What does the Consumer Price Index for prescription drugs really measure?

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This article examines the conceptually desirable attributes of a fully quality-adjusted prescription drug price index. It provides an understanding of how the Consumer Price Index for prescription drugs and medical supplies treats quality changes in prescription drugs and, in particular, quality changes associated with the introduction of new drugs.

Introduction

The rising costs associated with prescription drugs have become an important focus of public debate and congressional hearings in the health care arena U.S. House of Representatives 1985, 1987; U.S. Senate, 1989, 1991; Waldholz and Steptoe, 1987). Pharmaceutical prices have been rising more rapidly than both medical care prices and consumer prices in general, as measured by the Consumer Price Index for medical care, and for all items (CPI-all items). Because of the public policy focus on the escalation of pharmaceutical prices, it is important to understand how the change in drug prices, as measured by the Consumer Price Index for prescription drugs and medical supplies (CPI-drugs), compares with the concepts of price change that policymakers and analysts may have in mind. This article examines whether the CPI-drugs adjusts properly for quality changes of prescription drugs, focusing particularly on how the index deals with new drugs.

Accounting for technological change and new products is a general problem with price indexes. It appears to be an especially serious matter in the pharmaceutical industry, which is characterized by a relatively high rate of product innovation leading to relatively frequent introductions of new drugs that presumably embody improvements in quality (Schwartzmann, 1976; Wardell and Sheck, 1984; Wiggins, 1984). One indicator of the importance of innovation in the drug sector is the rate at which new products appear. The U.S. Department of Health and Human Services reports that from July 1982 through July 1987, 3,048 additions were made to the existing list of drug products (U.S. Department of Health and Human Services, 1982-87). Because the list contained 6,303 drug products as of July 1982, this represents an addition of nearly 50 percent over 5 years. With such a high turnover rate, the way CPI-drugs treats new drugs has a potentially important effect on the measured change in prescription drug prices.

As we shall see, the Bureau of Labor Statistics (BLS) does not explicitly adjust the prices of new drugs to reflect changes in quality. Furthermore, at the time a new drug enters the market its price and quality have no effect whatsoever on CPI-drugs, as that index is calculated. However, as we will show, one cannot be certain whether a price index that accounts for new drugs at the time of their entry, and that properly adjusts for quality, would decrease, increase, or leave unchanged the measured rate of increase of the pharmaceutical price index. This is true even if new drugs increase quality. Our objective is not to criticize the methods used but to highlight the consequences of the fact that adjusting for quality changes is so difficult that it is not being done.

Index construction

CPI-drugs is a subindex of CPI-all items, and most of the methodology used for the construction of CPI-drugs is shared with the other components of the CPI. In this section we give a brief explanation of the construction of CPI-drugs.[1] CPI-drugs is said by BLS to be a fixed quantity, fixed quality price index: the ratio of the costs of purchasing a fixed basket of prescription drugs and medical supplies (hereafter, "drugs") at two different times (U.S. Department of Labor, 1988). In fact, however, the index is neither fixed quantity nor fixed quality. To see this, it is necessary to examine how CPI-drugs is calculated.

CPI-drugs at time t relative to time 0 ($CPID_{t,0}$) is defined as:

$$CPID_{t,0} = (E_t/E_0) \cdot 100,$$

where

the base period expenditures on drugs, E_0, are taken from the Consumer Expenditure Survey (CES), and current period expenditures, E_t, are estimated by chaining together monthly data on price changes in drugs.[2] BLS multiplies base period expenditures on drugs by the estimated price change to estimate current period (t) expenditures on a changing set of drugs:

$$E_t = E_{t-1} \cdot P_{t,t-1} = E_0 \cdot P_{1,0} \cdot P_{2,1} \cdot \ldots \cdot P_{t,t-1}$$

[1]For readers who wish a more detailed summary of the index construction, a broad general survey of CPI construction can be found in U.S. Department of Labor, 1988.
[2]The Consumer Expenditure Survey for 1982-84 serves as the basis for the 1987 CPI revisions.

where

E_{t-1} is the estimated consumer expenditures on drugs at time $t-1$, and $P_{1,0}$, $P_{2,1}$, and $P_{t,t-1}$ are the drug price changes between times 0 and 1, 1 and 2, $t-1$ and t, respectively. CPI-drugs at time t can then be written as:

$$CPID_{t,0} = P_{1,0} \cdot P_{2,1} \cdot \ldots \cdot P_{t,t-1} \cdot 100.$$

Thus, CPI-drugs is not a fixed quantity price index; expenditures at time t are not derived by multiplying prices at time t by base period quantities.

