be difficult to implement and would attenuate somewhat the incentive improvement expected from price regulation. For those reasons, the differential formula (3) is used frequently and equation (1) is never used.

This theoretical background enables us to understand the function of each element of the LEC price cap plan. We can now assess how well each component has performed since 1990.

II. INFLATION

Inflation in the annual price cap adjustment formula plays a very specific role, and a role that has confused a number of parties in state and federal price cap proceedings. The confusion stems from mistaking equation (3) for equation (1) above. That is, it is sometimes thought that the role of the change in GNP-PI in the price cap formula is to measure changes in input prices, as denoted by dw in equation (1). On the contrary, as our above derivation shows, the role that GNP-PI plays in the price cap formula is to measure output price changes for the U.S. economy as a whole. More specifically, because the productivity offset is expressed as the differential between the LEC industry rate of growth of TFP and that of the U.S. economy, the measure of output price growth in the formula pertains to the specific entity whose TFP growth we have used in calculating the productivity differential.

The measure of national output price changes, combined with the productivity differential, accounts for changes in input prices affecting the LECs. It performs this

function by measuring the output price change corresponding to the sector of the economy against which LEC TFP growth is compared in the productivity offset. How have national output prices changed over time?

There are two commonly used measures of output price growth for the U.S. as a whole that could be used in the price cap adjustment formula:

- The GNP-PI measures the price change for the aggregate of the components of Gross National Product (GNP). At the initialization of LEC price caps, the GNP-PI was calculated using 1982 commodity weights. The same index was used in the 1991 annual filling. The index has since been reweighted and since 1992, filings have used an index with 1987 weights.[11]

- The GDP-PI measures price changes for the aggregate of the components of Gross Domestic Product (GDP) using 1987 commodity weights.

Both indices measure output price growth but for slightly different bundles of outputs. Gross National Product is the value of final goods (as opposed to intermediate goods) produced by U.S.-owned factors of production. Gross Domestic Product is about 99 percent of Gross National Product, omitting that portion of the output of final goods and services produced abroad by all U.S.-owned factors of production and including that portion of the output of final goods and services produced in the U.S. by foreign-owned factors of production.

[11]The two GNP-PIs use different weights to represent the relative importance of the different components of the GNP.

A. National Output Price Changes

Since 1982, the levels of GNP-PI, and GDP-PI have been virtually the same. These measures of national inflation have grown at average annual rates of 3.65 and 3.66 percent respectively.[12] Since 1990, during the price cap period, the two measures have averaged 3.50 and 3.51 percent growth respectively. Differences between the 1987-weighted GNP-PI and GDP-PI measures are negligible during the 1990-1993 period.

Currently, when applying the adjustment formula LECs are instructed to use the forty-five day preliminary GDP-PI numbers and then perform a true-up with a seventy-five day GNP-PI. To the extent that this is an administrative burden, we see clear advantages from allowing the LECs to use the GDP-PI throughout. The numerical differences are negligible, and in fact, there is a theoretical benefit from using the GDP-PI. The GDP-PI is somewhat more likely to measure output price changes for the bundle of goods and services whose TFP growth is measured by the BLS.[13]

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[12]Calculated by averaging annual rates of growth.

[13]The BLS produces aggregate TFP growth calculations for U.S. private business, non-farm business, and manufacturing. U.S. private business accounts for about 80 percent of GNP; it excludes the government sector, owner-occupied housing, nonprofit institutions, private household employees, and the rest-of-the-world (ROTW) account. Thus, the set of goods and services measured by the GDP-PI is somewhat closer to the set of goods and services produced by U.S. private business because both GDP and U.S. private business exclude the ROTW sector. As a practical matter, however, the LECs' current 3.3 percent productivity offset was not determined in the previous proceeding by subtracting a TFP growth rate for the LECs from a TFP growth rate for U.S. private business as calculated by the BLS. Nonetheless, the U.S. TFP data compiled by the BLS are commonly used, and most parties' perception of a reasonable productivity offset for the LECs is determined, at least in part, by those results. In practice, this adjustment is negligible for a shift to the GDP-PI because the growth rates of the GNP-PI and GDP-PI are so similar.

