# Cellular Telephone, New Products, and the CPI

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Since their introduction in 1983, cellular telephones' adoption has grown at 25%–35% per year. At year end 1997, about 55 million cellular telephones were in use in the United States. The Bureau of Labor Statistics (BLS) did not know that cellular telephones existed, at least in terms of calculating the Consumer Price Index (CPI), until 1998 when they were finally included in the CPI. Omitting cellular telephones from the CPI created a significant bias. I estimate a bias in the BLS estimate of the telecommunications-services index of between .8%–1.9% per year because of the omission of the cellular telephone. Rather than telecommunications-service prices increasing at about 1.1% per year, the correct calculation has them decreasing at about .8% per year. Omission of new goods from the CPI, for significant periods of time, leads to important bias in the calculation of the CPI.

KEY WORDS: Consumers surplus; Consumer welfare; Price index.

Cellular telephone is an example of a new product that has significantly affected how Americans live. Since their introduction in 1983, cellular telephones' adoption has grown at 25%–35% per year such that at year end 1997 about 55 million cellular telephones were in use in the United States. Thus, approximately 20% of all Americans use cellular telephones, and there are about 1/3 as many cellular telephones in the United States as regular (landline) telephones. The average cellular customer spends about $588 per year on cellular service. Thus, consumers and businesses have found cellular telephone to be a valuable addition to their lifestyles.

## 1. NEW GOODS AND SERVICES IN THE U.S. ECONOMY

Many other new products and services also have a significant effect on consumer welfare. Approximately 40–45 million subscribers to the Internet with growth of 70%–100% per year demonstrate the importance of this new service. I previously estimated the consumer value of the Internet (Hausman 1998). New software products such as Windows 95 also lead to significant gains in consumer welfare. Indeed, even new products such as new cereal brands create significant increases in consumer welfare, as I have estimated (Hausman 1996).

The Bureau of Labor Statistics (BLS) did not know that cellular telephones existed, at least in terms of calculating the Consumer Price Index (CPI), until 1998, when they were finally included in the CPI. By 1998, 15 years after the introduction of cellular telephones, over 55 million Americans were using cellular and PCS, mobile telephones based on the next generation of cellular technology. When the BLS finally included cellular telephones in the CPI for the first time in February 1998, it had *no effect* on the CPI because the BLS reported that the price of cellular had not changed from the previous month.

This neglect of new goods with their introduction into the CPI only after a long delay leads to an upward bias in the CPI that the recent Boskin Committee Report (Boskin, Dulberger, Gordon, Griliches, and Jorgenson 1996) found to be large and significant. Waiting 15 years to include cellular telephone in the CPI is not an isolated example; it took the BLS approximately the same amount of time to introduce room air conditioners into the CPI. Because the price of many new products typically falls rapidly, this long delay can lead to a significant bias. For instance, the original cellular telephones sold for about $3,000 in 1983 with the price to consumers now in the range of about $200, at most. Furthermore, the quality of cellular telephones has improved significantly, and the BLS typically does not adjust fully for quality in these types of products so that another upward bias is introduced. The Boskin Committee Report estimated that the delay in introducing new goods and failure to adjust sufficiently for quality improvements creates an upward bias in the CPI of .6% per year. This bias is large relative to yearly changes in the CPI of approximately 3% over the past decade.

The Boskin Committee Report's estimate of bias is too low, however, because the gain in consumer welfare from new products is not considered in the bias estimate. Because the BLS has stated that the CPI is designed to be a cost-of-living index (COLI), as recently reaffirmed by the Commissioner of the BLS (Abraham, Greenlees, and Moulton 1998), economic theory demonstrates that increases in consumer welfare from new goods and services should enter the estimation of the CPI.

Thus, the claim of Moulton and Moses (1997, pp. 321–322), who attempted to minimize the importance of the failure of the CPI to include new products in a correct manner by stating that cellular is "one of the most important new products," is likely to be incorrect. Consumer expenditure on Windows 95 or Internet services is again very large so that other important new products have been omitted in the CPI for a significant period of time. These products would have a significant effect on consumer welfare in a similar manner to what I find here for cellular telephone.

