> the problems are serious enough to warrant rejection of the measurements for use in calculating an X-factor.[104]

The Bush/Uretsky analysis explicitly tested the hypothesis that post-divestiture LEC input price movements differed fundamentally from the pre-divestiture condition against the Christensen hypothesis. Their results provide strong empirical support for the anecdotal, intuitive conclusion that post-divesture conditions are different. Significantly, nothing in the testimony offered in the California price cap proceeding by Drs. Christensen or Schmalensee for Pacific Bell or by Dr. Duncan for GTEC refutes the Bush/Uretsky/FCC conclusion.[105]

Other empirical evidence refutes USTA's claim of a zero input price differential.

Other empirical evidence refuting the USTA assertion that LEC input prices will increase at the same rate as overall economy-wide input prices comes from Dr. Christensen's own data and previous studies. Dr. Christensen's seminal study of long-term labor and capital costs confirms sustained and substantial differences in long-term price growth as between these two input categories for the private US economy.[106] According to Christensen's data, over the 38-year period 1929 to 1967, the labor input price index for the US economy grew by 3.90% as compared with capital input price growth of only 2.26%.[107] Data available from the US Bureau of Labor Statistics (BLS) confirms that this trend has continued to the present. The BLS data shows that for the post-divesture period 1984 to

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104. *Id.*, Appendix F, at 11.

105. Only Dr. Gregory Duncan for GTE-California attempted to address the Bush/Uretsky analysis. In empirical tests which Dr. Duncan claims support Christensen's finding of no long run difference in the input price series for the LECs as compared with the US economy, Dr. Duncan used a different statistical technique for modeling time series data, i.e, Autoregressive Integrated Moving-Average ("ARIMA") analysis, as compared with Dr. Christensen's use of standard regression analysis. However, the empirical tests performed by Dr. Duncan rely upon the same long run data series and suffer from the same infirmities as the Christensen analyses previously considered and rejected by the FCC in its price cap review proceeding. As such, Dr. Duncan's use of a different statistical technique than that adopted by Dr. Christensen does nothing to support the validity of Dr. Duncan's arguments, which are essentially the same as those made by Dr. Christensen in the first phase of the FCC's price cap proceeding.

106. Laurits R. Christensen and Dale W. Jorgenson, "U.S. Real Product and Real Factor Input 1929-1967," *Review of Income and Wealth*, Series 16, March 1970, pp. 19-50.

107. *Id.*, Table 4, Column 6 for Labor price growth; Table 5, Column 5 for Capital price growth.

1992, labor input prices for the US economy have grown by 4.24%, roughly *two and one-half times* the rate of capital input price growth (1.71%).[108]

Given these marked differences in input price growth as between capital and labor inputs, the critical piece of empirical evidence on input price growth for the LECs vs. the economy generally turns on relative intensities (i.e., cost shares) of capital and labor inputs for the LEC sector vs. the total US economy. Once again, compelling evidence is available from Christensen's own data. As shown in Table 1, for the US economy as a whole for the post-divestiture period 1984-1992, the annual input cost share for capital is only .314, with labor's cost more than double at .686.[109] For the LECs, based on Christensen/USTA study data for that same post-divestiture time period, the comparable annual input cost shares are a cost share for capital of .621, and a significantly smaller cost share for labor of .379.[110]

Thus, there is clear empirical evidence (from Christensen's own data) that capital input prices have grown at a significantly lower rate than labor input prices, and that the LECs are more capital-intensive than the US economy as a whole. These two pieces of empirical data provide compelling evidence that input prices grow at different rates in different sectors of the economy, and in particular, that LEC input prices have and are likely to increase more slowly than overall economy-wide input prices.

Table 1

CAPITAL/LABOR INPUT COST SHARES

	Capital	Labor
LECs	.621	.379
US Econ	.314	.686

108. Bureau of Labor Statistics, Office of Productivity and Technology, data prepared for February, 1995 Publications.

109. BLS data, *op cit.*

110. See Laurits R. Christensen, Philip E. Schoech, and Mark E. Meitzen, "Productivity of the Local Operating Telephone Companies Subject to Price Cap Regulation, 1993 Update, January 16, 1995, Table 2, Annual Input Cost Shares. To make the LEC input cost share data provided in the Christensen study comparable to national input/output accounting data produced by the BLS, I have excluded the materials category. When the materials category is included for the LECs, the annual input cost shares are as follows: .470 capital, .287 labor, and .243 materials.

Reflection of hedonic price changes would widen the downward trend in LEC input prices relative to economy-wide price changes.

The capital input price indexes used by Christensen — the Telephone Plant Indices (TPIs) — make no adjustment for changes in the nature of the input over time. By assuming that the nature of each of the items included within the TPIs remain constant, the TPIs fail to reflect changes in the character of the plant under study from one year to the next. Where the nature of the input is relatively stable — e.g., office furniture — this type of index may provide useful results. However, for many of the types of capital inputs used by LECs, i.e., inputs containing computer chips, digital electronics, fiber optics, digital switching equipment, and other high-technology items whose specifications and characteristics have evolved rapidly over time, the adjustment of price indexes to properly account for changes in quality and/or capacity is very significant. Indeed, failure to do so may have the effect of overstating price level increases and/or understating price decreases. In the economics and statistics literature, such adjustments for changes in quality and/or capacity are referred to as *hedonic* adjustments. Failure to make hedonic price adjustments will necessarily overstate input price growth and result in an X-factor that is misspecified and biased downward.

Recognition of hedonic-adjusted price changes is well-established in the economics literature. The Bureau of Economic Analysis (BEA) of the US Department of Commerce and the Bureau of Labor Statistics (BLS) have long recognized the importance of including quality change measurements in price indexes. BLS has studied hedonic methods as a way of dealing with quality change since the 1960s. Hedonic methods were first accepted and used in 1968 in the price index of new single-family houses. This index is currently also used as a proxy to deflate various construction activities. Hedonic methods won official acceptance in 1986, when the BEA announced a revision of the US National Income and Product Accounts to incorporate the use of a new computer equipment price index based upon hedonic methods. As a result, the BEA began using the hedonic price indexes of computers for deflation within the National Income and Product Accounts. By doing this, the BEA aimed at creating a better measurement to capture the effects of rapid technological advances in the computer market.