Deriving the sample of drugs for which the price changes will be used to estimate the one-period price change in drugs is a two-step process. First, a sample of retail outlets is drawn in each of 94 urban areas, termed primary sampling units (PSUs), and then a sample of drugs is drawn in each of those outlets.[3] Within each PSU, a point-of-purchase survey (POPS) is conducted in which consumers are asked to name the outlets where they purchase their drugs and the total amount they spend on drugs at each outlet. A sample of retail outlets is then constructed from all the outlets in the PSU, where the probability that an outlet x in PSU y will be selected for the sample is equal to the ratio of total expenditures on drugs in outlet x to total expenditures on drugs in all the outlets in PSU y.

Within each of the outlets, a sample of drugs is then drawn. The price sampling procedures starts by collecting the list of the last 20 prescriptions sold in the outlet and their prices. A prescription is defined by, among other things, the number and size of, for instance, the pills it contains, the drug's name, and its manufacturer. The probability of selecting a particular prescription to price (i.e., the quantity weight attached to the price of a particular prescription drug) is then calculated as the ratio of that prescription's cost to the total cost of all 20 prescriptions. A drug thus enters the pricing sample based on both the relative frequency with which it is prescribed and its relative cost per prescription in that outlet at the time the sample of prescriptions is drawn. Once a particular drug is selected for pricing in an outlet, BLS obtains a price quotation on it in that outlet each month for 5 years.

Thus, for 5 years the sample of prescriptions priced at each pharmacy remains fixed. Each year, in one-fifth of the urban PSUs, a new POPs is taken and the results are used to select new samples of outlets. Then, within each of the sample outlets, a new sample of prescriptions is drawn. It is only through this reinitiating process that new drugs enter the pricing samples at specific retail outlets, and can affect CPI-drugs.

[3]The urban areas to be sampled are derived from the 1980 Census using the consolidated metropolitan statistical area definitions. For additional information on the urban area samples, see U.S. Department of Labor, 1987.

Finally, the one-period price change in prescription drugs is calculated as:

$$P_{t,t-1} = \Sigma_j (\delta_j/\mu_j) \cdot (P_{j,t}/P_{j,0}) / \Sigma_j (\delta_j/\mu_j) \cdot P_{j,t-1}/P_{j,0}),$$

where

$P_{j,t}$, $P_{j,t-1}$, and $P_{j,0}$ are the prices in the particular pharmacy of sample prescription j at t, at $t-1$, and in the base period, respectively; δ_j is an estimate from the POPS of the total daily expenditure on all drugs in the PSU, and μ_j is the number of usable drug price quotes in that PSU.[4] Consequently, aside from the explicit quantity weight on each price quotation, which is a function of which PSU it is from, every drug has an implicit weight in CPI-drugs that depends on the total number of times the drug is priced over all the sample outlets. Recall that the probability that a drug enters a particular outlet's sample of prescriptions is a function of both the relative frequency with which it is prescribed and its relative cost per prescription. Furthermore, because of the reinitiating process, an individual drug's implicit weight in CPI-drugs depends on these two factors for the 5 years prior.

Figure 1 gives some indication of the amount of change that occurs in the prescription drug market. It shows the number of drugs that entered the list of the top 200 drugs, according to the number of prescriptions filled at retail pharmacies in a year, for the years 1973-87. During that period, the number of drugs new to the top 200, that is, drugs that were not included in the top 200 the previous year, averaged approximately 20, or 10 percent per year. Only 44 drugs made the top 200 every year during the period 1972-87.

