rates by prices of leasing goods (the relevant goods price indexes are imputed).

[7] Of course, prices are determined by both supply and demand factors. Yet, for the purpose of focusing on productivity of Japan's industries, the following discussion omits the demand-side

the gap between the low productivity growth of nonmanufacturers (in the CSPI) and the high productivity growth of manufacturers (in the WPI).

Still, there is an aspect that quality adjustment may not be enough in some service prices. It should be kept in mind that if the price decline due to quality adjustment were insufficient and if this tendency worsened further, this would make measured productivity growth of the Japanese services sectors look low. This indicates a part of the importance of the quality adjustment.

5. *Remaining Difficulties in Quality Adjustment of Service Prices*

As explained above, to compile the CSPI, appropriate application of various quality adjustment methods as well as introduction of new services and collection of as many samples as possible have borne fruit in capturing the actual trend of service prices. Yet, to describe the recent complicated and diversified economic activities in Japan more accurately, a large number of issues remain to be solved. These issues are not confined to Japan's case. Rather, they should be considered as problems commonly held worldwide. Quality adjustment of service prices should be understood as having far more difficulties than that of goods prices. Here, I would like to point out some difficulties concerning quality adjustment of service prices based on our experience as a compiler of the CSPI.

(*Ambiguity of the Definition of Service Output*)

To begin with, it should be pointed out that the output of services would vary depending on the definition of services. There are still many services whose concrete definitions are still ambiguous. One important aspect of services is that the purchase of a service often involves a substantial input of the user's time. Some services such as movie

---

factors.

theaters and amusement parks provide people the opportunities to consume time, and the others such as transportation and building maintenance provide them the opportunities to save time. The CSPI is focusing on the services transacted among corporations, thus handles only the latter services. Such consuming or saving of user's time should apparently affect user value of services, and thus the output of services. Of course, this issue can appear also in the goods market. For example, even the prices of some goods constituting the CPI often reflect the location of the retail stores, which are connected to the saving of customer's time. But in the services market—unlike the goods market—it is harder to avoid this issue, since the user's expenditure of time occurs simultaneously with the service consuming and the link between them appears clearer. Apart from the concept of time saving/consuming, unlike goods, the factors constituting services can be bundled or unbundled relatively easily. A financial service such as a derivative is a typical example of unbundling the function of financial intermediaries. Such bundling/unbundling is also a main feature of services. Because of this, it is even more difficult to define the "unique" output of each service. The following examples should vividly illustrate such difficulties.

Example 4

In financial services, the "convenience of banking" perceived by firms has changed dramatically with the emergence of electronic banking services. In fact, the introduction of PC terminals to the office has made it easier for firms to settle accounts at the bank. They can also make settlements after business hours and this can be done much more quickly. In light of this, contents of the services provided by banks have changed significantly. How should this change be captured as an output?

Example 5

As for warehousing and storage services, the number of cases of "bundled" pricing—which may include, for example, inspection, packing for freight, and inventory management services, is increasing. In such cases where services are included in one whole package, to what extent should we unbundle each service and define the output accordingly?

(*Services That Resemble Goods in Characteristics*)

If we set the difficulties in defining services aside, then can it be said that services are different from goods in treating characteristics even under perfect competition? Before drawing conclusions to this question, divide the "services" into two categories. These two services have different characteristics. In the first services, the volume of the output can be determined by the amount of labor inputs and capital inputs. This kind of services covers real estate services, leasing and rental, temporary employment services, motor vehicle maintenance and others. The characteristics of these services are similar to those of goods in the sense that the output can be quantitatively captured in a relatively easy way. In that case, quality adjustment by using the cost approach is sufficiently effective as long as cost-related data are available. Furthermore, from the viewpoint that service output can be quantitatively grasped, it is worth studying the feasibility of the hedonic regression approach to apply for some items of the CSPI. So far, however, this approach is not used because of limitations in data availability.

(*Services That Differ from Goods in Characteristics*)

The second services, which are quite different from goods in their characteristics, have various unique features and are all the more troublesome to treat. These services cover finance and insurance, telecommunications, legal and accounting services, and so on. First, it is difficult to use production functions from input through output in analyzing service outputs. This is partly because services like insurance are sometimes provided at one time while payment for services are done inter-temporally. The difference of timing in receiving and paying for service outputs is a main feature of the service transactions. Another reason is that, in the world of increasing returns to scale, like those in telecommunications services, the criterion of maximizing profits at given prices can never work. In these circumstances the production cost is not equal to the reservation price of the users' side. Second, since those services do not have any buffer stock, service providers have the incentive to increase their output if demand is strong. Therefore, the output and price are determined by the behavior of demand.

