

## Sources of Price Estimating Bias in the Medical Care Service Market

Sonny (Sunghwan) Chun<sup>†</sup>

*Department of International Industrial Information, Kyonggi University  
Suwon, Korea*

### <국문초록>

### 소비자 의료서비스 가격 추정 오류의 원인

천 성 환

경기대학교 국제대학 국제산업정보학과

본 논문에서는 시장에서 추계되는 소비자 의료가격지수의 바이어스를 가져오는 두 가지 원인을 살펴보았다. 첫 번째로 가격지수구성이 갖는 구조적인 특성으로부터 야기되는 바이어스 문제를 살펴보고, 두 번째로, 소비자가 시장에서 실제로 구매하는 의료서비스와 해당 서비스 가격에 대한 모호한 정의로부터 야기되는 바이어스 문제를 살펴보았다. 일반적인 가격 지수는 최종 소비재 및 서비스 가격 변동 추계를 원칙으로 한다. 그러한 원칙이 의료가격 지수 구성의 경우 무시되고 의료서비스 생산을 위한 생산 요소가격 변동을 추계하여 최종 의료 서비스 가격지수로 대응하고 있음을 보여주고 있다.

## I. Introduction

An accurate measurement of price changes has been one of the long sought after objectives for economists and policy makers. Since the real value of economic data could be generated by dividing nominal economic data by the price index, an accurate price index is necessary to evaluate the changes in real economic data.

---

<sup>†</sup> 교신저자 : 천성환, 경기대학교 국제대학 국제산업정보학과(031-249-8774, sonnychun@empail.com)

The measurement objective of the consumer price index (CPI) is the cost of living index, which is a ratio of the costs of achieving a given level of utility with current period prices and base prices.

However, due to the inability of observing the level of utility, an estimate for the cost of living index, such as the Laspeyres type price index, has been used for the construction of the CPI. As an estimate for the true cost of living index (COLI), each estimate incurs biases resulting from the properties of each estimating method.

This type of error or bias has been understood rather well among the interest group of users and constructors of the index numbers. In the case of the medical care service price index (MCPI), there is an additional bias caused by the unclear definition of the output products and corresponding prices. Then, accuracy in price forecasting and other areas in the market such as medical insurance market would be severely tarnished due to the errors in the price estimating data from the medical care service market.

Two sources of indexing errors for the medical care service industry have been examined in this paper. Overestimating properties of the Laspeyres type index method and underestimating properties of the Paasche index method are presented.

Secondly, informational distortion specific to the MCPI caused by the obvious unconventional practice of constructing the medical care service price index has been introduced with the US insurance claims data.

## II. Bias Caused by Properties of Indexing Method

The cost of living index (COLI), which is the measurement objective of the CPI, is based on the concept of how much, on average, the current cost of achieving a constant utility consumption bundle is different from the cost of achieving the same level of utility in a base period. The formula for the COLI index is

$$(1) \quad I_{\text{Cost of Living}} = \frac{E^1(p^1, U^0)}{E^0(p^0, U^0)}$$

$$s.t. \quad U^0(E^0, p^0) = U^1(E^1, p^1)$$

where  $p^0$  and  $p^1$  denote the vector of prices in the base period and in the current period respectively.  $U_i^0$  is  $i$ 's level of utility achieved by consuming the vector of goods and

services, which is denoted by  $q_i^0$ , in the base period. The inner product of  $p^0 q_i^0$  becomes expenditure(or income) for individual  $i$  in the base period.  $E_i(p^0, U_i^0)$  and  $E_i(p^1, U_i^0)$  represent consumer  $i$ 's expenditure functions to achieve base period utility level  $U_i^0$  with the base period price vector ( $p^0$ ) and with the current period price vector ( $p^1$ ) respectively.

The denominator in  $I_i(U_i^0)$  is interpreted as the total income or expenditure, which is the inner product of  $p^0 q_i^0$  for individual  $i$  to maximize utility while facing the base period prices vector ( $p^0$ ). This maximized utility is  $U_i^0$ . The numerator is the minimized expenditure for individual  $i$  in the current period facing the current prices vector to achieve the given level of utility  $U_i^0$ . Since the index allows substitution between the bundles of goods, it is referred to as a true cost of living index. Substitution between the bundles also allows variable quantity weights as the consumers substitute goods in response to price changes (Archibald, 1977).