In summary, CPI-drugs is not a fixed quantity index, nor would that be useful in a sector characterized by rapid product innovation. Expenditures at time t are not derived by multiplying prices at time t by base period quantities, but rather by chaining together one-period estimates of the price changes in a basket of prescription drugs, a basket that changes, in part, every year. Although the number of times a drug is priced at a particular point in time is similar to a quantity weight, it is a function of both quantity (the relative frequency with which the drug is prescribed) and the drug's relative cost per prescription. We now turn to the specific way CPI-drugs deals with new drugs and the changes in quality associated with them.

Accounting for quality changes

Every period, BLS attempts to obtain a price quotation on each of the sample prescriptions in the individual retail outlets. Sometimes, however, BLS cannot obtain a price on the identical sample prescription in an outlet. We consider BLS's solution to

[4]The price subscript 0 refers to the first price quotation obtained and may not correspond to a price quotation from the base period. Recall that the base period is the period of the expenditure data from the CES. A current price quotation for a drug is usable if a price quotation on the drug in the prior period is available in the outlet.

Figure 1
Drugs new to the top 200: 1973-87[1]
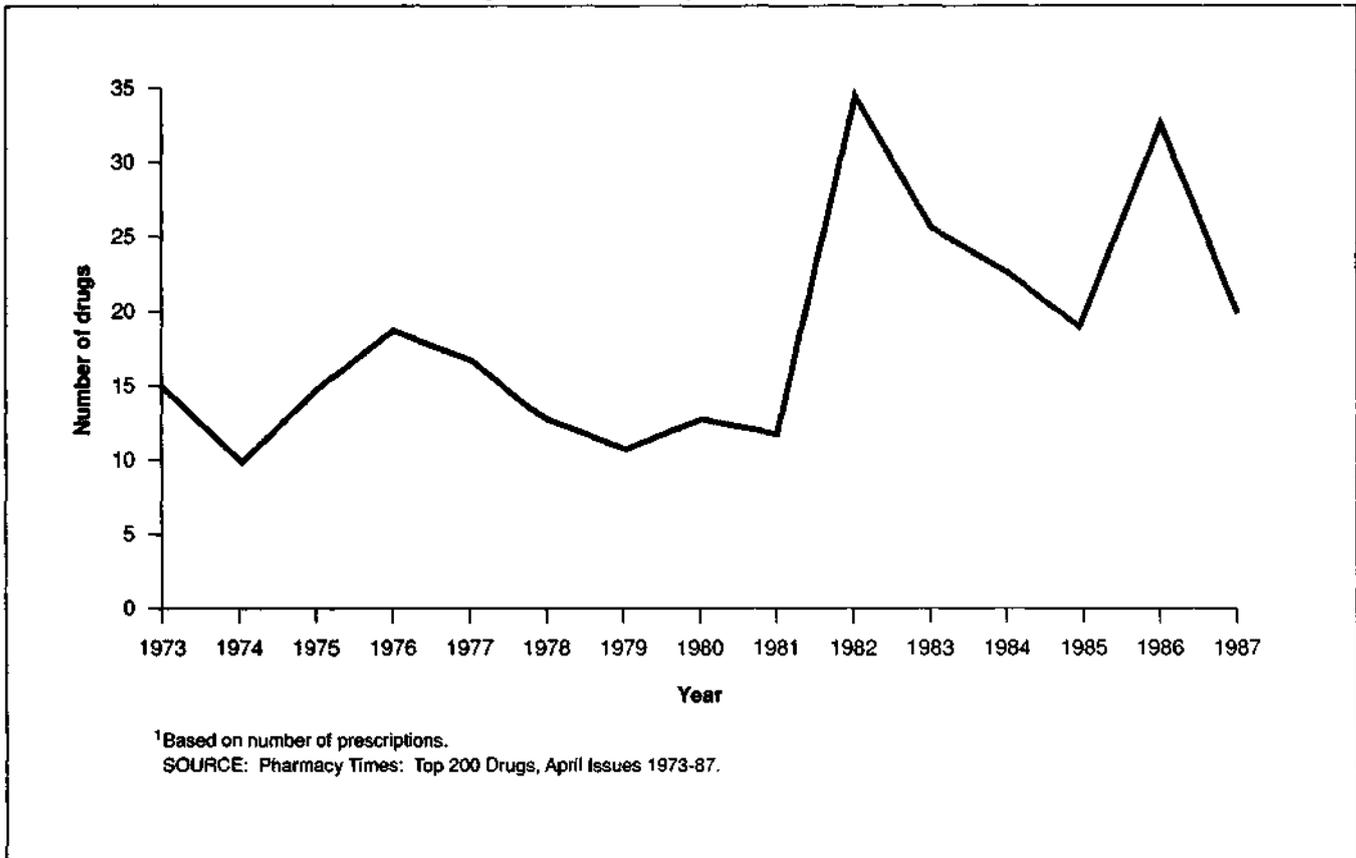
this problem in four different situations, and the consequences of each for interpreting changes in CPI-drugs. The four cases range from a change in the unit size in which a drug is available (e.g., the number of pills in a prescription) to a new drug.