Taking those features into account, it is not suitable to evaluate quality change of services from the production cost side. It should be appropriate to evaluate them from demand side: from the viewpoint of user value.

Example 6

As for telecommunications, in demand-growing and increasing returns to scale services, prices can be set even lower since the cost is decreased gradually on the side of service providers as demand grows. In fact, in case of services provided through the ISDN (Integrated Services Digital Network) and the ADSL (Asymmetric Digital Subscriber Line), prices have been lowered as the number of subscribers increased explosively. If the transmission speed provided through these lines improved, how could the quality of the service be grasped from the producer cost side?

As for these services, once we try to capture quality changes from demand side, we encounter various difficulties. To expand the discussion in Section 2, typically the following three difficulties should be recognized: 1) difficulties in capturing the quality change of customized services, 2) difficulties in estimating the impact of technological innovation, and 3) difficulties in dealing with the impact of recent deregulation on the acceleration of customization regarding service products and pricing. Point 1) is originally all the more characteristic in services products than in goods products, although the number of made-to-order machines increased even in the goods markets. Points 2) and 3) can be seen in both goods and services markets, but it is all the more difficult to cope with them in the services market. Although we are endeavoring to capture the true shapes of service prices as much as possible by using the various methods explained in section 2 and 3, these points still provide limitations on quality adjustment.

First, difficulties to capture the quality change can be seen in prices of customized services. In the skilled labor services markets the contents of services may vary according to the needs of customers. Legal and accounting services are typical examples. There are all sorts of skilled labor services, and each “service” does not

have a fixed form. In such a case, as each service is the only product produced, there are no other services to compare within the same category. The following example clearly brings out this feature. In addition, it is hard to capture the abilities and skills of such service providers numerically.

Example 7

Among legal advisory fees, as for monthly fixed fees paid regardless of the content of service provided, the price is not set according to the contents of the service provided but can be interpreted as buying the right to receive the service (a kind of option). The contents of actual legal advisory services provided change according to requests from customers every month while the price is fixed. On the other hand, the services provided by lawyers toward the lawsuit are made-to-order and their contents differ depending on the contents of files, and hence the quality may change according to the experience and knowledge of lawyers themselves. Overall, how should we specify the quality of legal services to compile continuous service price index?

Second, technological innovation can now be seen in many fields of services. Many new service products have appeared recently, typically in telecommunications services. The most difficult aspect of adjusting quality is specifying how the production isoquant or the utility function of users shifts when new service products are invented. This is because such innovations provide new services that were originally not defined. In most cases it is extremely difficult to define each characteristic unit that constitutes service products objectively and numerically.

Example 8

Among telecommunications services, the network structure of telephones has been switched from an analog network to a digital network. In a digital network, while the function of transmitting data remains unchanged, the transmission speed has changed. This shows that the quality of service has increased. How should we evaluate the quality improvement to compile the service price index? Moreover, with the emergence of cellular phones, not only has communication become more

convenient—it has also become possible to contact people at anytime, in any place. Hence, this has changed the behavior of people in the sense that meeting someone at a specific place is no longer necessary. How should we regard this change in efficiency due to the distribution of cellular phones?

Third, deregulation has progressed in many services market such as air passenger transportation, telecommunications, and many others. As a result, many service providers have enough room to expand the variety of prices. In the past, they changed their prices according to the transaction volume for keeping or expanding their market share. Most recently, however, such nonlinear pricing has entered to a new stage; that is, service providers try to maximize their profits by price customization on the assumption of the heterogeneity of customers. Customers feel satisfaction to differing degrees depending on each service and its combination, and the relations between the prices and the qualities are not proportionate. This has also been enabled by the progress in information technology.

Example 9

As for air passenger transportation, regulation of domestic air fares was liberalized completely in April 2000. Now many airline companies provide various kinds of discounted fare services in the domestic market. On the other hand, the introduction of the frequent flyer program (so-called mileage program) has become active recently along with the progress in information technology to manage the user information. By using the frequent flyer program, customers who continuously use the services of the same airline can obtain more inexpensive fares than those who do not use the same airline. In addition, the coverage of services provided by this program is broadened. How should we incorporate these various kinds of prices as continuous air passenger transportation index by using the quality adjustment methods?

Example 10

In the field of telecommunications services, the Ministry of Posts and Telecommunications (currently Ministry of Public Management, Home Affairs,

Posts and Telecommunications) abolished regulation to enter the telecommunications business in 1996 and in 1997 consecutively. Furthermore, under WTO agreement on basic telecommunications the MPT removed regulation for foreign companies in the Telecommunications Business Law to invest in domestic telecommunications carriers in 1998. Since then the number of telecommunications companies increased further and the intensification of competition triggered discussion about the introduction of the carrier selection service ("Myline," a service of registering the carrier of choice and dialing the carrier without the access code for selecting career). In May 2001, the carrier selection service started. At the same time, they increased the variation of the service ("Myline Plus," a carrier designation service at any conditions) with different fees and have provided various options to combine other telephone services with various prices. Customers can choose either service with any options and can switch the services easily and frequently. How should the prices be adjusted for quality change to compile the telecommunications service price indexes?