Failure to recognize quality effects in the capital input price indexes creates two separate, but not unrelated, sources of bias — the "substitution bias" and the lack of measurement of quality change. Substitution bias occurs because the weights in the index are based upon input expenditure patterns from prior years. As a result, the price index does not reflect changes in buying patterns in response to changes in relative prices. For example, "...even if the price of cellular phone calls drops relative to the price of postage stamps, so that consumers make more cellular phone calls and send fewer letters, the relative weight of cellular phones and postage stamps in the CPI will be based on expenditures in some

remote base year."[111] As another example, "the ability of firms using electronic components to substitute transistors for tubes, and then integrated circuits for transistors, and then successively more powerful integrated circuits for less powerful circuits, is not taken into account at all" in price indexes unadjusted for quality changes.[112]

Quality change bias occurs when improvements in the quality of products are inadequately measured or not measured at all. In fact, quality change measurements are basically non-existent. Changes in quality of new goods and services are not accounted for. Therefore, a bias occurs when a good is replaced by a new or improved good. For example,

> "...if the price of a tire increases but the quality of the tire is improved, then the change in the cost of living cannot be measured as simply a change in price. If the price doubles but the tire lasts twice as long, and other important qualities of the tire (traction, ride, and the like) are also better, then the quality-adjusted price change may in fact be zero or even negative."[113]

These biases have a direct impact on the various measurements that use price indexes, including productivity. Indeed, a recent report by the Advisory Commission to Study the Consumer Price Index suggested that when adding all the estimates of each source of CPI bias, the CPI overstated the actual rate of inflation by about 1.5% per year, with the quality change bias alone estimated at 0.2 to 0.6 of the total source of bias.[114] In recent years, there has been extensive debate about the negative impact to the economy of the so-called "CPI bias." Most economists agree that the CPI has been inflated due to methodological

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111. Gordon, Robert J.. "Measurement Errors in the CPI: Causes and Consequences," *Northwestern University and National Bureau of Economic Research*, Testimony presented before Senate Finance Committee, March 13, 1995 at 3.

112. Robert Gordon, "The Measurement of Durable Good Prices," University of Chicago Press, 1990, page 30. Gordon notes, as a consequence, that there was no accounting for the implicit price reduction that the invention of these new components implied, and that "the late introduction of integrated circuits as a totally new product and the use of obsolete weights helped account for the remarkable fact that the PPI group index (1178) for "electronic components and accessories" displays a 1967-83 price increase, while the price of virtually every type of final electronic product covered in this study (computers, PCs, electronic calculators, electronic typewriters, VCRs) declines at a double digital annual rate during the same interval.

113. O'Neill, June E., "Statement of June E. O'Neill Director Congressional Budget Office on the Consumer Price Index before the Committee on Finance United States Senate," Congressional Budget Office Testimony, March 13, 1995 at 8.

114. "Toward a More Accurate Measure of the Cost of Living," Interim Report to the Senate Committee from the Advisory Commission to Study the Consumer Price Index, September 15, 1995 at Executive Summary and page 27.

problems, particularly related to the failure of the CPI to incorporate hedonic adjustments. The CPI bias is also manifest in other indexes, such as the GDP-PI, that incorporate the CPI.[115]

The BEA's efforts to create more objective and accurate measurements have led to the recent announcement of a comprehensive revision of the national income and output accounts due at the end of 1995. The revision will result in new improved measurements of output and prices, using chain-type annual-weighted indexes. These improvements have been designed to deal particularly with the above described substitution bias. According to a recent article, "[b]y minimizing the substitution bias, the new measures of real GDP growth will also improve analysis of issues such as productivity, returns to investment, and the long-term growth potential for the economy."[116]

Hedonic price indexes are an attempt to measure changes in the characteristics of specific commodities. As alluded to above, much of the recent work in this field has focused on the computer industry — one of the fastest growing industries and one with rapid growth in technological change, both in terms of quality and capacity of the products.[117] According to one study, "...the quality-adjusted real prices for personal computers

115. For a discussion of the several causes of bias in the CPI, see, Diewert, Erwin W.. Written Testimony for the United States Senate Committee on Finance, April 6, 1995; Gordon, Robert J.. "Measurement Errors in the CPI: Causes and Consequences," *Northwestern University and National Bureau of Economic Research*, Testimony presented before Senate Finance Committee, March 13, 1995; O'Neill, June E.. "Statement of June E. O'Neill Director Congressional Budget Office on the Consumer Price Index before the Committee on Finance United States Senate," Congressional Budget Office Testimony, March 13, 1995; and "Toward a More Accurate Measure of the Cost of Living," Interim Report to the Senate Committee from the Advisory Commission to Study the Consumer Price Index, September 15, 1995.

116. Landefeld, J. Steven and Robert Parker. "Preview of the Comprehensive Revision of the National Income and Product Accounts: BEA's New Featured Measures of Output and Prices," *Survey of Current Business*, July 1995.

117. See, e.g., Ernst R. Berndt, Zvi Griliches and Neal J. Rappaport. "Economic Estimates of Price Indexes for Personal Computers in the 1990's," *Journal of Econometrics*, Vol. 68, 1995, pp. 243-268; Berndt, Ernst R. and Zvi Griliches. "Price Indexes for Microcomputers: An Exploratory Study," Chapter 2 in Murray F. Foss, Marilyn E. Manser and Alan H. Young, eds., *Price Measurements and their Uses*, Studies in Income and Wealth, Vol. 57, University of Chicago Press, 1993; Cohen, Jeremy Michael. "Rapid Change in the Personal Computer Market A Quality-Adjusted Hedonic Price Index 1976-1987," S.M. thesis, Alfred P. Sloan School of Management, Massachusetts Institute of Technology, May, 1988; and Cole, Rosanne, Y.C. Chen, Joan A. Barquin-Stollemen, Ellen Dulberger, Nurhan Helvacia and James H. Hodge. "Quality-Adjusted Price Indexes for Computer Processors and Selected Peripheral Equipment," *Survey of Current Business*, January, 1986.

have been dropping at an annualized cumulative rate of about 25%."[118] Another study found that since the late 1950s the trend in annual decline may have been as high as 28% for mainframe computers of a given speed and capacity, and noted the widespread belief within the industry that for supercomputers and for minicomputers and microcomputers the decreases may have been even greater.[119] Yet another more recent study on personal computers in the 1990s concluded that "...on average these quality-adjusted price indexes based on econometrically estimated hedonic price equations decline at about 30% per year."[120] The official BEA price index for the commodity aggregate of computers and computer-peripheral equipment types, based largely on hedonic regression procedures, continues the steady decline over time revealed for the period 1953-1972: Over the 1972-1984 era, the average annual growth rate (AAGR) of this quality-adjusted price index is -13.8%.[121] Moreover, if one combines the results for the 1953-1972 time interval with those for the 1972-1984 epoch, one finds that quality adjusted computers that cost $531.88 in 1953 cost only $1.00 in 1982; in other words, what would have cost more than a half a million dollars in 1953 cost only $1,000 in 1984.[122] Moreover, since the calculations involve only mainframe and minicomputers and exclude personal (micro) computers, it is possible that this price index understates the amount of quality improvement.[123]

Clearly, the importance of accurate and objective indexes for telecommunications inputs is of particular concern in the development of a TFP-based long-term price cap plan. Indeed, as noted in an important work on technological advance in the telecommunications industry: "In terms of technological intensity, measured by R&D investment as a percentage of sales, communications equipment (at 9 percent) is second only to computers (at 12

118. Cohen, Jeremy Michael. "Rapid Change in the Personal Computer Market A Quality-Adjusted Hedonic Price Index 1976-1987," S.M. thesis, Alfred P. Sloan School of Management, Massachusetts Institute of Technology, May, 1988 at 62.