In theory, this framework of constructing a true cost of living index seems rather simple. However, it is impossible to observe an individual consumer's utility level. Thus, it is necessary to find a way to estimate the true cost of living index. Two of the widely used methods of estimating the true cost of living index are the Laspeyres price index and the Paasche price index which are represented by

$$(2) \quad L_i = \frac{p^1 q_i^0}{p^0 q_i^0} \text{ (Laspeyres Index)}$$

$$P_i = \frac{p^1 q_i^1}{p^0 q_i^1} \text{ (Paasche Index)}.$$

The relation between the true cost of living index (COLI) and the Laspeyres index is as follows:

$$(3) \quad L_i = \frac{p^1 q_i^0}{p^0 q_i^0} \geq \frac{E_i(p^1, U_i^0)}{E_i(p^0, U_i^0)} = COLI_i(U_i^0).$$

Since the term  $E_i(p^1, U_i^0)$  in  $COLI_i(U_i^0)$  requires an optimization process for the individual  $i$  (i.e., a tangency condition to a given indifference curve with current period prices), a consumption bundle and its quantity for the individual consumer  $i$  to achieve a given level of utility in the current period may be different from that of the base period.

However, in the Laspeyres index, a consumption bundle and its quantity for individual

consumer  $i$  in the base period are to remain the same in the current period. A fixed consumption bundle concept in the Laspeyres index brings a certain degree of error in estimating true cost of living index (COLI).

For the Paasche index, the relation with the cost of living index becomes

$$(4) \quad P_i = \frac{p^1 q_i^1}{p^0 q_i^1} \leq \frac{E_i(p^1, U^1)}{E_i(p^0, U^1)} = COLI_i(U^1).$$

The numerator in the true cost of living index,  $COLI_i(U_i^1)$ , is interpreted as the total income or expenditure, which is the inner product of  $p^1 q_i^1$  for individual  $i$  to maximize utility while facing the current period prices vector ( $p^1$ ). This maximized utility is  $U_i^1$ . The denominator is the minimized expenditure for individual  $i$  in the current period facing base period prices vector ( $p^0$ ) to achieve given level of utility,  $U_i^1$ .

Meanwhile, the numerator in the Paasche index is the inner product of  $p^1 q_i^1$ , which is the expenditure for individual  $i$  in the current period and which is equal to . As in the Laspeyres index illustrated above,  $p^0 q_i^1$  in the denominator bounds the minimum expenditure, which is equal to , from above. This makes the Paasche index ( $P_i$ ) bound the true cost of living price index  $COLI_i(U_i^1)$  from below.

A graphical representation of these errors is given in Figure 1. The optimum consumption bundle for an individual consumer facing base prices ( $P^0$ ) is point A, where base period budget line is tangent to the indifference curve ( $U^0$ ). With current prices ( $P^1$ ), the optimum bundle achieving the same level of utility should be point C where  $P^{1^*}$  is tangent to  $U^0$ . However, due to the inability to observe the level of utility, the Laspeyres index estimates how much more or less expenditure is required to consume the same consumption bundle (or quantities of a chosen bundle) with current prices, as is shown with the dotted straight line passing through the base period consumption bundle ( $q_i^0$ ) at point A. This makes the Laspeyres index ( $L_i$ ) bound the true cost of living price index  $I_i(U_i^0)$  from above.

As for the Paasche index, the optimum consumption bundle for an individual consumer facing current prices ( $P^1$ ) is point B, where the current period budget line is tangent to the indifference curve ( $U^1$ ). With base prices ( $P^0$ ), the optimum bundle achieving the same level of utility should be point D where  $P^{0^*}$  is tangent to  $U^1$ . However, due to the inability to observe the level of utility, the Paasche index estimates how much more or less expenditure is required to consume the same consumption bundle (or quantities of a chosen bundle) with

base prices, as is shown by the dotted straight line passing through the current period consumption bundle ( $q_i^1$ ) at point B. This makes the Paasche index ( $P_t$ ) bound the true cost of living price index  $I_i(U_i^0)$  from below.