(*Pricing and Quality Adjustment under a Monopoly*)

So far the discussion of quality adjustment has taken place on the assumption that perfect competition holds. However, service prices are sometimes determined under a monopolistic situation. When the assumption of perfect competition does not hold, results of the quality adjustment differ depending on whether the service price index is perceived from the perspective of the demand side or supply side.

When the monopolistic producer improves the quality of the service, the new price reflects not only the marginal change in the production cost but also the monopolistic rent. Thus even if there is no change in the monopolistic power in between the old and new service products markets, the quality change estimated from the production cost side is usually not equal to that reflected in the price.

Pursuing to adjust the quality from the demand side under the assumption of

monopolistic producers will come up against the new difficulties. For instance, the prerequisite for applying the hedonic regression method will not hold[8]: user preference is individually distributed and the market for products is under perfect competition. Unless the rates of markup between prices and marginal costs are constant under monopolistic situations, it is difficult to use this method without any modification. Furthermore, if the monopolistic power changes between the old and new service products markets, it is difficult to estimate difference in quality from the price gaps between two services. When the monopolistic companies set the prices of the services, they take into account not only the quality of the services but also the income levels of the user companies, the uniqueness of the services, the volume of possession of the user companies, and the average cost of production.[9] They have the incentive to earn the monopolistic rent and the rent can vary depending on the degree of monopoly in the services markets. The possibility should be taken into account that the monopolistic power of the producer can change according to the change in the quality of the service.

Example 11

Among transportation services, the prices of railroad transportation are decided in an oligopolistic or a monopolistic way. Tolls charged for roads are also decided by the government. Even in other service sectors—banking services, for example—prices are not necessarily decided under perfect competition. In those areas, how should the quality change be incorporated in the service prices?

6. *Directions toward Expanding the Varieties of Quality Adjustment Methods*

Various discussions have taken place internationally on the quality adjustment methods

[8] See Rosen (1974) for further details.

[9] See Nakajima (2001) for formal modeling of this proposition. More precisely, only the change in

of the price indexes.[10] International discussions can be broadly divided into the following two streams: 1) enhancing the accuracy of price indexes through active quality adjustment using various methods while emphasizing the methods measuring the effects of quality adjustment directly, and 2) prioritizing the fact that it is possible for countries to compare the price indexes and placing importance on the unified quality adjustment method by extracting the price gap corresponding to quality change from market prices. However, as for the service products, there are a lot more restrictions to quality adjustment than those for the goods for both data availability and estimation methods. Because quality change may be still somewhat underestimated, the study of the effective methods must be studied further, and the adjustment of quality of service prices must be carried out more or less forcibly. This study should be at the vanguard of discussion on the appropriateness of the quality adjustment unification, even if the methods might have some measurement errors. Of course, when introducing new or revised methods, the concrete application of quality adjustment methods must be disclosed. Because there is still plenty of room for further study on quality adjustment methods, the prospects for further progress of the methods are all the more bright.

We, as compilers of indexes of service prices, should deepen the study of quality adjustment of service prices from the following standpoints which I present as concrete directions. Unfortunately, these studies are still under way—some of them have only just begun—and evident solutions have not yet been presented. It is expected that remarkable findings will be reported successively.

First, as for services that are close to goods (in the sense that the outputs are determined by the volume of input—labor and capital—and of which characteristics can be clearly defined), the wider application of the hedonic regression method should be developed in addition to the existing production cost method. Real estate services are a strong candidate here. The quality of real estate rental consists of some characteristics, that is, the location, size, and facility of the real estate. In this sense, it is possible to define

---

quality assessed by the last and marginal user is equal to the price change.

[10] See Bureau of Labor Statistics (1999) and Turvey (2000).

the scale of characteristics.[11] The current obstacles to be aware of are 1) lack of sufficiently large samples that include details needed for statistical estimation, and 2) instability of variables of this measurement. But these obstacles are likely to overcome technically by further advances.