A COLI approach answers the following question: How much income does a representative consumer require to be as well off this period as last period given changes in prices, introduction of new products, and exit of old products? Note


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that the use of the representative-consumer model is an important feature of the definition of a COLI as used here. Use of an expenditure function allows estimation of this required amount, which then allows the construction of an index that gives a COLI. Thus, even if the BLS did not delay the introduction of new products such as cellular telephone into the CPI for periods of 15 years, the BLS calculation of the CPI for new products would still be biased upward. The upward bias results because the BLS does not calculate the gains in consumer welfare from new products. I demonstrate how this gain in consumer welfare should be estimated, and I also give an approximation result, which the BLS could use to calculate gains in consumer welfare from new products for use in the CPI.

The BLS has three possible approaches to the inclusion of new goods into the CPI. (1) The BLS can ignore the new goods for a long time, as with the 15-year delay for cellular telephones. This article demonstrates that the BLS missed approximately 50% of the price decline in cellular telephones using this approach. (2) The BLS can add new products to the CPI earlier. My calculation shows that, if cellular telephones had been included in the CPI in 1988, five years after its introduction, the BLS would have missed about 25% of the price decrease, which would have been a significant improvement. (3) The BLS could introduce a true COLI measure that measures the value of the introduction of the new product to consumers, as well as the subsequent decrease in price. This article demonstrates that the value of new products such as cellular telephones to consumers can be very large. Thus, even if the BLS includes new products earlier, the CPI will still miss a large part of the effect on a COLI of new products. I demonstrate how an approximate measure of the consumer value of new goods can be included in the CPI.

## 2. CELLULAR TELEPHONE USAGE IN THE UNITED STATES

Cellular telephone has been in commercial operation in the United States for 15 years. Cellular telephones began operation in Chicago in 1983 and in Los Angeles during the 1984 Olympic Games. Operation then began within the next year in the top 30 MSA's (metropolitan statistical areas) and subsequently spread to the rest of the approximately 300 MSA's and more recently the RSA's (rural statistical areas). Cellular telephones are now available almost everywhere within the United States.

The cellular telephone has been, along with 800 telephone service, the great success story of new telecommunications services offered in the past 40 years. At the time of the AT&T divestiture when it was not clear whether AT&T or the divested Bell operating companies would inherit the cellular spectrum that the Federal Communications Commission had granted to AT&T, an AT&T prediction for cellular subscription levels in the year 1999 was about one million. At year end 1997 with two years to go to reach the 1999 planning horizon, cellular subscribership in the United States exceeded 55 million, with the growth rate of 25%–35% a year holding for the past decade, using data from the Cellular Telephone Industry Association (CTIA). Beginning in 1996, the next generation of cellular technology, PCS, has been introduced in the United States so that growth rates for mobile telephone usage are likely to continue at their high levels, or even increase, over the next few years.

The average cellular subscriber spends $49 per month on cellular service, or about $588 per year. Thus, about $32 billion per year is spent on cellular service, with additional amounts spent by consumers on purchasing cellular telephones. Cellular revenue now is somewhat over 1/3 as large as long-distance revenue, so cellular telephone represents a significant expenditure category in telecommunications.

Average expenditure per month for cellular service has decreased from $96.83 per month in 1987 (the first year the data were collected) to $49 for 1997. This approximately 50% decrease does not provide a reliable price index for cellular service, however, because, although cellular-service prices have decreased, average cellular usage has also decreased. "Early adopters" of a new product or service receive the greatest value for its usage on average, so economic theory predicts that as prices decrease the "later adopters" will not use the service as much.