119. Kenneth Flamm, "Technological Advance and Costs: Computers versus Communications," in Robert W. Crandall and Kenneth Flamm, Eds. *Changing the Rules: Technological Change, International Competition, and Regulation in Communications*, The Brookings Institution/Washington, D.C., 1989, page 16.

120. Berndt, Ernst R., Zvi Griliches and Neal J. Rappaport. "Economic Estimates of Price Indexes for Personal Computers in the 1990's," *op cit*, 1995.

121. Ernst Berndt, *The Practice of Econometrics: Classic and Contemporary*, "The Measurement of Quality Change: Constructing an Hedonic Price Index for computers Using Multiple Regression Methods," (Chapter 4), Addison-Wesley Publishing Company, 1991, page 125.

122. *Id.*, pages 125-126.

123. *Id.* page 126.

percent) among America's commercial high-technology industries."[124] Another key study identifies electronic computers and electronic telephone switching systems as two "technologically progressive products...characterized by new model introductions in which performance is improved relative to price."[125] This study notes in particular the substantial increases in carrying capacity made possible by new model introductions of both transmission and switching technologies that have resulted in unmeasured price declines over the years.[126] LEC capital inputs continue to be characterized as technologically progressive and by new model introductions, making it overwhelmingly evident that quality changes are an important component of productivity growth in the telecommunications industry.

Yet neither historic nor current measurements of LEC capital input prices used by LECs capture technology-driven capacity and capability improvements. The TPIs that were developed by each of the LECs participating in the USTA/Christensen study do not reflect quality or capacity changes that affected the various capital input categories during the 1984-92 period.[127] By failing to reflect quality characteristics, the ending values for the TPI data series incorporated in the Christensen study are consistently and systematically biased in the upward direction.

As noted in a study which examined TPIs of the pre-divestiture Bell System:

> No allowance is made for changes in price per unit of the desired quality characteristic, that is, per circuit mile for transmission equipment or line capacity for a switching system. In effect, only price changes following the initial introduction of a new model have any effect on the aggregate TPI. We learned in studying computer prices that much of the rapid rate of price decline measured by hedonic price indexes occurs with the introduction of new models, and the evidence of Cole et al. (1986) was cited showing that a matched model index for computer processors declined during 1972-84 at a much slower rate than a hedonic regression index. It would be surprising if price declines in telephone equipment did not also occur with the introduction of new models.[128]

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124. Kenneth Flamm, *op cit*, page 13.

125. Robert J. Gordon, *op cit*, page 29.

126. *Id.*, pages 398-399.

127. The same is true of the historic input price growth data presented by USTA's economic consultants to support their assertion that the long run LEC input price differential is zero.

128. *Id.*, page 398.

This same criticism applies to the post-divestiture TPIs developed by the LECs and incorporated in the Christensen study.

The study also identifies numerous other unmeasured aspects of quality change not taken into account in price indices for telephone plant, providing further support for the notion that TPIs developed by the LECs understate the "true" rate of price decline. With respect to technological advances in switching equipment:

- First, reduced maintenance cost and energy use in electronic switching systems creates value for the user beyond the sheer carrying capacity of the switches. In addition to these savings, electronic switching equipment has made possible radical reductions in equipment space occupied per line served, thus allowing many telephone companies to eliminate whole multistory buildings that would have been required with the previous technology to accommodate today's calling volumes.

- Second, for switching equipment, the basic measurement unit is taken to be the "line," but a telephone line is not the same as it was twenty or forty years ago. Today's switches allow calls to be completed much faster than before, saving time for customers, and the programming capabilities of modern switches allow the equipment to search for alternative routings, thus reducing the incidence of "circuit busy" signals.

- Third, today's digital switches (by converting analog voice signals into digits) reduce distortion and provide a clearer line.

- Finally, modern switches allow the provision of additional services, including the routing provision of itemized bills for subscribers, as well as paging and electronic call transfer services.[129]

The technological advances noted by the study were by no means limited to switching equipment. The study found that "the transition to fiber optic cable must have created a decline in the effective cost of transmission equipment during this period even more rapid than that of switching equipment," citing a rate of price decline for fiber optic cable of 45 percent per year from 1980 to 1985.[130]

129. *Id.*, pages 403-404.

130. *Id.*, page 404.

There are several implications of this discussion of quality effects for the results of the USTA/Christensen TFP study and its application to the X-factor:

- By overstating the growth in the TPIs or asset price deflators used to develop capital input price and quantity indices over the study period, a slightly overstated value for the TFP is likely to result.

- However, the more predominant effect under the USTA/Christensen approach, is that by overstating the growth in input prices, the differential between LEC input price level growth and economywide input price growth is understated.

As noted above, this Report does not develop specific hedonic adjustments to use in the calculation of the X-factor. However, sensitivity analysis of Christensen's results indicates that incorporation of hedonic price adjustments would result in a significantly higher X-factor. These results confirm the necessity of taking hedonic effects into account in the calculation of the X-factor for a long-term price cap plan — if not directly with the use of explicit hedonic price deflator series,[131] then indirectly by the Commission's adoption of a compensating input price adjustment and consumer productivity dividend.