Second, as for the services other than the above ones close to goods, the basic approach would be to make an econometric model that comprises the concept of saving or consuming time by using the service. One way to find the value of input of time is to capture the changes in demand of alternative services or the opportunity cost of not using this service. Telecommunications and transportation are the candidates for this trial. Let me use the case of cellular phones described in Section 5 as an example. Someone might think that the content of this service is the same as the other domestic fixed telephone services. However, is it true that the user's utility function in using the cellular phone is the same as that of the other telephone services? This new service can save time in arranging meetings in advance because they can communicate whenever they need to do so. You may see evidence of such changes in utility function by searching for the changes in consumption of other services. Once the formulation of the econometric models incorporating the changes in utility function succeeds, the reduced form equation can then be drawn. Henceforth, the effect of quality adjustment on prices can be estimated by using the reduced form equation and a large sample data. This process is quite similar to estimating the hedonic regression method.[12] So far, no concrete model using this approach has been designed.[13] One of

---

[11] Studies of the application of hedonic regression method for rents in Japan can be seen at Ito and Hirono (1992), and Nishimura et al. (2001) To find other application studies for other services, see Enge (2000) et al.

[12] Baily and Zitzewitz (2001) op.cit. suggests a possible general approach to measure and value convenience-related customer time savings and to use hedonics to estimate market valuations of service quality differences where possible.

[13] Other than this, one idea of treating heterogeneous users is to make hypothetical "typical users" as a measurement unit and use their valuation as the basis for quality adjustment. This idea assumes that typical users to purchase typical services are homogeneous even if there are heterogeneous users. These companies are not necessarily "representative companies" and are chosen from the viewpoint of making calculation easier by using actual data for index compilation. Nishimura et al. (2001) chose "typical" used-condominiums bought by "typical" users through omitting those of differrent

the most important keys for succeeding at this approach is the degree to which the statistics compilers can collect detailed data concerning the behavior of users.

In reality, however, it is often difficult to make econometric models due to data limitations. In those cases, another idea is to use survey data on the degree of satisfaction in using the corporate services. For example, there are many studies that survey the extent to which customers feel satisfaction by using a specific service, which cover both B-to-B (business to business) and B-to-C (business to consumer) transactions. The research of J.D. Power[14] is a concrete example of that kind of survey. As for B-to-B service transactions in Japan, J.D. Power has conducted a survey on dealer satisfaction toward car makers. *Consumer Reports*,[15] a US magazine, is another concrete example. This degree of satisfaction can be converted to the user value (or utility of users). To judge the appropriateness of such a method, the pros and cons of using the survey data should be inspected. From the viewpoint of the statistics compilation it is relatively easy to apply the results of the survey data to changes in quality of services. On the other hand, users may sometimes act differently from their answers on the questionnaires. As the user value (or utility of users) does not necessarily coincide with the subjective degree of satisfaction, the degree of such bias should be checked. It is more formal to use the actual tracks of user behavior, as opposed to just their answers. Taking all such pros and cons into account, however, utilization of the survey data is still an effective candidate for quality adjustment, despite its occasional inaccuracies and biased results.

Finally, when perfect competition does not hold, we have to estimate the relation between changes in quality and those in prices by the econometric models that take the behavior of monopolistic companies into consideration. By applying this approach, it becomes possible to adjust the quality of service products even under a monopoly. In Japan, only a few case studies have been attempted. Nakajima (2001) studied one

---

purchasing purposes using econometric methods, and estimated their imputed rent.

[14] http://www.jdpower.com

[15] http://www.consumerreports.org/main/home.jsp

example of comparing the quality gap between the monopolistic service and the perfect competition service with the price gap.[16] Under the assumption of monopoly, the price may not have enough information for guessing the quality. The prospects of this approach depend on how further studies about formulating the econometric models will progress and conquer the limitation of data availability.

7. *Conclusions and Some Reservations*

This paper has introduced the actual methods of quality adjustment in compiling the CSPI and the results of quality adjustment in 2000. It has also explained the Bank's efforts in selecting the most appropriate quality adjustment method according to the situation to solve problems surrounding quality adjustments to the greatest extent possible. The results succeed in showing more or less the features of service industries: that is, low productivity growth.

However, in the process of such quality adjustment, the Bank has faced many obstacles in capturing the quality that is connected to how the output of services should be defined. The latter part of this paper has drawn out the many limitations involved in capturing quality, and has suggested directions toward expanding varieties of quality adjustment methods: expansion of the hedonic regression method, inventing econometric models to capture the value of time saving or consuming, utilizing survey data on customer satisfaction, and inventing new econometric models to take into account the monopolistic behavior of service producers. All these new approaches focus on the demand side of services, as opposed to the producer side. We should continue to develop and to utilize quality adjustment methods more positively and to

[16] Nakajima (2001) introduced the concept of luxury and ordinary quality products for estimating the price and quality difference of tickets regarding international and domestic orchestra concert. According to his estimation, the more the qualities of monopolistic services improve, the more the producer strengthens its monopolistic power in the market and hence the more prices are decoupled from quality. The result should be carefully interpreted by taking into account the possibility that

further improve the accuracy of quality adjustment.