To construct a price index for cellular service, I have surveyed cellular companies in the top 30 MSA's since 1985. The top 30 MSA's make up about 41% of the total U.S. population. To account for changes in cellular usage, I calculate the lowest price subscriber plan for 160 minutes per month of cellular usage with 80% peak and 20% off-peak usage. I then use this plan to compute a price index. In Figure 1 I graph the price index for cellular service, with a base of 100 in 1985. By the beginning of the year 1998 the index had decreased to .73 so that cellular prices had decreased by about 27% over the period. Combined with the significant decrease in retail cellular-telephone prices, which I graph in Figure 2, the failure of the BLS to include cellular telephone in the CPI creates a significant bias. An overall index of the cost of cellular service and the cost of cellular telephones is graphed in Figure 3, in which the overall decrease from the base of 100 in 1985 is 51%. To create the combined index, I assume a "churn" (customer drop) rate of .33, which has been the approximate rate for

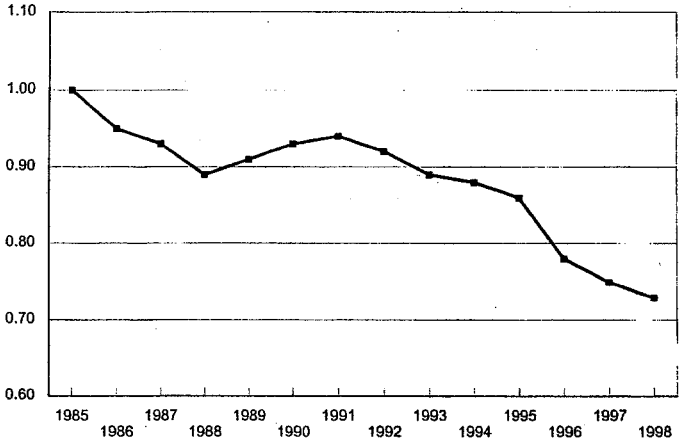


*Figure 1. Cellular Average Price Index for Top 30 MSA's: 1985–1998 (base: 1985 = 1.00).*

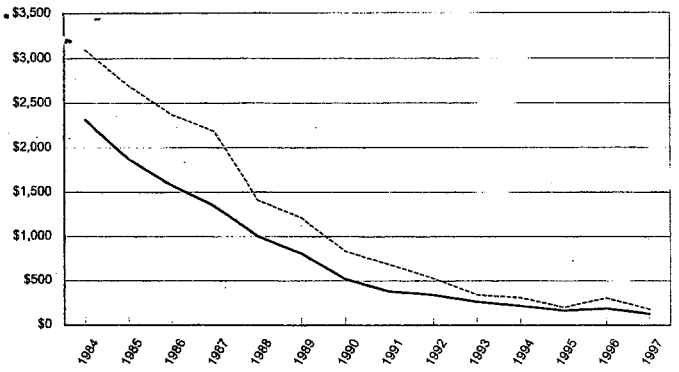


*Figure 2. Cellular Telephone Average Prices: 1984–1997: ———, Mobile; - - - -, Portable.*

the past decade. When the BLS finally included cellular telephone in the CPI in 1998 with the actual price index at .49, the BLS began its index at the 1998 service and handset prices, neglecting the previous 51% decrease that had occurred. This neglect causes a bias in the CPI, as well as measures of standards of living and U.S. economic performance. I strongly recommend that the BLS speed up its inclusion of new goods and services in the CPI. A 15-year delay is much too long.

Even if the BLS had not waited 15 years to include cellular telephone in the CPI, however in terms of a COLI, the preceding index would still lead to a significant upward bias. The gain in consumer welfare from new products or services must also be included in a COLI. I discuss the theory of inclusion of new products and services in a COLI in Section 3.

## 3. NEW PRODUCTS AND SERVICES IN A COLI

According to the BLS, the CPI serves as an approximation to an ideal COLI. A COLI answers the question of how much more (or less) income a representative consumer requires to be as well off in period 1 as in period 0 given changes in prices, changes in the quality of goods, and the introduction of new goods (or the disappearance of existing goods). The BLS omits the effect of the introduction of new goods in its calculation of the CPI, however, thus imparting an upward bias. I first explain the theory of COLI's and demonstrate how new goods should be included using the classical theory of Hicks (1940) and Rothbarth (1941) and then derive an approximation that should be useful for the BLS in including the effect of new goods in the CPI.