The following relation among the Laspeyres, Paasche and the cost of living index is supported by the analysis

$$(5) P_t \leq COLI_t \leq L_t.$$

Getzen (1992) constructed an alternative index constructed by the Paasche index formula for hospital-related services from 1927 to 1990 and compared the results with the corresponding BLS index. The results suggested that by a simple change in the weight structure from the Laspeyres type base period weight to the Paasche type current period weight, a 0.3 percent annual reduction in price increase over 1927-1990 was revealed. His research supports the theoretic analysis that the Paasche index bounds the Laspyres index from below.

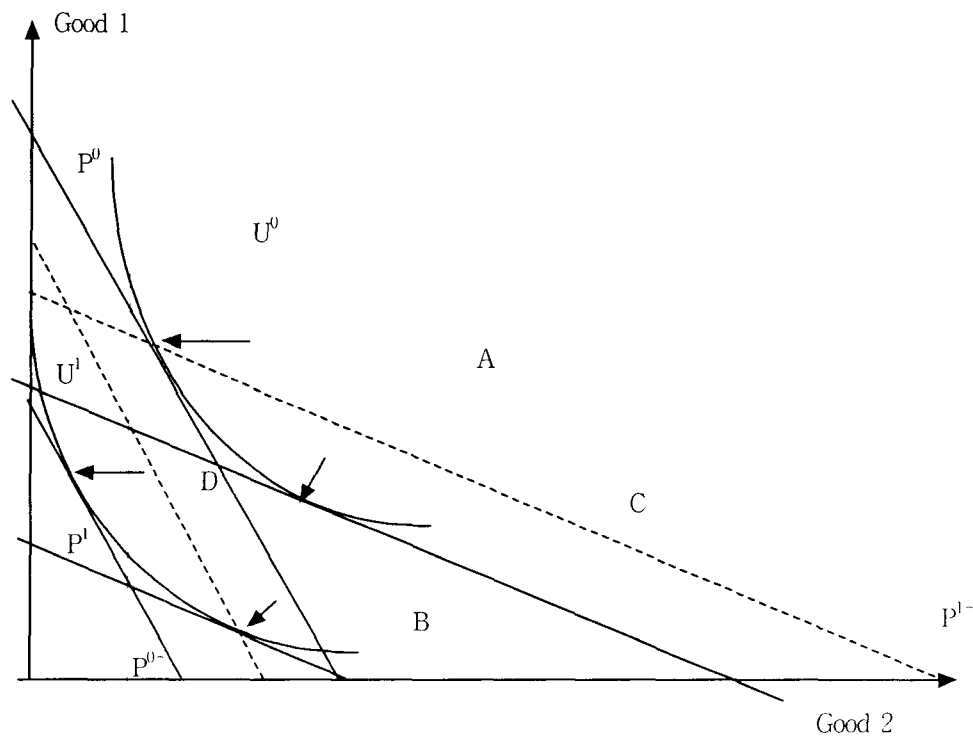


Figure 1. Biases Of Laspeyres Index And Paasche Index From The True Cost Of Living Index

### III. Bias Caused by Unconventional Practice of Constructing MCPI

#### A. Input Factor Price Changes As Output Price Changes

Market baskets for all of the non-medical care price indices are composed of final goods or services, such as a can of tomato sauce, a bottle of soda, a one-night stay in a hotel room, and so on.

When an individual medical care service customer goes out to shop for medical care services, he or she is not going to buy one night's stay in a hospital room or a half day's use of a hospital operating room. What he or she truly wants to buy might be a complete sequence of treatment for a health-related episode. Pollak (1998) raised a similar question about how to define goods or services consumers are purchasing in the market.

In regard to medical care services, most of the indexing agencies use unit input factor prices of the medical care services production as the components of the basket for constructing a final output price index of medical care services. In general, the major input factors for medical service production are physician-related services, hospital-related services, and pharmaceutical drugs.

Nordhaus (1998) pointed out that prices measured in medical care services are almost universally input prices rather than output prices. For example, a visit to a doctor's office or a one-night stay in a hospital room is measured rather than the price of a specific treatment for a certain medical need, which is an actual medical care services consumers are purchasing in the market.

Anne Scitovsky's price indexing study (1967) with Palo Alto, California area clinical data from 1951 to 1965 was done based on the average costs of treatment of illnesses as a relevant measuring unit rather than the prices of selected items, which are the major input factors of medical care services.

Keeler and Rolph (1988) pointed out in their study on how cost sharing affects the use of health care services that an episode of care is the natural unit for analyzing the effect of price in consumers' decision behavior for medical care services.