Sources of LEC input price data

The Commission seeks comment on whether there are other sources of LEC input price data that could be used to calculate the input price differential that would be preferable to the data used in the Christensen/USTA study.[132] In addition, the Commission seeks comment regarding the development of a telecommunications specific input price index.[133]

Section 2 of this Report discusses in detail the empirical problems with the data used in the Christensen/USTA study. In this section of the Report, we identify other sources of data that can be used to develop input price data for the LECs that would involve objective, auditable data series, for example BEA/BLS asset deflator data in lieu of LEC TPI data, and net book value capital stock in lieu of replacement capital stock. However, the problems we identify concerning the input data used in the Christensen/USTA study impact the overall validity of the study; they discredit the TFP results calculated using that input data as much as the input price differential derived from that data. The basis of Ad Hoc's argument that the LEC input price data should be derived from data used in the Chris-

131. With additional time and resources, more precise quantitative measures can (and are) being developed.

132. FFNPRM, para. 59-60.

133. *Id.*, para.60.

tensen/USTA study was not that Christensen's data was necessarily good data, but rather that if Christensen's data was acceptable for purposes of calculating TFP, it is acceptable for calculating the input price differential. There is no validity to USTA's arguments that the quality of Christensen's input data is acceptable for calculating TFP yet unacceptable for calculating an input price differential. Indeed, as noted in the FFNPRM, the Bush/Uretsky study found that the data problems cited by USTA were not serious enough to preclude use of the Christensen data in calculating an input price differential.[134]

Development of a telecommunications-specific input price index would have the potential of solving many of the issues raised in the FFNPRM. However, since many of the problems with the Christensen/USTA study emanate from the use of proprietary, unauditable, data controlled by the LECs, a telecommunications-specific input price index constructed by USTA may very well suffer from the same infirmities. To be an improvement over the Christensen/USTA study, the telecommunications-specific input price index must be developed based upon objective sources of data not under the control of the LECs, as well as reflect the productivity of firms other than the LECs. We understand that the BLS was working on the development of such an index, but that the status of that index is uncertain at this time, particularly in the context of government funding cutbacks.

There is no valid rationale for using a post-divestiture input price data series in calculating TFP, but a long-term pre-and post divestiture input price series for calculating the input price differential.

In any event, any telecommunications-specific input price index of data series that is utilized for purposes of calculating TFP must also be used, and for the corresponding time period, to establish the input price differential. USTA has consistently argued that it should be permitted to apply the post-divestiture input price series in calculating TFP, while relying upon a long-term, pre- and post-divestiture series for establishing the input price differential. There is simply no valid rationale for this inconsistency, and in fact it is more the inconsistency, rather than the choice of time period *per se*, that creates the misstatement of the X-factor.

A lower rate of input price growth (as occurred during the post-divestiture period) when applied to input expenditure data corresponds to a higher rate of input quantity growth, and implies a lower overall TFP for the study period. It was thus to USTA's benefit for Christensen to adopt and utilize the post-divestiture input price experience in his post-divestiture input-price study. Obviously, however, application of the post-divestiture input price differential to the X-factor would cause it to be considerably greater than the X-factor value

134. *Id.*, para. 59.

estimated by Christensen, hence USTA "cherry-picked" its way through inconsistent time periods and proposes the use of the long-term price series for this purpose.

ETI previously examined the effect of resolving this inconsistency by substituting the long-term input price growth (i.e., GDP-PI plus economy-wide TFP) advocated by Christensen and other USTA economic consultants for the LEC-specific post-divestiture input price growth experience actually incorporated in the Christensen study.[135] Although we do not support this method (because it understates physical input quantity growth during the post-divestiture period), we undertook to examine the effect upon the overall TFP result were the long-term input price data assumed for both the TFP calculation and to establish the input price differential in the X-factor. The results of that analysis, as applied to the USTA/Christensen 1993 Update study, are that TFP increases from 2.4% to 4.9%[136], implying an X-factor (on the same total company basis) of 5.4%, including the 0.5% CPD.

In rebuttal to similar points raised in the California price cap proceeding, Pacific Bell put forth the argument that with respect to the capital component of input, capital input quantities are measured directly, such that a higher rate of input price inflation does not translate directly into a lower rate of input quantity growth.[137] This argument is a spurious one. Whether a TFP study, such as the one performed by Christensen, measures input quantities directly or computes them indirectly by deflating input expenditures by input prices does not alter the fundamental accounting identity upon which a TFP study is based. This fundamental accounting identity holds that expenditures (on inputs or outputs) equal prices times quantities. One can use data on any two of the three variables, expenditures, prices, or quantities, to derive the third unknown variable. Indeed, Christensen's TFP study makes repeated use of this fundamental accounting identity. For example, Christensen derives his estimate of quantity growth for the materials input by dividing material expenditure data by a price series based on the GDP-PI. Christensen derives his estimates of price growth for inputs labor and capital (which he uses as weights in order to construct an aggregate input quantity index), by dividing labor and capital expenditures by corresponding labor and capital input quantity series. For a study such as Christensen's to be valid, the three variables, expenditures, prices, and quantities, must be internally consistent. Thus, for a given series of input expenditure data, if one assumes a

135. See Letter from Leah Moebius to William F. Caton, Re: *Ex-Parte* Meeting, CC Docket No. 94-1, February 14, 1995.

136. For the 1984-1993 time period, GDP-PI grew 3.6%. Adding the economy-wide TFP of 0.3% results in a long-term input price growth assumption of 3.9%. Given LEC input expenditure growth of 2.4%, and this input price growth assumption of 3.9%, input quantity growth would be -1.5% [2.4% minus 3.9%]. With output quantity growing 3.41%, and input quantity growing -1.5%, TFP would be 4.91%.

137. Richard L. Schmalensee, Timothy J. Tardiff, and William E. Taylor, "Incentive Regulation and Competition: Reply Comments," NERA, September 18, 1995, page 14.

higher rate of input price growth, then by virtue of the fundamental accounting identify, there will be a correspondingly lower rate of input quantity growth — regardless of whether input quantity growth in the study was initially measured on a direct basis or computed indirectly from data on input price growth and input expenditures.

A LEC-specific input price series should be developed for the same period that is to be used to develop LEC TFP, and should be applied consistently both in the TFP and the X-factor calculations. The price index should be adjusted to capture hedonic effects occurring during the subject time period, either by a direct analysis of LEC plant or by the use of surrogates. Inconsistent use of LEC input price data, as USTA has attempted to do, should not be condoned.

Direct Measurement of LEC Unit Costs

The Commission seeks comment on the desirability of measuring LEC unit cost growth directly (by subtracting LEC productivity growth from LEC input price growth) rather than indirectly by adjusting GDP-PI by the aggregate US economy-wide productivity growth rate.[138]

As recognized in the FFNPRM, reliance upon economy-wide statistics introduces a significant lag into the calculation of the X-factor, whereas the direct approach would reduce, if not eliminate, this lag.[139] As discussed below in the context of USTA's moving average proposal, the notion of a significant lag is totally at odds with behavior in a competitive market environment, where productivity gains are flowed through to consumers, rather than retained by shareholders.

Another very positive attribute of the direct method is the explicit recognition of the equal role that LEC input price growth plays alongside LEC productivity growth in determining the appropriate level of price changes that should be permitted in a long-term price cap plan. The direct method therefore highlights the unreasonableness of USTA's position that the measurement of LEC input price growth should be based upon a different (and substantially longer) time period than that used to measure LEC productivity growth and that, in USTA's short-term model, LEC input price growth is only a secondary or subsidiary series of data used to derive LEC productivity growth.

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138. *Id.*, para. 61.