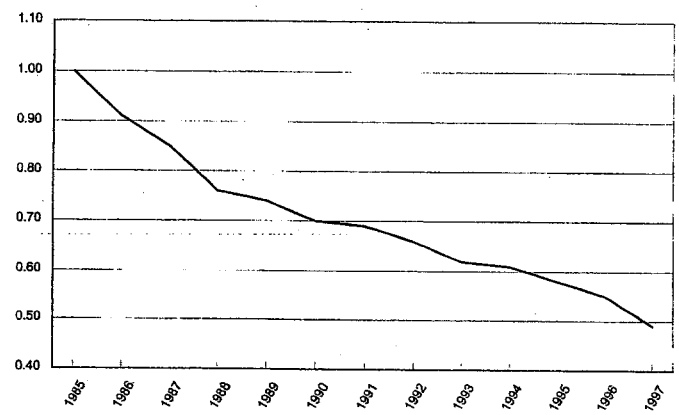


*Figure 3. Combined Cellular Service and Equipment Prices: 1985–1997 (base: 1985 = 1.00).*

The correct price to use for the new good in the preintroduction period is the "virtual" price, which sets demand to 0. Estimation of this virtual price requires estimation of a demand function that in turn provides the expenditure function that allows exact calculation of the COLI. Given the demand function, I can solve for the virtual price and for the expenditure function (or indirect utility function) and make correct evaluations of consumer welfare and the change in the COLI from the introduction of a new product or service. In period 1, consider the demand for the new good, $x_n$, as a function of all prices and income, $y$:

$$x_n = g(p_1, \ldots, p_{n-1}, p_n, y). \tag{3.1}$$

Now, if the good were not available in period 0, I solve for the virtual price, $p_n^*$, which causes the demand for the new good to be equal to 0:

$$0 = x_n = g(p_1, \ldots, p_{n-1}, p_n^*, y). \tag{3.2}$$

Instead of using the Marshallian demand-curve approach of Hicks (1940) and Rothbarth (1941) in Equations (3.1) and (3.2), however, I instead would use the income-compensated and utility-constant Hicksian demand curve to do an exact welfare evaluation. In Equation (3.2), income, $y$, is solved in terms of the utility level, $u^1$, to find the Hicksian demand curve given the Marshallian demand-curve specification. I use a similar approach here to that of Hausman (1997), who estimated the lost consumer value from regulatory delay. Lost consumer value from delay of new products is closely related to measuring the value of new products.

In terms of the expenditure function, I solve the differential equation from Roy's identity, which corresponds to the demand function in Equation (3.1), to find the (partial) expenditure function, using the techniques developed by Hausman (1981). The approach solves the differential equation that arises from Roy's identity in the case of common parametric specifications of demand:

$$y = e(p_1, \ldots, p_{n-1}, p_n, u^1). \tag{3.3}$$

The expenditure function gives the minimum amount of income, $y$, to achieve the level of utility, $u^1$, which arises from the indirect utility function that corresponds to the demand function of Equation (3.1) and the expenditure function of Equation (3.3). To solve for the amount of income needed to achieve utility level $u^1$ in the absence of the new good, I use the expenditure function from Equation (3.3) to calculate

$$y^* = e(p_1, \ldots, p_{n-1}, p_n^*, u^1). \tag{3.4}$$

The exact COLI becomes $P(p, p^*, u^1) = y^*/y$. As with any index-number calculation, I could use the preintroduction utility level $u^0$ to calculate the COLI. Almost no change would occur in $y^*/y$, however, because of the relatively small percentage of expenditure on the cellular telephone compared to income $y$.

Note that to use this approach one must estimate a demand curve as in Equation (3.1), which in turn implies the

expenditure function and the ability to do the exact welfare calculation of Equations (3.3) and (3.4). Thus, the only required assumption is to specify a parametric form of the demand function.