In Table 1, for example, patient identified with the number 10667760 has a medical episode related to a Sebaceous cyst (diagnosis code 7062 by the ICD-9-CM). The four entries under

the PROC1 are the required procedures for treating the Sebaceous cyst. Those procedures are 11441 (an excision of lesion diameter 0.6-1.0 cm), 88304 (a surgical pathology, gross and microscopic examination of skin-cyst), 17101 (a destruction by any method, including laser, with or without curettement, all benign or pre malignant lesions), and 87220 (a tissue examination for fungi).

The table clearly shows the cost of each procedure for treating the Sebaceous cyst in the PAY field (\$80 for procedure 11441, \$38 for procedure 88304, \$10 for procedure 17101, and \$10 for procedure 87220) on February 26, 1990 (SVC DAT column). The actual total price for treating the individual's medical episode, the Sebaceous cyst, is \$138, which is the sum of four rows in the PAY field in Table 1.

<Table 1> Of Each Procedure For Treating The Sebaceous Cyst

OBS	PATIENT	PAY	SVC DATE	AGE	GENDER	DX1	PROC1
1	10667760	80	900226	46	F	7062	11441
2	10667760	38	900226	46	F	7062	88304
3	10667760	10	900226	46	F	7062	17101
4	10667760	10	900226	46	F	7062	87220

Unless medical care services are produced by a steady state, fixed-proportion production function with respect to input factors, tracing changes in the input prices might produce major distortion in the information about price changes regarding the final medical services the producers deliver to the market.

Suppose a typical medical care producer's profit function at the base period is

$$(6) \quad \begin{aligned} & \text{Max} \sum p_i^0 q_i - \sum w_j^0 x_j \\ & \text{s.t. } F^0(q_i, x_j) = 0. \end{aligned}$$

Where  $p_i^0$  is the base period output price,  $q_i$  is the level of production,  $w_j$  is the input factor price,  $x_j$  is the input factor and  $F^0(\cdot)$  is the production relations in the base period technology.

The first order condition for profit maximization yields

$$(7) \quad w_j^0 = p_i^0 \frac{\partial F^0(q_i, x_j)}{\partial x_j}.$$

The right hand side of the equation represents the marginal value product of the input factor  $x_j$ , which equals the price of the input factor  $x_j$  at the base period, which is. Suppose the marginal product of the input factor  $x_j$  stays the same in the current period. This implies technology for producing a medical care service stays the same as in the base period. The changes in the output prices will move at the same proportion with the input prices as illustrated below:

$$(8) \quad w_j^1 - w_j^0 = (p_i^1 - p_i^0) \frac{\partial F^0(q_i, x_j)}{\partial x_j}.$$

Since there are no changes in production technology, implying  $\partial F^1(q_i, x_j)/\partial x_j$  equals to  $\partial F^0(q_i, x_j)/\partial x_j$ , the price index based on input prices ( $w_j^1 - w_j^0$ ) could represent the output price index ( $p_i^1 - p_i^0$ ) accurately (i.e., percentage changes in input prices and the percentage changes in output prices are equal).

However, if production technology changes period by period, implying the base period technology ( $\partial F^0(q_i, x_j)/\partial x_j$ ) is not the same as that of current technology ( $\partial F^1(q_i, x_j)/\partial x_j$ ), then changes in the input factor prices are not necessarily the same as the changes in the output prices.

Think of a hospital operating room as an input factor for providing a medical service such as treatment for an acute appendicitis. Suppose, at the base period, two patients were treated in an operating room in a day. Due to new technology, four patients could be treated at the current period. The marginal product of the operating room doubles. Therefore, the output price index, such as the CPI, constructed by measuring the input factor price changes, could not represent the price changes of output product properly.

Therefore, if there is a technological change for a major procedure or substitution among input factors is allowed, the optimal mix of input factors for producing medical services might change dramatically. Then, the output price index may show quite different patterns than the input-based price index calculated by aggregating the unit-input price changes.



## B. Quality Changes in Medical Care Industry

In general, under the absence of technological changes and quality changes, the changes in the input price index represent how much the changes in the cost of producing output would be. However, the medical service industry has been one of the most technologically changing fields. Advanced medical technology means higher quality of medical care service. In that sense, quality change derived from the advancement of medical technology is one of the major causes for the bias on the medical consumer price index.