Before finishing the discussion of quality adjustment of service price indexes, however, three reservations should be taken into account from broader perspectives. The first is the effect on the other statistics from two directions. One direction is to increase the accuracy of the real-term statistics. For example, unless the price decline due to quality adjustment of price indexes is sufficient, real GDP is underestimated. Another direction is the risk of distorting real-term statistics. If the nominal aggregations themselves are distorted by ignoring the differences in quality, real aggregations deflated by the price indexes correctly reflecting the quality change become distorted. Take wage statistics, for instance. Wage statistics are compiled without distinguishing the skills of and kinds of employees. In this case, the risks of distorting real wages by using the correct deflators would rise. It would distort the developments of real labor input and then those of total factor productivity in capturing the potential growth of the economy. Another example is the consistency with other price statistics. If the service prices of the CPI, prices of services to consumer households, and prices of the CSPI—prices of services to corporations—adopted the quality adjustment methods in a completely different way, the volume of real output of services would vary depending on whether the demand side comes from households or from corporations.

Second, as for central banks trying to stabilize the inflation rate, we must account for the fact that the pace of changes in quality of prices is moving, not stable. If the pace of quality change were stable, the relation between the growth rate of prices after quality adjustment and that of true prices (perfectly adjusted prices) would also be stable, making it somewhat easier for central banks to conduct monetary policies. However, when the speed of changes in quality varies, and if the quality were not adjusted sufficiently and continuously, it might cause the deviations between them. Although further careful research on whether this phenomenon would really distort price indexes on an aggregated basis is needed, there might have a potential risk of making the monetary policies more difficult.

---

price behavior under a monopolistic situation may be model-dependent.

Third, for the central banks to conduct monetary policies, it is important to think about whether the "price" of the price stability is really the same as the "price" of the price indexes after adjusting the quality.[17] The deflators are a concept to define real income consistent with the changes in the utility of users, and a fluctuation of deflators does not by itself directly mean a decrease in the utility of users. Whether the "price" of price stability means that on a nominal basis or that in quality-adjusted terms depends on how the cost of price movements is evaluated. Suppose price stability regarding monetary policy management points to a situation in which various economic agents such as households and corporations can smoothly make future decisions on economic transactions such as consumption and investment without being disturbed by price fluctuations. Based on this definition, it is not clear which can be called price stability. Another viewpoint is the cost of nominal rigidities. From the standpoint that in a world of staggered price setting, changes of prices on a nominal basis cause menu cost to rise; it may be concluded that monetary policy should see price stability as a nominal basis. However, if the discussion that instability of the general price level leads to unnecessary variations in relative prices among corporations that adjust their product prices at different times and that the distribution of resources becomes distorted is based on the utility-based welfare criterion of private agents,[18] price stability is, in this sense, consistent with the "price" of price indexes after adjusting for quality.[19]

These reservations do not mean that we should slow down the tempo of adjusting the quality. Rather, they indicate the necessity of improving the accuracy of quality adjustment more while devising ways to see the contents of or factors behind price movements. At a minimum, close attention should be paid to the contents of the movement of the price indexes.

To develop the quality adjustment of service prices, this paper presented various

---

[17] This discussion comes originally from Hayakawa and Yoshida (2001) op.cit..

[18] See Woodford (2001) for further details.

viewpoints, although most of them require breakthroughs to be applied practically to service prices. This paper should function as a catalyst to additional theoretical and analytical support from academics, and to active discussions among international price statistics compilers.

[19] Kimura et al (2001) discusses the meaning of price stability from monetary policy perspectives.

[References]

Armknecht, P.A., and D.H. Ginsburg, "Improvements in Measuring Price Changes in Consumer Services: Past, Present, and Future," Z. Griliches ed. *Output Measurement in the Service Sectors*, NBER, University of Chicago Press, 1992.

Baily, M.N., and E. Zitzewitz, "Service Sector Productivity Comparisons: Lessons for Measurement," C.R. Hulten, E.R. Dean, and M.J. Harper ed. *New Developments in Productivity Analysis*, NBER, University of Chicago Press, 2001.

Bank of Japan, Research and Statistics Department, Explanation of the 1995 Base Corporate Service Price Index, http://www.boj.or.jp/en, 2000.

Bureau of Labor Statistics, "Consumer Price Indexes: Methods for Quality and Variety Change," Joint ECE/ILO Meeting on Consumer Price Indices, 3-5 November 1999.