Estimation of the expenditure function in Equation (3.4), as well as $y^*$, typically requires significant amounts of data and estimation of a demand curve. Compared to the usual BLS procedure in estimating the CPI, this approach using features of a demand function is considerably more complicated. Estimation of the demand function for a new product (or equivalently a utility or expenditure function) is a necessary approach to estimation of $y^*$, however, so that the traditional Laspeyres index-number formula or superlative formulas such as a Fisher index will not suffice in this situation. I now propose a conservative approach that decreases the information requirements and should provide a "lower-bound" estimate. Once the demand curve is estimated, an approximation can be used by taking the supporting hyperplane at the observed price and quantity $(p_1, q_1)$, which then leads to an estimate of the virtual price of the lower-bound linear demand curve to the actual demand curve. Now I claim that this estimate is conservative because the estimated virtual price from the linear demand curve will be less than the virtual price from the actual demand curve, unless the "true" demand curve is not convex to the origin, which, although theoretically possible, would not be expected to occur for most new products and services. The change in expenditure to hold utility constant with the introduction of the new product, $y - y^*$, is the compensating variation that again can be approximated by the area under the approximate demand curve above the observed price. This amount is easily computed as

$$y - y^* \approx \text{CV} = (.5p_1q_1)/\alpha, \tag{3.5}$$

where CV is the compensating variation (consumers surplus) from the introduction of the new product and $\alpha$ is the own-price elasticity of demand. To estimate Equation (3.5), current revenue $R = p_1q_1$ is required. These data are often available from scanner data for new products, which the BLS should begin to use rather than its outmoded price-checking approach, however, or from industry sources such as cellular data from the CTIA. The only econometric estimate needed is for the price elasticity $\alpha$, and this parameter appears to be the irreducible feature of the demand curve that is needed to estimate the change in the COLI from the introduction of a new product or service.

## 4. A COLI-BASED INDEX FOR CELLULAR TELEPHONE

I now turn to the econometric estimation to implement the expenditure-function approach of Equations (3.3) and (3.4) and the approximation approach of Equation (3.5). To do so, I collected price and subscribership data for the period 1989–1993 from a (confidential) survey of cellular operators. I use these five years of data to run a log-linear regression of cellular prices in the top 30 MSA's. These top 30 MSA's contain about 107 million pops (population), or about 41% of the entire U.S. population. The estimated demand curve was reported by Hausman (1997, table 3, p. 21). Using instrumental-variables methodology to take into account possible joint endogeneity of price and demand models, I estimated the demand elasticity to be $-.51$ (standard error $= .17$). The results seem reasonable because the lower-bound estimate (from the approximate linear demand curve) of the virtual price is \$97 per month, although the dataset demonstrates that some actual monthly fees were as high as \$125 per month with significant demand at this price level. Thus, the conservative estimate of the lower-bound virtual price does turn out to be quite conservative.

To calculate the expenditure function of Equation (3.4), I now use the results of Hausman (1981) to calculate

$$e(p, \bar{u}) = [(1 - \delta)(\bar{u} + Ap^{1+\alpha}/(1 + \alpha))]^{1/(1-\delta)}, \tag{4.1}$$

where $A$ is the intercept of the demand curve, $\alpha$ is the price elasticity, and $\delta$ is the income elasticity estimate. The CV is calculated from Equation (4.1), where $y$ is income:

$$\text{CV} = \left\{ \frac{(1-\delta)}{(1+\alpha)} y^{-\delta}[p_1x_1 - p_0x_0] + y^{(1-\delta)} \right\}^{1/(1-\delta)} - y. \tag{4.2}$$

I then use Equation (4.2) to calculate the CV for the introduction of the cellular telephone using the average revenue and subscribership data from the CTIA, which I discussed earlier, as well as the econometric estimates of the parameters of the demand function and associated expenditure function.

In Figure 4 I graph the resulting price index for a COLI based on these results. Note that, using a basis of 1988, the COLI index for the cellular telephone decreases to about .116. The calculated price index is extremely similar, whether the exact or approximate demand-curve estimates are used. Note that the index of .116 is well below the price index, which I calculate in Section 2 to be .73. Thus, use of a COLI index rather than a price index can have significant effects for new products and services, even if the new