Quality changes and technology advancement in the medical sciences make many of the treatments for illnesses, such as diagnosis techniques and operative procedures, simpler than in the past, and patients experience less discomfort and down time.

Twenty years ago, gallbladder surgery required a six-day stay in the hospital. With today's technology, it requires only a half-day's stay in the hospital. This reduction in hospital stay should have led to a reduction of the cost of treating cholecystitis.

In another example, before the balloon angioplasty technique was available, patients who had coronary atherosclerosis (hardening of the arteries, or blocking of the arteries) had to undergo open-heart bypass surgery. The cost of open-heart bypass surgery for a single vessel is generally higher than that of a single vessel Percutaneous Transluminal Coronary Angioplasty (PTCA). The patient also stays in the hospital much less time than that of the patient who had open heart surgery.

The chargemaster prices for of an open-heart bypass surgery for a single vessel and Percutaneous Transluminal Coronary Angioplasty (PTCA) for single vessel is shown in the Table 2. There is almost \$20,000 difference in the price of the two treatments for the single vessel heart ailment. In addition to the huge differences in the price of each procedure, the difference in the number of the patients who are treated by the new technology based procedure is growing. In 1993, there were 114 patients who were treated by balloon angioplasty and nine patients treated by open-heart bypass surgery at St. Joseph Hospital in Bryan, Texas (Chun, 1996, mimeo). The number of angioplasty patients in 1994 increased to 151 at the same hospital, while the number of patients who had bypass surgery stayed at 7.

These simple statistics may explain the benefits of patient care through the advancement of technology in medical science. If angioplasty had not been available in 1994, the 151

patients who had a heart ailment would have had no alternative treatment but to have the open-heart surgery. Then, each of the 151 patients might have incurred an additional cost for open heart surgery, let alone the opportunity cost of not being able to work during the recovery period and the opportunity cost of being physically uncomfortable for a longer period of time.

<Table 2> Input Factors for Open Heart Bypass Surgery vs. PTCA, Single Vessel

	Single Vessel Open Heart Bypass Surgery	Single Vessel PTCA
Room	\$5,286.67	\$2,810.18
Pharmacy	\$6,168.52	\$2,909.62
Supplies & Equip	\$10,001.50	\$5,352.54
Lab	\$5,227.38	\$2,104.82
Imaging	\$358.30	\$197.44
Surgery	\$6,021.65	\$158.18
Cath Lab	\$2,284.08	\$3,368.14
Other	\$2,532.35	\$1,084.32
Total	\$37,880.45	\$17,985.24

Source : St. Joseph Regional Hospital, Bryan, Texas, 1995

Griliches (1971) reported an analogous situation in his empirical study on hedonic price index estimation on the quality changes in automobiles. If an engine's output is horsepower and the price for the engine are the input factor costs for producing horsepower, the price of a V-8 engine will be higher than that of a V-6 engine. However, the per unit output price of horsepower of a V-8 should be lower than that of a V-6.

His study supported the argument that even though the input factor price increases due to using new technology, the unit price of an output produced by the new technology input factor could be lower.

The example of horsepower and engine type can be applied to the medical care industry. Producing better quality medical care services may require more expensive additional diagnostic and/or operative input factors such as MRI and/or Laparoscopic equipment for surgery. Even though new or advanced medical equipment generally has a higher unit cost

than the old or existing equipment, improved productivity of the equipment in diagnosis and operative procedures eventually reduces the total cost of treating a certain medical episode by either eliminating obsolete diagnostic procedures or by dramatically reducing the patients' recovery time.

For example, a Laparoscopic surgery on appendicitis needs additional new equipment than in the traditional open stomach surgery. If the price for treating appendicitis was measured based on a unit input price of new equipment, an index constructed this way would overestimate a change in output prices for treating appendicitis because other inputs, like a hospital stay, might have declined substantially.

In terms of the consumers' cost of living index, higher quality medical services received by consumers with the same price means a lower price of treatment. Cutler (1996) reported that the true quality adjusted price index for treating heart attacks actually declined by 5.5 percentage points per year relative to the corresponding component of the MCPI.

### C. Improper Definition of Price in MCPI

The improper definition of price and quantity in the medical care service market seems to be another cause of the bias.