Diewert, W.E., and K.J. Fox, "The Productivity Paradox and Mismeasurement of Economic Activity," IMES Discussion Paper 98-E-15, Institute for Monetary and Economic Studies, Bank of Japan, December 1998.

Enge, A.K., "Developing PPIs on Architectural and Civil Engineering Services—the Norwegian experience," Paper presented at the 15th Voorburg Group on Service Statistics, September 2000.

Gordon, R.J., "Management Consulting Firms: Some Approaches to Output Measurement," Discussion Paper for presentation at the Workshop on Measuring the Output of Business Services, Brookings Program on Output and Productivity Measurement in the Service Sector, May 1999.

Gordon, R.J., "Problems in the Measurement and Performance of Service-sector Productivity in the United States," Working Paper 5519, NBER, March 1996.

Hayakawa, H. and T. Yoshida, "Bukka shisu wo meguru gainenteki sho mondai (Conceptual Problems Surrounding Price Indexes; available in Japanese only)," Research and Statistics Department, Bank of Japan, Working Paper Series 01-5, May 2001.

Ito, T., and K. Hirono, "Juutaku shijou no kouritsusei: micro data ni yoru keisoku (Efficiency of Residential Construction Market: Estimation by Using Micro Data, available in Japanese only)," *Kinyu Kenkyu*, 1992, Vol. 11, No. 3.

Kimura T., T. Kurozumi, and K. Momma, "Nozomashii kinyuu seisaku no taiou wo megutte—Kyoukyuu kouzouno henka ni taisuru seisaku unei wo chuushin ni—

(Optimized Monetary Policy Responses—Focusing on Policy Responses against the Structural Changes in Supply-side—, available in Japanese only)," Discussion Paper for presentation at the Bank of Japan Workshop on Price Stability, Policy Planning Office, Bank of Japan, June 2001.

Levy, F., A. Beamish, and R.J. Murname, "Information Technology and Skill Requirements: Examples from a Car Dealership," Working Paper, MIT Department of Urban Studies and Planning, March 2000.

Mesenbourg, T.L., "Measuring Electronic Business," U.S. Census Bureau E-Stats Research Papers, 2000.

Nakajima, T., "Nihon keizai no seisansei bunseki (Productivity Analysis of Japan's Economy, available in Japanese only)," Nihon Keizai Shinbunsya, 2001.

Nakajima, T. and T. Matsuura, "Productivity Measurement for the Retail Service Industry," mimeo, 11 July 2001.

Nishimura, K.G., C. Shimizu, and Y. Asami, "Fukanzen shijou no kosuto—Tokyo juutaku fudousan ryuutsuu shijou— (Measuring Costs of Imperfect Information in Tokyo Residential Real-Estate Markets, available in Japanese only)," *Fudousan shijou no keizai bunseki*, Nihon Keizai Shinbunsya, forthcoming, 2001.

Price Statistics Division, "Quality Adjustment of Price Indexes—Wholesale Price Index and Corporate Service Price Index: Current Situation and Future Implications—," Research and Statistics Department, Bank of Japan, Working Paper Series, 01-6, July 2001.

Rosen, S., "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," *Journal of Political Economy*, vol. 82, pp. 34-35, 1974.

Sen, A., *Choice, Welfare and Measurement*, Basil Blackwell, 1982.

Triplett, J.E., and B.P. Bosworth, "Productivity in the Services Sector," Paper presented at Workshop on Productivity in the Services Sector, Brookings Institution, January 2000.

Turvey, R., "Quality Differences and New Products," http://www.turvey.demon.co.uk/, 2000.

Woodford, M., "Inflation Stabilization and Welfare," National Bureau Economic Research Working Paper 8071, 2001.

Chart 1

Replacement of Price Data in CSPI (During 2000)

(1) Number of replacements of price data

Major group	No. of surveyed prices (A)	No. of cases (B)	(Ref). no. of cases in the previous year	Ratio of change (B)/(A)
Miscellaneous services	849	113	23	13.3
Transportation	709	53	48	7.5
Finance and insurance	397	49	38	12.3
Communications and broadcasting	153	46	31	30.1
Leasing and rental	152	40	6	26.3
Total	2957	361	171	12.2

Notes: 1. Changes in surveyed prices indicate changes in the content of services, transaction conditions, and surveyed company.
2. Surveyed prices are those of December 2000.

(2) Quality adjustment methods used for old and new services

cases, figures in () are those of the previous year.

	No. of cases
Production cost meth.	47(51)
Overlap meth.	3 (9)
Hedonic regression meth.	--
Direct comparison meth.	155(48)
Unit comparison meth.	18 (3)
Difficult to compare	138(60)
Others	0 (0)

Note: "Others" indicate changes in the contracted currencies.

(3) Measures taken in the index

cases, figures in () are those of the previous year.