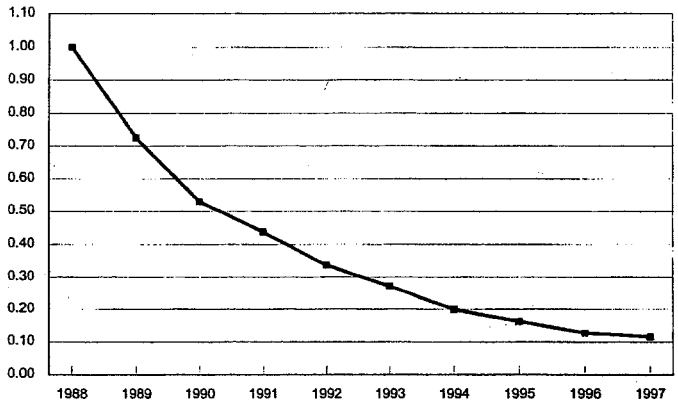


*Figure 4. Exact and Approximate Cost of Living Index: 1988–1997: — ■ —, Exact; —♦ —, Approximate.*

product is introduced at a very early period into the CPI. To estimate a COLI accurately, the third approach discussed in Section 1 is required. The second approach of introducing new goods at an earlier time period solves only part of the problem of bias from new goods that currently exists in the CPI.

The index correctly captures the overall gain in consumer welfare from the introduction of cellular telephones. Because both individual and business use of cellular telephones is present, some proportion of the welfare gain would be placed in the CPI while the rest would appear in the PPI. The relative proportions are straightforward to estimate given household expenditure data.

A question that often arises in discussion of introducing new goods into the CPI is evident from Figure 4. The exact COLI for cellular decreases rapidly in Figure 4, but if cellular had been included in the CPI in an early year, say 1988, it would have a small expenditure weight compared to its current expenditure weight. Does the year of introduction affect the importance of a new product or service in a correct COLI? The correct answer is no, as Equations (3.3) and (3.4) demonstrate. For an earlier year of introduction, $y^*$ from Equation (3.4) is smaller, but once cellular telephone is introduced into the COLI, the demand curve typically continues to shift outward for a significant period of time. This outward shift in the demand curve caused by increased quality and diffusion creates additional consumer welfare, which would be incorporated into a COLI through Equation (4.2). Still, much more frequent updates of expenditure weights in the CPI would help alleviate the current problem. This change has been recommended by many economists; for example, the Boskin et al. (1996) report.

Thus, in each year two effects are present, a decreased price for the given demand curve and an outward shift of the demand curve holding price constant. Because of the use of Hicksian compensated-demand functions and expenditure functions in Equations (3.3) and (3.4), the combined effect of the two economic factors is path (year of introduction) independent. Introduction of new goods and improved quality of existing goods are actually similar economic effects that enter a COLI in a similar manner. This discussion demonstrates why, in the presence of the introduction of new goods and quality improvement (or quality deterioration) of existing goods, *both* prices and quantities (or revenues) must be used to calculate a correct COLI. The BLS approach of only using prices and ignoring the information in quantity data will never allow for a correct estimate of an exact COLI in the presence of new goods and improvements in existing goods.

## 5. ESTIMATION OF A CORRECTED TELECOMMUNICATIONS–SERVICES CPI

The BLS calculates a telephone-services CPI each month. The three components of the telephone services CPI are local-access charges, intrastate long-distance (toll) charges, and interstate long-distance (toll) charges. Cellular telephones have not been included in the telephone-services CPI. The telephone-services CPI is approximately 1.7% of the overall CPI.

I now estimate a corrected telecommunications-services CPI in which I include cellular service. I take into account the decline in cellular-service prices (e.g., Fig. 1) and also the gain in consumer welfare from the introduction of cellular service (e.g., Fig. 4). Thus, I approximate a COLI-based telecommunications-services CPI.

To construct the corrected telecommunications-services CPI, I use yearly expenditures weights based on total local and long-distance expenditure for residential customers. Thus, I am estimating the welfare effect on consumers from cellular telephones and eliminating the effect of business users, by assuming that consumers use cellular telephones in the same proportion that consumers use long-distance service compared to businesses. Thus, the claim by Moulton and Moses (1997) that I have included business cellular customers (in an earlier version of this article) appears to be based on a misunderstanding. Because I do not have expenditure-share data across the various years, my method leads to an approximation. The approximation should be relatively accurate, however, given the average expenditure of households on long distance with similar demographic characteristics to consumer cellular users. To the extent that the proportion of consumer usage of cellular telephones is approximately equal to consumer usage of local and long-distance services, these weights create a superlative price index (see Diewert 1976). Otherwise, the calculation leads to an approximation to a telecommunications CPI that would need data on consumer expenditure shares to become a superlative index.