Consider first the situation where the BLS representative cannot obtain a price quotation on a sample prescription because the drug is no longer available in that precise unit size. In this simple case, BLS makes a price adjustment; it uses a quantity adjusted price for a prescription identical to the original prescription in all respects except for unit size (e.g., number of pills):

$$P'_{s,t} = P_{s,t} \cdot \frac{\text{number of pills in the original prescription}}{\text{number of pills in the substitute prescription}}$$

where

$P_{s,t}$ and $P'_{s,t}$ are the price and adjusted price of the substitute prescription at time t. The price per unit (e.g., 50 milligram pill) remains the focus of the index.

Next, suppose that a price quotation is unavailable on a sample prescription at time t because the outlet no longer carries the particular brand of the drug. In this situation, BLS uses as a substitute the price of the brand of the drug that is the closest available substitute, in that outlet, to the original prescription's brand of the drug. No adjustment is made; the price of the substitute

prescription at time t is used in the calculation of the price change in the original prescription between $t - 1$ and t. Hence, it is assumed implicitly that different brands of a drug or a generic, if it is the closest substitute, are of essentially identical quality. To the extent that the substitute brand of the drug is of lower (or higher) quality than the original prescription's brand of the drug, CPI-drugs is biased downward (or upward) compared with a price index that is properly adjusted for the change in product quality. Of course, such an adjustment is difficult and controversial. The alternative of omitting the drug from the calculation of the price index, however, also poses problems, as we will discuss in the next section.

A third situation is the case in which a prescription drug that is already in the pricing sample changes in some dimension of quality between $t - 1$ and t. We consider two scenarios, one in which BLS currently makes no attempt to adjust prices, and one in which it does. First, since major aspects of the therapeutic value and toxicity of a drug may only become known some time after it has been on the market, the evaluation of a drug's effectiveness may change over time (Wardell and Sheck, 1984). As a result, the professionally perceived quality of a drug may change, gradually or dramatically, during its inclusion in the CPI-drugs pricing sample although the chemical composition of the drug does not change. Because BLS is unable to estimate confidently the magnitude of quality change for a particular product as information about its

effectiveness and side-effects accumulates, and to translate the new information into an equivalent price change, BLS makes no adjustments at all for such learning. To be sure, the task is difficult.

Consequently, to the extent that such changes in the perceived quality of a sampled drug occur, CPI-drugs is biased compared with a price index for constant quality drugs. The overall direction of any bias is not predictable, however, because some drugs prove through time to be of lower quality, while others of higher quality, than had previously been believed.