	No. of cases
Price increase	6 (2)
Unchanged	330(155)
Price decrease	25 (14)

Note: Even when the overlap method (a method that regards the price difference between old and new services as the quality difference in the two services and incorporates them as unchanged in real terms into the index) is applied, the decrease (increase) of the new surveyed price compared to that in the previous month is incorporated as price decrease (increase) into the index.

Chart 2

Replacement of Price Data in WPI (During 2000)

(1) Number of replacements of price data

Group	No. of surveyed prices (A)	No. of cases (B)	(Ref). no. of cases in the previous year	Share of replacement (%) (B)/(A)
Domestic Wholesale Prices	3375	641	447	19.0
Electrical machinery	412	193	115	46.8
Chemicals	356	54	49	15.2
Textile products	275	40	31	14.5
Transportation equipment	83	40	29	48.2
Processed foodstuffs	379	36	41	9.5
Other manufacturing industry products	292	36	45	12.3
Electric power, gas & water	77	30	1	39.0
Pulp, paper & related products	138	29	22	21.0
Export Prices	624	134	111	21.5
Electrical machinery	163	59	50	36.2
General machinery	101	19	4	18.8
Other manufacturing industry products	71	14	18	19.7
Import Prices	895	144	114	16.1
Machinery & equipment	197	63	38	32.0
Foodstuffs & feedstuff	202	31	29	15.3
Textiles	88	16	9	18.2
Total	4894	919	672	18.8

Notes: 1. Changes in surveyed prices indicate changes in the content of commodities, transaction conditions, and surveyed company.

2. Surveyed prices are those of December 2000.

(2) Quality adjustment methods used for old and new commodities

cases, figures in ( ) are those of the previous year

	Domestic Wholesale Prices	Export Prices	Import Prices	Total
Production cost meth.	221 (136)	47 (38)	29 (28)	297 (202)
Overlap meth.	73 (97)	9 (5)	21 (13)	103 (115)
Hedonic regression meth.	20 (8)	5 (6)	3 (2)	28 (16)
Direct comparison meth.	121 (78)	22 (16)	26 (25)	169 (119)
Unit comparison meth.	12 (13)	0 (0)	0 (0)	12 (13)
Difficult to compare	194 (115)	46 (29)	54 (35)	294 (179)
Others	0 (0)	5 (17)	11 (11)	16 (28)

Note: "Others" indicate changes in the contracted currencies.

(3) Measures taken in the index

cases, figures in ( ) are those of the previous year

	Domestic Wholesale Prices	Export Prices	Import Prices	Total
Price increase	3 (8)	3 (1)	1 (2)	7 (11)
Unchanged	464 (301)	85 (81)	113 (91)	662 (473)
Price decrease	174 (138)	46 (29)	30 (21)	250 (188)

Note: Even when the overlap method (a method that regards the price difference between old and new commodities as the quality difference in the two commodities and incorporates them as unchanged in real terms into the index) is applied, the decrease (increase) of the new surveyed price compared to that in the previous month is incorporated as price decrease (increase) into the index.

Chart 3

Quality Adjustment Effect in CSPI

y/y % chg.

	2000 (1995 base)			[Ref.] 1998 (1990 base)		
	After quality adjustment (A)	Before quality adjustment (B)	Quality adjustment effect (A)-(B)	After quality adjustment (A)	Before quality adjustment (B)	Quality adjustment effect (A)-(B)
All items	-0.3	-0.4	***0.1***	-0.9	-0.9	***0.0***
Finance and insurance	-1.2	-1.2	***0.1***	-2.3	-2.4	***0.0***
Real estate services	-1.7	-1.6	***0.0***	-0.7	-0.7	***0.0***
Transportation	2.7	2.7	***0.0***	-1.1	-1.2	***0.1***
Information services	0.0	-0.1	***0.1***	1.2	1.2	***0.0***
Communications and broadcasting	-2.1	-2.1	***0.0***	-1.7	-1.7	***0.0***
Advertising services	1.5	1.6	***-0.1***	-0.7	-0.6	***-0.1***
Leasing and rental	-5.8	-5.8	***0.0***	-2.3	-2.3	***0.0***
Industrial waste and sewage disposal	1.1	1.0	***0.0***	0.6	0.4	***0.2***
Motor vehicle and machinery maintenance	-1.2	-2.1	***0.9***	-0.2	-0.2	***0.0***
Other professional services	-0.8	-0.6	***-0.2***	--	--	--
Miscellaneous services	-0.7	-1.1	***0.4***	--	--	--
Civil engineering and architectural services	--	--	--	-1.0	-1.1	***0.1***
Legal and accounting services	--	--	--	0.2	0.1	***0.0***
Temporary employment services	--	--	--	1.2	1.2	***0.0***

Reference: calculated based on the assumption that the price declines in leasing and rental are totally regarded as quality change.

y/y % chg.