139. *Id.*

However, the direct calculation approach (calculated by subtracting LEC productivity growth from LEC input price growth) requires annual measurement of LEC input price changes specifically. By contrast, the "input price differential" approach that ETI has supported assumes a consistent long-term relationship between the growth rate of LEC input prices and economy-wide price growth (GDP-PI), and does not require annual measurement of LEC input price changes specifically. We would support a direct calculation approach if an objective and accurate LEC input price index could be developed, such that the use of GDP-PI or any other economy-wide price level index could be avoided.

Interstate versus Total Company TFP

The Christensen/USTA TFP study considers total company, as distinct from jurisdictionally *interstate* productivity. To the extent that these may differ, the possibility exists that the resulting X-factor and Price Cap Index derived therefrom may fail to accurately track jurisdictionally *interstate* cost changes. While the Commission, in the *First Report and Order* declined to address the possible distinction between interstate and total company TFP at that time, it expressly deferred resolution of this issue to this Further Notice. Specifically, in the FFNPRM, the Commission asks parties to comment on whether there is a valid distinction between intrastate and interstate productivity and whether interstate productivity is economically meaningful.[140]

It has long been recognized that cost, demand growth, and other pertinent conditions facing LECs may differ as between the interstate and state jurisdictions. There are several reasons why this is so:

(1) *Differences in the rate of demand growth for individual services.* The various services offered by LECs are experiencing different rates of growth. Individual subscriber access lines, for example, are growing by approximately 3% per year nationally, subject to regional variations.[141] Total (local+toll, intrastate+interstate) Dial Equipment Minutes (DEMs) are growing by approximately 3.7% annually, whereas *interstate* switched access minutes are experiencing annual growth rates of approximately 10%.[142]

(2) *Differences in the input mix for individual services.* The processes by which individual LEC services are produced are subject to considerable variation, particu-

140. *Id.* at para. 62-68.

141. FCC Industry Analysis Division, *Trends in Telephone Service*, February, 1995.

142. *Id.*

larly with respect to the relative cost shares of labor and capital and the pace of technological change with which each such service is created. Subscriber access lines, for example, involve a highly stable technology (copper loops) and exhibit a relatively high labor component for installation, maintenance and customer service (retailing) functions. By contrast, switched services (local and toll calling, switched access) has been and continues to be heavily impacted by technology (digital switching, Signalling System 7, Advanced Intelligent Network) and requires minimal labor input on an ongoing basis.

(3) *Disproportionate presence of highly capital-intensive, switched services in the interstate jurisdiction.* There is a considerable difference in the *mix* of services subject to interstate vs. state regulation. In general, the predominant interstate LEC services are switched access ($20.2-billion in annual revenues) and special access ($6.2-billion).[143] There is also a small amount of interstate intraLATA and corridor toll, which are treated in a separate price cap basket. By contrast, the predominant *intrastate* service is local exchange access line service ($31-billion), or about 50% of total intrastate LEC revenues ($62-billion).[144]

(4) *Arbitrary assignment of rate base and operating expenses as between the interstate and state jurisdictions.* The manner by which investment costs and ongoing operating expenses as allocated between the interstate and state jurisdictions is dictated by Part 36 of the Commission's rules and bears little direct relationship to the manner in which costs are actually incurred. Consequently, it would be highly coincidental — and highly unlikely — for the pattern of cost growth in each of the two jurisdictions to track the year-to-year incremental change in economic costs engendered by the ongoing provision of services.

So long as Part 36 and the legal standard upon which it is based[145] remain in effect, it will be necessary for any *interstate* price cap program to track changes in *jurisdictionally interstate* costs as these occur over time. Failure to do so would create either an over- or under-recovery of jurisdictional revenue requirements for reasons entirely unrelated to an individual LEC's performance and efficiency.

In fact, there is substantial reason to expect that the mix of services subject to the interstate jurisdiction is experiencing significantly lower overall cost growth on a per-unit basis than the mix of services regulated at the state level. As noted above, interstate toll

143. See *Telecommunications Reports*, May 15, 1995, at 4.

144. FCC *Statistics of Communications Common Carriers*, 1994.

145. *Smith v. Illinois Bell Telephone Co.*, 282 US 133 (1930).

and interstate switched access are growing at over three times the rate exhibited by subscriber access lines, and these switched services are also the ones in which the greatest productivity gains through mechanization and advanced switching and signalling technology have occurred. Hence, use of a total company TFP measure as the basis for an *interstate* X-factor creates a systematic upward bias in year-to-year changes in interstate rate levels overall.

The Commission has asked parties to comment on whether the separate measurement of an interstate productivity is economically meaningful. While points (1) through (3) above provide a fully sufficient basis to conclude that it is, there is in fact a far more straightforward demonstration of the appropriateness of calculating a separate interstate TFP: At a minimum, the identification and estimation of a separate interstate TFP for purposes of establishing a separate interstate X-factor and Price Cap Index is no less "economically meaningful" than the long-standing practice of identifying and allocating investment and operating costs as between the interstate and state jurisdictions. Thus, although the Commission's question can be answered in the affirmative, it is not necessary that this question even be answered at all so long as the underlying jurisdictional cost separation requirement remains in effect.

In fact, the presence of a systematic bias in the use of a total company TFP to establish the interstate X-factor will create unacceptable results at both the interstate and state levels. If, for example, both the FCC and the state commissions were to base their respective X-factors on *total company* TFP, and if per-unit interstate costs are growing more slowly than those applicable for services regulated at the state level, the following scenario will arise:

- At the interstate level, prices will increase at a faster rate than costs, leading to windfall earnings growth. LECs will have a strong incentive to elect the X-factor/sharing option that eliminates sharing and an earnings cap (as five of the seven RBOCs have done[146]) and, having made that election, will be able to amass and retain persistent, excessive interstate earnings.

- At the state level, prices will increase at a *slower* rate than costs, leading to persistent *underrecovery* and underearnings. The same LECs that are enjoying unlimited earnings growth at the interstate level will be able to invoke low-end earnings protection mecha-

146. FFNPRM, para. 8.

nisms[147] or, potentially, seek to invoke fifth amendment protection against confiscation as permitted by the *Hope* and *Bluefield* decisions of the US Supreme Court.[148]

Thus, even if the combined state and interstate earnings are reasonable, the separate jurisdictional treatment of each will permit the same LEC to keep the interstate windfall while claiming poverty in the states. There can be no justification, legal, economic or otherwise, for this jurisdiction-shopping, "heads-I-win, tails-you-lose" outcome.[149]

Calculation of an interstate TFP

For the same reasons that the presence of jurisdictional cost and revenue separations requires that separate interstate (and intrastate, at the state level) TFPs and X-factors be calculated, the methodology for such calculations must track the jurisdictional cost and revenue assignment processes themselves. Because most LEC plant and associated expenses are assigned to the interstate and state jurisdictions on the basis of a fixed 25/75 ratio that was established by the Federal/State Joint Board in CC Docket 87-339,[150] the growth of *aggregate* jurisdictional costs over time is largely (but not entirely) unrelated to the disparate growth in jurisdictional revenues that results from differing growth rates for individual services. Table 2 summarizes the composite interstate cost assignment for each

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147. For example, the California "New Regulatory Framework" permits a price cap LEC to seek additional rate increases if earnings fall at least 325 basis points below the authorized market-based rate of return for two consecutive years. D.89-10-031, 33 CPUC 43, 141; D.94-06-011, I.87-11-033, June 8, 1992, at 2.