Wesley C. Mitchell (1937) emphasizes formulating a meaningful economic concept first and then finding out a method that best estimates the economic variable in question. Therefore, the first step we should take is to define what is the price that makes sense conceptually and economically. A comparative analysis on the proper representativeness of price indices measuring changes in the price that is conceptually ill-defined seems to be less meaningful.

Currently, the BLS constructs the MCPI using the out-of-pocket expenses of medical care consumers as prices. Is out-of-pocket payment an actual price for the services consumers are purchasing in the medical care service market? The answer to that question is No. Since the majority of medical care consumers are beneficiaries of one form of insurance or another, and insurance companies or HMOs are picking up a substantial portion of the tab, it seems unreasonable to construct a price index with only a very small portion of the complete price (or total cost). Out of pocket expenses paid by medical care consumers account for only about 19 percent of total medical care service expenditures.

Thus, the MCPI constructed with only out-of-pocket expenses by consumers, as was the current MCPI by the BLS, might not correctly represent the changes in the actual price of medical care service products.

Suppose the average copayment (a small portion of the payment made by a consumer whenever he or she receives a medical service) for an office visit to a local doctor is \$5 in the base period, and the copayment is increased by an HMO to \$10 in the current period. The net change on consumers' out of pocket expenses will be a 100 percent increase. However, it is not plausible to expect the total cost of medical treatment from the doctor's office to increase by 100 percent.

Then, the answer to the question of Does the MCPI correctly represent the changes in the price of the medical care service products? should be No.

Without the current third party payment arrangement, the employers' payment for medical insurance coverage for their employees might transfer to the employees as an extra income, and the employees, who are consumers of medical care services, might have to pay medical claims, which is an actual price of the services, out of their pocket.

If payment by insurance companies and HMOs is not a free gift to consumers from Heaven, it surely does have an impact on consumers' welfare. Therefore, it seems that using the total cost of treating a specific medical episode is an accurate representation of the price of a specific service that a consumer is purchasing in the market.

The total cost of treating a specific episode, which is a reasonable representation of an accurate price for the service, should be the sum of the third party payment (mostly by insurance companies and HMOs), the copayment and deductible (a preset amount up to which a consumer is liable to pay for medical bills, and, when the preset amount has been met, the insurance carrier picks up the tab) paid by the medical care service consumer, minus any other savings, including the coordination of benefits and penalties.

Under the trend of increasing managed care coverage, defining price as out-of-pocket expense paid by medical service consumers might bring a tremendous upward bias on the MCPI.

A common understanding is that the medical insurance market is considered as a derived market from the medical care service industry. Accurate market analysis in a derived market would be severely tarnished if there are errors in the price estimating data from the primary market.

However, 81 percent of the total medical care expenditure which is paid by insurance companies and HMOs is not included in the calculation of the current MCPI. Then, it is safe to say that the current MCPI could provide relatively small or no amount of information to the market participants in the medical insurance industry.

Lack (difficulty) of clear differentiation between the price of a medical service and expenditures on the medical service might be another cause of the bias. Without changes in the price, expenditures on certain medical service could increase or decrease depending on the usage of the medical care services. As the intensity of the usage of a medical service increases, meaning more quantities of services consumed in the current period than in the base period, expenditures on that service could increase even without an increase in the price.

#### IV. Conclusion

An accurate estimate of the true cost of living index (COLI) has been one of the primary objectives of price indexing efforts. Any indices incur biases resulting from the properties of each estimating method.

The upper bounding property of the Laspeyres index and lower bounding property of the Paasche index have been reviewed. Getzen(1992) suggests that by re-indexing the existing Laspeyres index with the Paasche indexing method reduces price hikes as much as 0.3 percent annually.

In most of the medical care service price index (MCPI), however, measurement of input factor prices of the medical care service as output prices, improper definition of the output services and corresponding prices, rapid technological changes in medical care industry may have caused additional biases in the MCPI.

Since the majority of medical episodes require multiple medical procedures for treating a single medical episode, it is relatively reasonable to identify an actual output service price by summing up the actual cost of necessary medical procedures.

It seems reasonable to generate the price for a specific medical service a consumer is purchasing in the market by summing up the third party payment mostly by insurance companies and HMOs, the copayment and the deductible paid by the medical care service consumer.