In general—not simply for drugs—when a product changes in a way such that BLS is able to estimate with confidence the effect of the change in quality on the price of the product, BLS does adjust the price accordingly. Products for which this is the case, for at least certain changes in quality, include automobiles and major household appliances (Triplett, 1971). We could also envision a scenario for which it would be the case for prescriptions. Suppose that between $t-1$ and t child-resistant containers became standard for prescriptions, and suppose also that separate markets existed for both regular and child-resistant containers. Since child-resistant containers represent a quality improvement, prices of prescriptions, which reflect both the drug and its container, at time t should be adjusted. In this case, because of the existence of markets for the two types of containers, BLS could adjust the prices of prescriptions at time t by subtracting the difference between the market price of a child-resistant container and that of a regular container.[5]

Finally, we examine the treatment of new drugs in the calculation of CPI-drugs. Suppose a new drug is introduced between periods $t-1$ and t. Also suppose that new samples of prescriptions are drawn in one-fifth of the PSUs in period t (as the reinitiating process proceeds), at which time the new drug first enters the pricing sample. Because BLS cannot obtain a price on the new drug at $t-1$ and, therefore, cannot calculate the change in its price between $t-1$ and t, the new drug is simply excluded from the calculation of CPI-drugs at time t.

An important assumption implicit in this procedure is that between $t-1$ and t, the change in the price of the new drug, which is not observed, is equal to the weighted average change in the prices of all the drugs that are included in the calculation of CPI-drugs (drugs for which prices are available in both periods). It is not until the next period, $t+1$, when a second price quotation on the new drug has been obtained, that the new drug enters the price index, for only then can the change in price of the new drug be observed. To have

included the drug earlier, when it first appeared in the sample, would have required some imputational process for determining a price for the drug in the period before it entered the market (Diewert, 1988).

Suppose, however, that the quality of the new drug relative to that of an old drug is known. For example, suppose the new drug is known to be twice the quality per unit as an old drug, C, for which a price is available at $t-1$. Then the price of drug C at $t-1$ could be compared with one-half the price of the new drug at t, reflecting the fact that the new drug is twice the quality, to measure the change in price of the new drug between $t-1$ and t. In this way the change in the price of the new drug, adjusted for quality, could be included immediately, when it first appeared in a sample, in the calculation of CPI-drugs at time t.[6] Until such quality comparisons across old and new drugs can be developed, however, the important question is how CPI-drugs is affected by the systematic exclusion of new drugs. This is particularly important if it is granted that new drugs are generally improvements over previously available drugs, and in this sense constitute systematically higher quality. Does CPI-drugs overstate the rate of increase of a quality adjusted index of pharmaceutical prices?

The answer is not clear. Omission of new drugs causes CPI-drugs at time t to be biased either upward or downward, depending on whether the unobserved change in price of the new drug between $t-1$ and t is smaller or larger than the weighted average change in the prices of all the old drugs that are included in CPI-drugs because their prices are available at both $t-1$ and t. No clear bias is indicated.

A numerical example illustrates this result. Suppose that at $t=0$ only three drugs exist, A, B, and C, and that between $t=0$ and $t=1$ a fourth drug, D, is introduced. Assume, for simplicity, that there is only one PSU and one outlet in that PSU. Also suppose that the sample of prescriptions to be priced in that outlet is reinitiated at $t=1$ and, as a result, contains the new drug D for the first time, along with the old drugs A, B, and C. Finally, suppose the following data are available in the sample outlet at $t=1$:

Prescription i	n_i	$P_{i,0}$	$P_{i,1}$
drug A	4	6	6.6
drug B	2	8	8.8
drug C	1	10	11.5
drug D	3	NA	$P_{D,1}$

where

n_i is the relative weight for prescription i in the sample of prescriptions to be priced in the outlet; $P_{i,0}$ and $P_{i,1}$ are the prices of prescription i in the base period and at $t=1$, respectively, in the outlet; and NA indicates that the data are not available in the outlet.

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[5] An analogous adjustment was actually made by BLS with the introduction of tamper-proof packaging in the case of over-the-counter (OTC) drugs. BLS estimated the average cost of a tamper-proof package at 2½ cents and used this cost estimate as an estimate of the monetary value of the quality change in drug packaging; thus, the prices of all OTC drugs in tamper-proof packages were reduced by 2½ cents in calculating the index.

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[6] A recent examination of pharmaceutical price index issues refers to the possibility of "accounting for quality changes" and then "computing quality adjusted price indexes," but identifies these as matters for future research (Berndt, Griliches, and Rosett, 1990).