In Figure 5 I graph the BLS telecommunications services CPI along with the corrected COLI's for telecommunications services. I also graph the price index from "early inclusion" of cellular into the CPI in 1988. As demonstrated in Figure 5, the BLS telecommunications CPI estimates that since 1988 telecommunications prices have increased by 10.1% or an increase of 1.07% per year. This estimate ignores cellular service. A corrected telecommunication-services COLI that includes cellular service decreased from 1.0 in 1988 to .928 in 1997 for a decrease of .8% per year. Thus, the bias in the BLS telecommunications-services CPI equals approximately 1.9% per year. Over the period 1988–1997, the BLS telecommunications-services CPI is biased

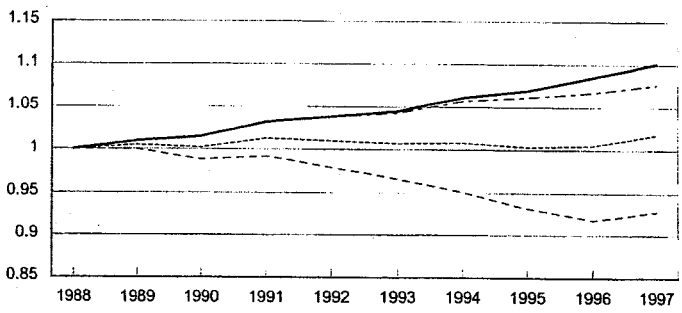


*Figure 5. Telecommunications CPI: BLS Calculations and Correct COLI Calculations: ———, BLS; – – –, Exact COLI; - - - -, Approximate COLI; – - –, BLS Early Inclusion.*

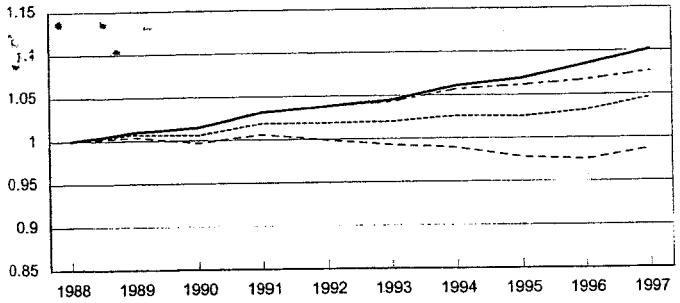


*Figure 6. Telecommunications CPI: BLS Calculations and Correct COLI Calculations; Higher Demand Elasticity for Cellular: ———, BLS; – – –, Exact COLI; - - - -, Approximate COLI; – – –, BLS Early Inclusion.*

upward by about 18%. This bias was not removed when the BLS included cellular in the telecommunications CPI in 1998 because inclusion of the cellular telephone into the CPI in early 1998 had no effect on the CPI.

Next, I do similar calculations using the lower-bound approximation to the COLI using Equation (3.5). In Figure 5, this approximate telecommunication-services CPI that includes cellular service is essentially unchanged since 1988 with the increase only 1.8% over the entire period. Thus, the BLS telecommunications index would still have a bias of approximately 1% per year with respect to the lower-bound approximation. Last, in Figure 5 I graph the telecommunications CPI that would have resulted from the early inclusion of cellular into the CPI in 1988. Here in 1997 the estimated telecommunications price index would have been 1.076, compared to the actual BLS price index of 1.10 and the correct COLI price index of .93. Thus, the early-inclusion approach discussed in Section 1 would have led to only a small decrease in the bias of the CPI that results from the approach used by the BLS.