Because the medical care service market functions as a primary market for the market such as medical insurance market, biases in measuring price changes in the medical care service market may have significant consequences in the derived markets.

## Reference

- Archibald, Rae W. and Newhouse, Joseph P. *Social Experimentation: Some Whys and Hows*. Santa Monica, CA: Rand, 1980.
- Archibald, Robert B. On The Theory of Industrial Price Measurement: Output Price Indexes. *Annals of Economic and Social Measurement*, 6/1, 1977, pp. 51-72.
- Armknrecht, Paul A.; Lane, Walter F. and Stewart, Kenneth J. New Products and the U.S. Consumer Price Index. *The Economics of New Goods*, Bresnahan, T. and Gordon, R. J., eds., 1996.
- Bernt, Ernst R.; Cutler, David M.; Frank, Richard G.; Griliches, Zvi; Newhouse, Joseph P. and Triplett, Jack E. *Price Indexes for Medical Care Goods and Services: An Overview of Measurement Costs*. Cambridge MA: NBER, November 1998.
- Boskin, Michael J.; Dulberger, Ellen R.; Gordon, Robert J.; Griliches, Zvi and Jorgensen, Dale. *Toward a More Accurate Measure of the Cost of Living: Final Report to the Senate Finance Committee from the Advisory Commission to Study the Consumer Price Index*. U.S. Senate Finance Committee, December 1996.
- Bureau of Labor Statistics. *The Consumer Price Index*. Chapter 19 in *BLS Handbook of Methods*, September 1992.
- \_\_\_\_\_. *Price Movements, January 1995*. CPI Detailed Report Data, January 1995, pp. 1-3.
- \_\_\_\_\_. *Relative Importance of Components in the Consumer Price Index, 1994*. Bulletin 2463, June 1995.
- \_\_\_\_\_. *Measuring Price Change for Medical Care in the CPI*. Summary 97-9, U.S. Department of Labor, June 1998.
- Cleeton, David L.; Goepfrich, Valey T. and Weisbrod, Burton A. What Does the Consumer Price Index for Prescription Drugs Really Measure? *Health Care Financing Review*, Spring 1992, pp. 45-50.
- Congressional Budget Office. *What Has Caused the Rapid Increase in Health Expenditure?* Congressional Budget Office Study, Congress of the United States. October 1992, pp.

21-27.

- Cutler, David M.; McClellan, Mark; Newhouse, Joseph P. and Remler, Dahlia. Are Medical Prices Declining? Evidence from Heart Attack Treatments. *Quarterly Journal of Economics*, v 113, i4, November 1998, p 991.
- Dow, William H.; Gertler Paul; Schoeni, Robert F.; Strauss, John and Thomas, Duncan. Health Care Prices, Health and Labor Outcomes: Experimental Evidence. Santa Monica, CA: Rand Corp., July 1996.
- Fisher, Franklin M. and Griliches, Zvi. Aggregate Price Indices, New Goods, and Generics. *The Quarterly Journal of Economics*, February 1995.
- Fisher, Franklin M. and Shell, K. The Economic Theory of Price Indices. New York, NY: Academic Press, 1972.
- Fisher, Irving. The Making of Index Numbers. Cambridge, 1922.
- Fleetwood, William. Chronicon Preciosum: Or an Account of English Gold and Silver Money; The Price of Corn and Other Commodities; and of Stipends, Salaries, Wages, Jointures, Portions, Day-labour, &c. in England, for Six hundred Years last past: &c..., London: Printed for T. Osborne, in Gray's-Inn. 1745. Fleetwood, William London, 1707, 1st Edition.
- Ford, Kay I. and Sturm, Philip. CPI revision provides more accuracy in the medical care services component. *Monthly Labor Review*, April 1988, Vol. 111, No. 2.
- Freeland Mark S.; Chulis, George S.; Arnett, Ross H.; and Brown, Aaron O. Measuring Input Prices for Physicians: The Revised Medicare Economic Index. *Health Care Financing Review*, Summer 1991, pp. 61-67.
- Gillingham, Robert. A Conceptual Framework for the Consumer Price Index. Proceedings of the American Statistical Association 1974 Business and Economic Statistics Section, (Washington, D.C., American Statistical Association, 1974).
- Glandon, Gerald L. Relative Changes in Medical Care Prices: The Consumer Price Index, 1970-1980." Profile of Medical Practice 1981, pp. 119-130 edited by David Goldfarb, Chicago, American Medical Association.
- Gode, Dhananjay K. and Sunder, Shyam. Allocative Efficiency of Markets with Zero-Intelligence Traders: Market as a Partial Substitute for Individual Rationality. *Journal of Political Economy*, 1993, 100 (1), 119-137.
- Griliches, Zvi. Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change. In Price Indexes and Quality Change, ed. Zvi Griliches. Harvard University