148. *Bluefield Water Works and Improvement Co. v. Public Service Commission of West Virginia*, 262 U.S. 679 (1923), and *Federal Power Commission v. Hope Natural Gas Co.*, 320 U.S. 591 (1944). The Commission should take note of the fact that both Pacific Bell and GTE-California have advanced such confiscation arguments in the current California PUC "local competition" rulemaking investigation, CPUC I. 95-04-044. See Testimony of Paul N. MacAvoy (GTEC), page 3; Testimony of Peter A. Darbee (Pacific), pp. 2-4; and Testimony of Daniel Spulber, pp. 5-6 (Pacific).

149. For examples of LEC testimony in intrastate jurisdictions seeking state regulatory commissions to consider intrastate only results and conditions consistent with past practices under traditional rate of return regulation, see Rebuttal Testimony of Richard G. Petzold (Bell Atlantic-DC), page 18, District of Columbia Public Service Commission, Formal Case No. 814, Phase IV, September 15, 1995. BA-DC witness Petzold testifies that:

> The Staff recommendation for a total company productivity study (including FCC regulated interstate operations) would be contrary to the use of intrastate productivity studies starting with Formal Case No. 798 (Order No. 7866, dated October 3, 1983). The Staff has not raised any arguments to reverse the history of intrastate only productivity studies being germane to intrastate ratemaking, and their proposal would add considerable record keeping to track non-intrastate price increases.

150. Amendment of Part 36 of the Commission's Rules and Establishment of a Joint Board, Establishment of a Program to Monitor the Impact of Joint Board Decisions, CC Docket Nos. 80-286 and 87-339, 7 FCC Rcd 4541.

of the years 1991-94. As shown in Table 2, the trend in composite interstate cost assignment has been very stable (in the vicinity of 24%) over the past several years of price cap regulation, despite the phase-out of the Subscriber Plant Factor (SPF) during this period. As such, input growth in the interstate jurisdiction can be approximated by total company input growth.

Table 2

COMPOSITE INTERSTATE COST SHARES

	Interstate Revenues	Interstate Expenses
1991	25.18%	24.35%
1992	25.10%	23.93%
1993	25.08%	23.74%
1994	25.48%	23.70%

On the output side, separate interstate and state output growth rates can be estimated through the use of deflated revenues in each jurisdiction (essentially the Christensen/USTA method). We use this method for purposes of this report, however, for the reasons described earlier in the discussion of output, direct measurement of physical output (interstate minutes of use, intrastate subscriber lines, minutes of use, etc.) would be preferable to Christensen's deflated revenue method.

Using this approach, i.e., interstate input growth approximated by total company input growth and interstate output growth estimated through the use of deflated revenues for services offered in the interstate jurisdiction including switched access, special access, and end user access, ETI has developed a TFP estimate for the interstate jurisdiction. As shown in the results presented in the next section of this report, the X-factor based on interstate input and output growth is significantly higher than one based on total company results.

Distinguishing between regulated and nonregulated services, or using service-specific productivity, for purposes of calculating the X-factor

The Commission seeks comment on whether nonregulated services should be excluded from the TFP calculation, and similarly whether productivity for specific services such as video dialtone should be separated out for purposes of calculating X-factor.[151] A strong case can be made for separating out productivity for nonregulated services as well as for services such as video dialtone which have such markedly different demand and supply characteristics from traditional regulated telephone services and which will be offered in such an intensely competitive market environment. In its comments in the first phase of this proceeding, Ad Hoc noted that ongoing efforts by LECs to replace existing plant with

151. FFNPRM, paras. 69-70.

new facilities capable of supporting future broadband and video services would have the effect of depressing the *apparent* productivity growth rate exhibited by these companies.[152] This occurs because (a) the rate of growth of LEC capital inputs is greater than it would otherwise be absent these competitive-driven investment programs, and (b) the remaining lives of embedded voice/narrowband facilities is shortened by an accelerate rate of plant replacement and retirement, producing higher economic and accounting depreciation rates than would prevail absent the competitively-driven replacement initiatives. Whether examined on the basis of TFP or realized earnings (the so-called "Frentrup-Uretsky" method), the effect of such plant replacement programs is similar and mutually consistent.

The issue of separating out productivity for video dialtone/broadband services was specifically addressed in comments submitted by Ad Hoc in this proceeding concerning the treatment of video dialtone services under price cap regulation. As set forth in those comments, the unbundling of the productivity factor as between video dialtone/broadband and other traditional price cap services is necessary to ensure that alleged cost improvements that have been attributed by the LECs to their deployment of broadband facilities and used by the LECs to justify allocations of the overwhelming majority of those costs to voice services would in fact be flowed through to customers of voice services rather than being diverted to support video entry.[153] As explained in Ad Hoc's earlier comments, it is important that the creation of a separate video dialtone basket be coupled with an appropriate disaggregation of the composite X-factor. Given the Commission's finding that a zero productivity factor is applicable to video dialtone,[154] the disaggregation of the composite X-factor will necessarily produce an X-factor applicable to price cap services other then video dialtone/broadband that is higher than an overall average X-factor based on the inclusion of video dialtone services.[155] The Commission therefore must take this fact into consideration in the calculation of the X-factor for a long-term price cap plan — if not directly with an explicit unbundling of the X-factor, then indirectly by the Commission's adoption of a compensating consumer productivity dividend.

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152. Comments of the Ad Hoc Telecommunications Users Committee, CC Docket No. 94-1, May 9, 1994, at 9.

153. Comments of the Ad Hoc Telecommunications Users Committee, CC Docket No. 94-1, April 17, 1995, at 11-16. Ad Hoc stresses, however, that while unbundling of the X-factor is necessary to prevent cross-subsidization, it is by no means sufficient. The only true means of ensuring video dialtone costs are not recovered through charges for other interstate access services is a diligent and thorough cost allocation methodology and tariff review process. *Id.* at 4.

154. *Second Report and Order and Third Further Notice of Proposed Rulemaking*, CC Docket No. 94-1, September 21, 1995 at para. 23.