In Figure 6 I do a sensitivity test of my results. I reestimate the cellular-demand model allowing for a different price elasticity for each year. Although a hypothesis test does not reject the hypothesis of the same price elasticity across the five years of my sample, nevertheless I use the highest demand-elasticity estimate found for any year, which is about 50% higher that the estimate used in Figure 5. My results change by only a relatively modest amount, with the exact COLI estimate in 1997 increasing from .928 to .987. Note that even using the significantly higher demand elasticity for cellular telephones, the conclusion remains that a correct COLI-based telecommunications price index decreased over the period 1988–1997, but the BLS-computed price index for telephone services increased by 10% over the period. Thus, the results seem fairly robust to changes in the econometric specification.

## 6. CONCLUSIONS

I have demonstrated how a new product such as cellular telephone should be included in a COLI. The BLS attempts to estimate a COLI, but it fails to account for the gains in consumer welfare from the introductions of new products and services. Thus, even if the BLS introduced new products much earlier into the CPI, a significant bias would remain from the neglect of the gain in consumer welfare as the calculations have demonstrated.

I find it interesting that many people, including some economists, do not feel that the consumer value of new goods should be included in a CPI (e.g., Deaton 1998). They accept the fact that substitution among existing products when relative prices change should be included. They continue to have in mind a static choice set, however, without accepting the implication that new products and services that gain significant demand often lead to large gains in consumer welfare that should be included in a COLI. To respond to the observation that many new goods are very much like existing goods, the economist's answer is that the own-price elasticity tells us how similar the products are. A high own-price elasticity, together with a high cross-price elasticity that arises from the Slutsky equation, will arise for new products that are similar to old products. Equation (4.2), or even easier Equation (3.5), demonstrates that in the situation of a high price elasticity only a small gain in consumer welfare will occur. Thus, introduction of a new "brand" of milk will have almost no effect because it will have a high price elasticity. Cellular telephone, however, with a relatively low price elasticity and high demand, has a large effect on consumer welfare.

I also find a bias in the BLS estimate of the telecommunications-services index of between .8%–1.9% per year. Rather than telecommunications-service prices increasing at about 1.1% per year, the correct calculation has them decreasing at about .8% per year. Differences of this magnitude are significant and likely arise from other new goods and services such as Internet services. Now that data are increasingly available, I will find it interesting to see whether the BLS incorporates the correct measure of consumer welfare for new products in its estimate of the CPI, or whether it continues to neglect this potentially important component of a COLI.

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## REFERENCES

Abraham, K., Greenlees, J., and Moulton, B., (1998), "Working to Improve the Consumer Price Index," *Journal of Economic Perspectives*, 12, 27–36.

Boskin, M. J., Dulberger, E. R., Gordon, R. J., Griliches, Z., and Jorgenson, D. W. (1996), "Toward a More Accurate Measure of the Cost of Living," Final Report to the Senate Finance Committee, December 4.

Deaton, A. (1998), "Getting Prices Right: What Should Be Done?" *Journal of Economic Perspectives*, 12, 37–46.

Diewert, W. E. (1976), "Exact and Superlative Index Numbers," *Journal of Econometrics*, 4, 115–146.

Hausman, J. (1981), "Exact Consumer Surplus and Deadweight Loss," *American Economic Review*, 71, 662–676.

——— (1996), "Valuation of New Goods Under Perfect and Imperfect Competition," in *The Economics of New Products*, eds. T. Bresnahan

and R. Gordon, Chicago: University of Chicago Press, 209–237.
——— (1997), "Valuing the Effect of Regulation on New Services in Telecommunications," *Brookings Papers on Economic Activity, Microeconomics*, 26, 1–39.
——— (1998), "Telecommunications: Building the Infrastructure for Value Creation," in *Sense and Respond*, eds. S. Bradley and R. Nolan, Cambridge, MA: Harvard Business School Press, pp. 63–81.
Hicks, J. R. (1940), "The Valuation of the Social Income," *Economica*, 42, 105–124.
Moulton, B., and Moses, K. (1997), "Addressing the Quality Change Issue in the Consumer Price Index," *Brookings Papers on Economic Activity, Microeconomics*, 26, 40–78.
Rothbarth, E. (1941), "The Measurement of Changes in Real Income Under Conditions of Rationing," *Review of Economic Studies*, 8, 100–107.