	2000 (1995 base)			[Ref.] 1998 (1990 base)		
	After quality adjustment (A)	Before quality adjustment (B)	Quality adjustment effect (A)-(B)	After quality adjustment (A)	Before quality adjustment (B)	Quality adjustment effect (A)-(B)
Leasing and rental	-5.8	-0.5	***-5.3***	-2.3	0.0	***-2.3***
contribution to CSPI	-0.4	-0.1	***-0.3***	-0.2	0.0	***-0.2***

Notes: 1. To observe the quality adjustment effect of the relevant year, the year-to-year percent changes are calculated by using the index as of December and that of the previous December.

2. As for civil engineering and architectural services, legal and accounting services, and temporary employment services, the categorization was revised at the time of switching to the 1995 base and has been rearranged into other professional services and miscellaneous services. In this chart, they are divided into three services for the 1990 base and divided into two services in the 1995 base.

3. The price decline in leasing includes not only quality changes but also the pure price decline of the item. Thus, this calculation is estimated as the upper limit value of quality adjustment. Changes in interest rates are not regarded as changes in prices of items but as changes in leasing rates.

Chart 4

Quality Adjustment Effect in Domestic WPI

(1) Developments of quality adjustment effect

y/y % chg.

Surveyed period / Average y/y % change	First half of the 1990s (Ex. of 1993) <1990 base>	Middle of the 1990s (Ex. of 1995) <1990 base>	Second half of the 1990s (Ex. of 1998) <1995 base>	Recently (Ex. of 2000) <1995 base>
After quality adjustment (A)	-2.1	-0.7	-2.2	-0.1
Before quality adjustment (B)	-1.7	-0.4	-1.9	0.3
Quality adjustment effect (A)-(B)	***-0.4***	***-0.3***	***-0.3***	***-0.4***

(2) Details of the quality adjustment effect

y/y % chg.

	2000 (1995 base)			Reference: 1998 (1995 base)		
	After quality adjustment (A)	Before quality adjustment (B)	Quality adjustment effect (A)-(B)	After quality adjustment (A)	Before quality adjustment (B)	Quality adjustment effect (A)-(B)
Total average	-0.1	0.3	***-0.4***	-2.2	-1.9	***-0.3***
Processed foodstuffs	-0.2	-0.1	***-0.1***	1.4	1.2	***0.2***
Textile products	-0.8	-1.3	***0.4***	-3.8	-4.0	***0.2***
Lumber & wood products	-0.7	-0.3	***-0.4***	-3.9	-3.8	***-0.1***
Pulp, paper & related products	2.7	2.6	***0.1***	-3.5	-3.6	***0.1***
Chemicals	2.3	2.5	***-0.1***	-2.6	-2.6	***0.1***
Plastic products	-0.6	-0.6	***0.0***	-1.7	-1.7	***0.0***
Petroleum and coal products	14.6	14.6	***0.0***	-8.3	-8.3	***0.0***
Ceramic, stone & clay products	-0.8	-1.0	***0.2***	-0.9	-1.4	***0.5***
Iron & steel	0.0	-0.1	***0.1***	-5.4	-5.4	***0.0***
Nonferrous metals	2.0	2.0	***0.1***	-7.1	-7.2	***0.0***
Metal products	-0.2	-0.2	***0.0***	-0.9	-1.0	***0.1***
General machinery	-0.6	-0.1	***-0.5***	-1.1	0.1	***-1.2***
Electrical machinery	-4.0	-3.4	***-0.5***	-3.7	-2.6	***-1.1***
Transportation equipment	-1.5	1.5	***-3.1***	-0.6	0.5	***-1.1***
Precision instruments	-1.3	1.2	***-2.5***	-0.5	-0.4	***-0.1***
Other manufacturing industry products	0.0	0.1	***-0.1***	-0.8	-0.7	***-0.1***
Edible agricultural, livestock & fishery products	-2.1	-2.0	***0.0***	0.3	0.3	***0.0***
Inedible agricultural & forestry products	-2.7	-2.6	***-0.1***	1.9	1.9	***0.0***
Mining products	-2.0	-2.0	***0.0***	-2.4	-2.4	***0.0***
Electric power, gas & water	-0.5	-0.5	***0.0***	-5.3	-5.3	***0.0***
Scrap & waste	1.0	1.1	***-0.1***	-35.1	-35.1	***0.0***

Note: To observe the quality adjustment effect of the relevant year, the year-to-year percent changes are calculated from the December index and the previous December index.