155. *Id.* at 15-16.

Inclusion of firms other than LECs in a TFP-based X-factor

The Commission poses the question of whether firms other than the LECs should be included in a TFP-based X-factor.[156] As discussed in comments submitted by Ad Hoc in the first phase of this proceeding, only by including nonregulated firms and other telecommunications providers whose rates are in fact entirely disconnected from LEC costs can a truly exogenous X-factor be established.[157] Such an X-factor would be based on comparable services furnished by IXCs, CAPs, value-added network service providers, and other industry members that can be identified as providing comparable services and for which data can practically be collected. While data limitations preclude our consideration of other telecommunications providers at this time, the inclusion of non-LEC firms in a TFP-based X-factor is particularly critical in the context of a long-term price cap plan where earnings sharing and periodic reviews are replaced with some sort of moving average annually recalculated TFP measure, as proposed by USTA at the tail end of the first phase of this proceeding. Whereas in principle price cap regulation is supposed to de-link rates from costs, under USTA's moving average proposal, the X factor would actually be driven by LEC TFP trended by means of a moving average.

156. *Id.*, para. 73.

157. Letter from Colleen Boothby to William F. Caton, CC Docket No. 94-1, February 2, 1995, at 17.

4 RESULTS OF CORRECTED X-FACTOR ANALYSIS

When key corrections are made to the Christensen/USTA TFP study, the X-Factor is found to be significantly greater than the paltry 2.1% claimed by USTA and even the highest 5.3% level adopted by the Commission in the *First Report and Order.*

In the preceding section of this report, we identified a number of serious infirmities with the Christensen/USTA TFP study and offered specific ways in which some of the problems inherent in that study could be corrected. In this section, we quantify the effect upon the X-factor that would result were these corrections made, or at a minimum, identify the direction of the bias introduced by the specific errors made by Christensen. In several cases, a lack of data does not permit us to quantity precisely the effect upon the X-factor that results from a needed correction to the Christensen/USTA study.

However, since as noted previously, even a small percentage change in the X-factor has a profound dollar impact upon rates for interstate services,[158] the sensitivity of Christensen's results to specific corrections or improvements will be highly significant and must be taken into account. The results of our analysis demonstrate that, when the required corrections are made to the Christensen/USTA study, the X-factor will be found to be considerably greater than the 2.1% claimed by USTA and even the highest 5.3% value adopted by the Commission in the *First Report and Order*.

The specific revisions we are able to analyze quantitatively at this time include the following:

(1) Calculation of TFP for services subject to the interstate jurisdiction;

(2) Replacement of internally-generated LEC TPI series with BEA asset price deflator data used and available from the Bureau of Labor Statistics (BLS);

158. See footnote 39, *infra*.

(3) Adjustment to the tax factor used in the formula for the rental price of capital so as to reflect the differential tax effect of debt versus equity; and

(4) Replacement of general economy-wide depreciation rates with depreciation rates applicable to the LECs.

In addition, while our initial analysis does not provide a specific estimate of the effects of hedonic price changes for inputs used by the LECs, sensitivity analysis permits us to identify the direction of the bias that results from Christensen's failure to adjust for hedonic effects.

The following analysis summarizes the results of the various corrections that we have been able to address. As shown in Table 3 below, the X-factor for interstate LEC services, including the input price differential (IPD) and a 0.5% Consumer Productivity Dividend (CPD), increases from a "base case" of 5.1% based upon the "1993 Update" Christensen/ USTA study to 9.9%.[159] The 5.1% "base case" result is a total company result based directly on Christensen's 1993 Update study methodology, which we were able to replicate and modify using Times Series Processor (TSP) software.[160] Consistent with the Christensen/USTA study, the X-Factor we calculate in our analysis covers the entire post-divesti-

159. The 5.1% "base case" result is comprised of a total factor productivity of 2.456%, an input price differential of 2.13% and a consumer productivity dividend of .5%. Alternatively, given the empirical problems with the 1993 Update study discussed in Section 2 of this report, it would be reasonable to choose as our "base case" the total company result from Christensen's original May 1994 Study. The "base case" result corresponding to the original Christensen study is 5.7%, comprised of a total factor productivity of 2.6%, an input price differential of 2.6% and a consumer productivity dividend of 0.5%. Given the original "base case" result is some .6% *higher* than the Update "base case" result we rely on in our analysis, the results we present will be generally in the range of .6% *lower* than they would be had we relied instead on the original study as a starting point for our analysis. Thus, the counterpart of the 9.9% interstate only X-Factor result we present in our report could be expected to be in the range of 10.5% if calculated starting from a "base case" result from Christensen's original study.

160. TSP is a general purpose computer language for econometric and statistical data processing and estimation developed by economists. TSP performs a full array of standard and advanced techniques to economic time series data in an accurate and efficient form. Of special relevance, TSP has built-in commands which compute fundamental components of a total factor productivity study with simplicity and ease. In particular, the DIVIND command computes aggregate price indices (called Divisia Indices) from several underlying price series, and the CAPITL command computes a capital stock series from a given gross investment series using a perpetual inventory method and a constant depreciation rate assumption (CAPITL command). These two commands enable the analyst to readily evaluate the effects of changes in underlying data and assumptions on the basic components of productivity. TSP can be obtained from TSP International, P.O. Box 61015, Station A, Palo Alto, California 94306, (415) 326-1927.

ture period beginning with 1984.[161] Although only the interstate X-factor is relevant for application in the interstate jurisdiction, we also present a corrected calculation of the total company X-factor for comparison purposes.

Interstate X-factor results

Perhaps the most significant result of our analysis is the substantially higher TFP associated with services subject to interstate (FCC) jurisdiction in contrast to the Total Company TFP that was calculated in the Christensen/USTA study. Making no changes to the Christensen study methodology or data other than to adjust for interstate-specific output growth, the X-Factor result, including both the IPD and a 0.5% CPD, increases 2.8%, from 5.1% based on the revised Christensen/USTA study to 7.9%.[162] Thus, the 7.9% X-factor result is the interstate only equivalent of the Christensen total company "base case" result.

Table 3

SUMMARY OF RESULTS
INTERSTATE ONLY X-FACTOR

	TFP	Input Price Diff.	CPD	X-Factor
Base Case	5.3%	2.1%	0.5 %	7.9%
Corrected	6.0%	3.4%	0.5 %	9.9%

To this interstate only base case result, we make three separate corrections. The first correction involves the use of BEA/BLS asset price deflators in place of the internally-generated, proprietary LEC TPI series. Substitution of the BEA/BLS asset price deflators

161. This treatment is consistent with the Commission's finding that:

> ...unlike the Frentrup-Uretsky Study, the USTA Study does not show disparate results for the periods 1984-90 and 1985-90. If LEC productivity gain in the 1984-85 tariff year were really as different from the subsequent five years as the 1984 data point would indicate, that difference should have shown up in USTA's TFP Study. The fact that the USTA TFP Study results are not much affected by the inclusion or exclusion of 1984-85 data lends additional credence to the view that the data underlying the 1984 data point in the Frentrup-Uretsky Study was seriously flawed.