Because a price is unavailable on the new drug D at $t = 0$, BLS does not include an estimate of the change in its price between $t = 0$ and $t = 1$ in the calculation of CPI-drugs at $t = 1$, but will calculate the index as:

$$CPID_{1,0} = P_{1,0} \cdot 100 = \frac{\sum_{i=A}^{C} n_i \cdot (P_{i,1}/P_{i,0})}{\sum_{i=A}^{C} n_i \cdot (P_{i,0}/P_{i,0})} \cdot 100$$

$$= \frac{\sum_{i=A}^{C} n_i \cdot (P_{i,1}/P_{i,0})}{\sum_{i=A}^{C} n_i} \cdot 100$$

$$= (7.75/7) \cdot 100 = 110.71.$$

Hence, BLS would calculate the weighted average change in the price of the old drugs, A, B, and C, between $t = 0$ and $t = 1$, to be 10.71 percent.

If it is known, however, that the new drug D is, say, twice the quality of drug C, then the change in the price of the new drug between $t = 0$ and $t = 1$ could be imputed as $0.5 P_{D,1}/P_{C,0}$ and included immediately in the calculation of the price index. In this case, the adjusted price index for drugs at $t = 1$ $(ADJD_{1,0})$ could be calculated as:

$$ADJD_{1,0} = \frac{\sum_{i=A}^{C} n_i \cdot (P_{i,1}/P_{i,0}) + n_D \cdot (.5 P_{D,1}/P_{C,0})}{\sum_{i=A}^{D} n_i} \cdot 100$$

The following presents the value of the adjusted price index, $ADJD_{1,0}$, and the quality adjusted change in the price of the new drug, $(.5 P_{D,1}/P_{C,0}) - 1$, for various values of $P_{D,1}$:

$P_{D,1}$	$ADJD_{1,0}$	$(.5 P_{D,1}/P_{C,0}) - 1$
21.60	109.90	8.0 percent
22.14	110.71	10.7
23.00	112.00	15.0

This example illustrates the relationship between CPI-drugs and a price index that includes the change in the imputed quality adjusted price of a new drug at the time it is introduced. The quantitative conclusion is ambiguous; CPI-drugs, as currently measured, will be less (or greater) than such a price index when the quality adjusted change in the price of a new drug is greater (or less) than the weighted average change in the prices of the old drugs used to calculate CPI-drugs.

Even if we cannot be certain that a pharmaceutical price index that included new products at the time of

their introduction would show any systematic relationship to CPI-drugs as currently calculated, can anything be said about the probable bias of CPI-drugs relative to such a quality adjusted price index? In our judgment, little can be said about the relationship between these two price indexes.

Consider the implications of the current pressure for cost containment in health care. Insurers, for example, State Medicaid authorities, are increasingly adopting rules that permit payment for a new drug only if it is expected to be "cost-reducing." Thus, we might presume that for a new drug to compete successfully in the marketplace, its quality adjusted price must be less than the price of, for example, its closest competitor. It might appear, therefore, that the exclusion of new drugs from CPI-drugs imparts an upward bias to the measured index relative to an index that reflects quality adjustment.

That, however, is not necessarily the case. Even if a new drug has a quality adjusted price that is lower than the price of its nearest competitor, exclusion of the new drug from CPI-drugs has no predictable effect. CPI-drugs will be biased upward compared with a quality adjusted price index only if the change in the quality adjusted price of the new drug is less than the weighted average change in the prices of the drugs used to calculate CPI-drugs. In any event, the case seems strong for undertaking difficult empirical work to link new drugs to CPI-drugs by devising meaningful mechanisms for quality adjustments.

Discussion and conclusion

CPI-drugs, a retail price index for prescription drugs and medical supplies, is not a fixed-base period quantity weighted price index for a constant market basket of items. Through a reinitiation process, new samples of prescriptions to be priced are drawn in one-fifth of the sampling units each year, and it is only in this way that new drugs can enter the market basket of drugs being priced.