- Press, Cambridge, Massachusetts, 1971.
- Helms, L. Jay and Newhouse, Joseph P. Copayments and Demand for Medical Care: The California Medicaid Experience. Santa Monica, CA: Rand Corp., 1978.
- Hicks, J. R. The Valuation of Social Income. *Economica*, VII, N.S. (1940).
- Keeler, Emmet B. and Rolph, John E. The Demand for Episodes of Treatment in the Health Insurance Experiment. *Journal of Health Economics*, 7, 1988, 337-367.
- Lee, James A. and Mitchell, Janet B. Physician Reaction to Price Changes: An Episode of Care Analysis. *Health Care Financing Review*, Winter 1994, 16 (2), 65-83.
- Morris, Carl N. and Newhouse, Joseph P. On the Theory and Practice of Obtaining Unbiased and Efficient Samples in Social Surveys. Santa Monica, CA: Rand, 1980.
- Mitchell Wesley C. The backward Art of Spending Money and other essays, 1937.
- Moulton, Brent R. Basic Components of the CPI: Estimation of Price Changes. *Monthly Labor Review*, December 1993, 116:12, 13-24.
- Newhouse, Joseph P. Price and Income Elasticities for Medical Care Services. Santa Monica, CA: Rand, 1974.
- Newhouse, Joseph P. and Phelps, Charles E. Coinsurance and the Demand for Medical Services. Santa Monica, CA: Rand, 1974.
- Philipson, Thomas and Zanjani, George. Consumption vs. Production of Insurance. NBER Working Paper No. 6225, October 1998.
- Pollak, Robert A. Group Cost-of-Living Indexes. *The American Economic Review*, Vol. 70, No. 2, 1980, pp. 273-278.
- \_\_\_\_\_. The Consumer Price Index: A Research Agenda and Three Proposals. *Journal of Economic Perspectives*, Vol. 12, Number1, Winter 1998, pp. 69-78.
- Reder, M. W. Some Problems in the Measurement of Productivity in the Medical Care Industry. In Fuchs (1969).
- Saving, Thomas R. and Rettenmaier, Andrew J. Medicare Policy for Future Generations: A Search for a Permanent Solution. U.S. Senate Committee on Finance, Subcommittee on Health, February, 1997.
- Scitovsky, Ann A. An Index of the Cost of Medical Care A Proposed New Approach. In The Economics of Health and Medical Care, Proceedings of the Conference on the Economics of Health and Medical Care, May 10-12, 1962, The University of Michigan, Ann Arbor, 1964.
- Changes in the Costs of Treatment of Selected Illnesses, 1951-65. *American*



- Economic Review*, Vol. 57, No.5, December, pp.1182-1195.
- Shapiro, Matthew D. and Wilcox, David W. Mismeasurement in the Consumer Price Index: An Evaluation. Cambridge, MA: NBER, Working Paper 5590, May 1996.
- Skinner, Jonathan and Wennberg, John, E. How Much Is Enough? Efficiency and Medicare Spending in the Last Six Months of Life. NBER Working Paper No. 6513, April 1998.
- Sofaer, Shoshanna and Davidson, Bruce N. Illness-episode Approach: Cost and Benefits of Medigap Insurance. *Health Care Financing Review*, Summer 1990, 11 (4), 121-132.
- Triplett, Jack E. Accounting for Health Care: Integrating Price Index and Cost-Effectiveness Research. AEI Conference Paper, December 12, 1997.
- Weiss, Samuel. The Development of Index Numbers in the BLS. *Monthly Labor Review* 78(1):20-25.
- Zuckerman, Stephen; Holahan, John; Popkin, Joel; Terrel, Sherry and Kochhar, Rakesh. Measuring Prices of Medicare Physician Services. *Medical Care*, 1993, 31 (8), 694-710.