162. The service categories included in our interstate only X-factor calculations are interstate switched access, interstate special access, and interstate end user access. The output quantity series for these three service categories used in our analysis are taken directly from the Christensen 1993 Update study. Ideally, physical measures of output quantity would be developed and used in lieu of Christensen's output quantity series based on deflated revenues. As discussed in the preceding section, given the relatively stable trend of the percent of total company expenses assigned to the interstate jurisdiction over the past several years, it is appropriate to assume that growth in interstate input costs for the LECs is proportional to that experienced by the LECs on a total company basis.

has the effect of increasing the base case interstate X-Factor by 1.6%. The second correction adjusts the implicit rental price of capital to reflect the debt/equity distinction. This second correction increases the base case interstate X-Factor measure by 0.4%. The third correction involves an adjustment to the inappropriate economy-wide depreciation rates used by Christensen to reflect a level of depreciation rates consistent with FCC prescribed rates. Making this third correction increases the base case interstate X-Factor measure by 0.3%. As shown in Table 3, the combination of these three corrections, applied to the interstate base case, results in a X-factor of 9.9%., an increase of some 2.0% vis-a-vis the interstate base case and some 4.8% above the total company base case result.

Total Company X-factor results

Even when considered on a total company basis, the corrections to the Christensen/USTA study result in a significant increase in the overall X-Factor. The Total Company X-Factor (again including both the IPD and a 0.5% CPD) derived directly from the Christensen/USTA January 1993 Update study (i.e., making no changes whatsoever to either Christensen's study methodology or data) is 5.1%.[163] To this total company base case result, we apply the same three corrections identified above in the context of the interstate only X-factor analysis. Since the differences between our interstate and total company scenarios involve output series only, the corrections we have made have the same percentage change effect on X-factor findings relative to the respective interstate and total company base case numbers: use of BEA/BLS asset price deflators increases the base case total company X-Factor by 1.6%; adjustment of the implicit rental price of capital increases the base case total company X-Factor by 0.4%; and revising depreciation rates increases the base case total company X-Factor measure by 0.3%. The combined effect of these three corrections, as shown in Table 4, is an increase to the total company base case of 2.0%, producing a total company X-factor of 7.1%.

Table 4

SUMMARY OF RESULTS
TOTAL COMPANY X-FACTOR

	TFP	Input Price Diff.	CPD	X-Factor
Base Case	2.5%	2.1%	0.5 %	5.1%
Corrected	3.2%	3.4%	0.5 %	7.1%

163. The corresponding X-Factor based on the original May 1994 Christensen/USTA Study was 5.7%.

Effects of hedonic adjustments

In the previous section of this report, the importance of hedonic price changes for telecommunications inputs was firmly established. However, the impact on the X-factor from including hedonic adjustments is an empirical matter that cannot be determined *a priori*. While we have not at this time been able to derive a set of asset price deflators adjusted for hedonic effects, we have performed sensitivity analyses of the effect on the X-factor of including quality-adjusted asset price indices.

To demonstrate the degree of sensitivity of the X-factor result to the inclusion of hedonic adjustments, we have estimated the effect of a modest 10% annual downward adjustment in the asset price deflators most closely associated with computers to reflect the persistent and significant technological advances and product improvements that have occurred in the computer industry over the past decade.[164] In particular, the 10% adjustment was applied to the asset price deflator applied to central office switching and the computer component of general support equipment. Incorporation of this highly conservative adjustment for quality effects, as summarized in Table 5, increases the corrected interstate X-factor from 9.9% to 10.3%. Similarly, the corrected total company X-factor further adjusted for hedonic effects increases from 7.1% to 7.5%. Our analysis indicates that hedonic adjustments to asset price deflators are likely to increase the overall X-Factor by reducing LEC input price growth and increasing the input price differential. We conclude therefore that the effect of using an hedonic-adjusted set of asset price deflators in place of either the LEC TPI series or the BLS asset price deflator data is likely to result in a significant increase in the X-Factor, both on an interstate and a total company basis. Use of more precise hedonic adjustments is likely to produce even higher X-factor results.

Table 5

SUMMARY OF RESULTS
CORRECTED/QUALITY ADJUSTED
X-FACTOR

	TFP	Input Price Diff.	CPD	X-Factor
Interstate	5.5%	4.3%	0.5%	10.3%
Total Company	2.7%	4.3%	0.5%	7.5%

164. As described in Section 3 of this report at pages 37-38, studies of quality-adjusted price movements in the computer industry have suggested considerably higher annual impacts, in the range of 25%-30%. Moreover, studies indicate hedonic impacts are also significant for other LEC asset categories, such as cable.

Recognition of hedonic effects on the cost of LEC capital inputs adds further weight to the importance of incorporating an explicit input price differential in the price cap formula. While the Christensen/USTA study examines *endogenous* productivity growth *within the LEC industry* itself, incorporation of an input price differential recognizes the *exogenous* productivity growth that has occurred within those sectors of the economy that *supply inputs to the LECs*. Since the purpose of the X-factor is to track *overall LEC cost changes over time and the deviation of those changes from the economy-wide inflation rate*, it doesn't matter whether the specific source of such deviations is the result of the endogenous productivity growth (studied by Christensen), exogenous productivity growth in the supplier sectors (reflected in the input price differential), or from the salutary effects of price cap regulation itself (reflected in the CPD). Recognition of hedonic effects on the growth of LEC input prices teaches that proportionately more of the total LEC price growth deviation from economy-wide inflation may be attributable to exogenous productivity growth in supplier sectors than to the endogenous productivity achieved within the individual LECs. This result should be neither surprising nor disturbing, *but it should be fully captured in the X-factor that drives the Commission's price cap program.*

If the TFP method for establishing the X-factor is to be utilized, the various corrections identified here must be adopted.

Our analysis does not attempt to address all empirical shortcomings of the Christensen/USTA study discussed in the preceding section. However, we believe the few key corrections we have analyzed clearly demonstrate that the correct X-Factor is significantly greater than the paltry 2.1% claimed by USTA and is well above even the highest 5.3% level adopted by the Commission in the *First Report and Order*. The failure of the Commission to adopt a correct interstate X-Factor that is based upon sound methodology and upon correct, objective, and publicly-available data, will result in substantial LEC overcharges, creating unprecedented windfall profits for these companies.