When a new drug first enters the sample of prescriptions on which CPI-drugs is based, there is no previous price for it. Not having a readily available basis for price comparison, BLS does not include any estimate of that drug's price change in the calculation of CPI-drugs in that time interval. In effect, this assumes that the change in the price of the excluded drug is equal to the weighted average change in the prices of the (old) drugs included in the calculation of CPI-drugs.

The effect of this procedure, through which new drugs are not incorporated in CPI-drugs at the time of their introduction, but only later when successive prices can be observed, cannot be determined a priori, even if all new drugs are unambiguously of higher quality than the drugs they replace. CPI-drugs may be biased upward, downward, or not at all, compared with a price index that includes the imputed change in the price of a new drug at the time of its introduction. The bias, if any, depends on whether the imputed change in the price of the new drug, adjusted for quality, would be

smaller or larger than the weighted average change in the prices of the drugs used to calculate CPI-drugs. If it is smaller, then CPI-drugs is biased upward; if it is greater, the index is biased downward.

In addition to the way it handles new drugs, CPI-drugs does not reflect changes in knowledge about the effectiveness and safety of existing drugs. What CPI-drugs shows is that a non-constant quality price index of a changing set of drugs is rising relatively rapidly. Clearly, it would be useful to know the change over time in a price index that holds quality constant by adjusting the prices of drugs for the changes in quality they represent. Equally clearly, the adjustment process is difficult, but until one is implemented, the usefulness of CPI-drugs will be limited, given the rapid rate of product innovation and given changes in perceived quality of drugs over time.

We think the potential exists. For example, in the case of antibiotics, it may be possible to develop a quality index based on a variable such as the speed with which the drug eliminates the infection; this would permit the quality of a new antibiotic to be compared with that of existing antibiotics.

Another point of concern with interpretations of CPI-drugs is the need to recognize that drugs are but a single input into the production of health, and that they are important substitutes for, and complements to, non-drug inputs. Consider the case of a new drug that serves as a lower cost alternative to a non-drug, medical therapy; examples of this include the drug cimetidine, which substitutes for ulcer surgery (Geweke and Weisbrod, 1984) and psychotropic drugs that substitute for institutionalization of the mentally ill (Weisbrod, 1983). When a new drug substitutes for a non-drug therapy, a price index for drugs alone would be a misleading indicator of the cost of health care. This is not to fault CPI-drugs, but to recognize that drugs have a complex role to play in the overall health system.

New drugs may also be complements to, rather than substitutes for, non-drug health inputs. For example, drugs that have greatly reduced the probability of rejection of transplanted organs have had the effect of increasing the frequency of organ transplants. In the case of kidney disease, the transplant is less costly, especially for younger people, than a lifetime of dialysis treatments. Hence, in this case, the price of the immuno-suppressant drug cyclosporine is less important for understanding health care costs than is the fact that the drug facilitates, i.e., is a complement to, costly kidney transplants, and that transplants substitute for dialysis.

It should also be noted that CPI-drugs measures the change in drug prices at retail pharmacies only. As an increasing proportion of the population joins health maintenance organizations and obtains prescription drugs through those organizations, and as an increasing proportion of the population turns to nursing homes where drugs are provided to patients directly, the retail level CPI-drugs comes to provide price information relevant to a decreasing proportion of the overall pharmaceutical market.

If a price index for drugs is to be useful for policy purposes, we must recognize precisely what the index does and does not measure. A price index such as CPI-drugs cannot be interpreted as an indicator of consumer welfare because of:

• The way in which CPI-drugs deals with new products, by disregarding them at the time of their introduction.
• The rapid rate of introduction of new drugs.
• The complex production relationships between drugs and other health care inputs.
• The decreasing proportion of drugs that are purchased through retail pharmacies.

Our purpose is not to find fault with BLS techniques. Rather, it is to highlight the problems of constructing a price index when new products are introduced frequently, and interpreting changes in an index that captures only a diminishing portion of the market and that includes commodities that have important substitution and complementary relationships with commodities that it does not encompass. We show that an explicit quality adjustment process for new drugs would not necessarily reveal that drug prices have increased more slowly than CPI-drugs indicates, even if all new drugs are unambiguously of higher quality than the drugs they replace.

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