B. Input Price Changes

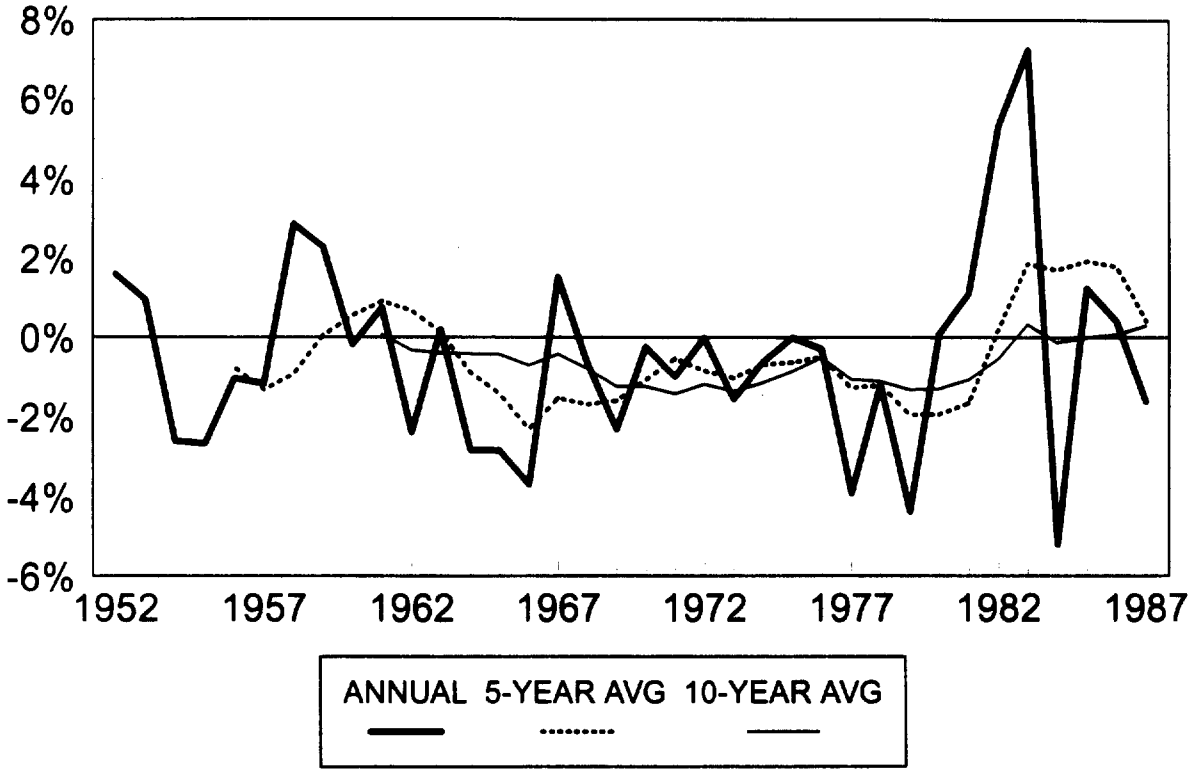
Central to the interpretation of the productivity offset in the price cap formula is the assumption that input price growth for the U.S. economy is the same as that for the LEC industry. If these input price growth rates differ, that difference is included as part of the productivity offset, as can be seen in equation (3).[14] To shed some light on the relationship between telecommunications input price growth and national input price growth, we compared the input price index for the U.S. telecommunications industry and the U.S. Private Business Sector for two different analysis periods: 1951-1987 and 1984-1990. Each analysis period corresponds to available data.

For the first period, 1951-1987, we rely upon a TFP study conducted by L.R. Christensen. Using the Bureau of Labor Statistics (BLS) multifactor productivity growth estimates for U.S. Private Business and the GNP-PI measure of national output price changes, we calculated an input price index for the U.S. economy for the years 1951-1987. While in any year, this estimate of input price growth differs between the telecommunications industry and the U.S. economy, those differences largely balance out over time. If we calculate a ten-year moving average annual growth rate for both, the largest difference between the two is 1.4 percentage points over the 1961-1987 period. In a given year, the difference in input price growths can be as little as 0.01% or as much as 7.2%. Figure 1 shows that over the long run, however, input price growth for the U.S. approximates telecommunications input cost inflation. As of 1987, long-run

[14]When the indirect method of measuring the historical productivity offset is used--as the Commission did in 1990--the measured value of X includes both the productivity differential and the difference--if any--in input prices.

annual input price growth averaged 6.53% for the industry and 6.23% for the U.S, differing by only 0.30%. Moreover, there was no statistically significant difference between industry and U.S. input price growth.

Figure 1
Annual Input Price Growth Rate Differences
Telecommunications - U.S. Economy
1951-1987



Our analysis of input price growth differences over the shorter, more recent period (1984-1990) yields similar results.[15] Using the recent industry TFP study of L. R. Christensen, BLS multifactor productivity growth estimates for U.S. Private Business, and the GNP-PI measure of national output price changes, we again calculated an input price

[15]While the recent Christensen study reports results from 1984 to 1992, BLS multifactor productivity results are only available through 1990.

index for the U.S. economy. Between 1984 and 1990 input price growth for the U.S. ranged from 3.5 to 6.3 percent while input price growth for the industry ranged from -0.4 to 12.0 percent. For this period of analysis we again find that there was no statistically significant difference between industry and U.S. input price growth. From this exercise, we conclude that the productivity offset in a price cap plan should be the simple differential between the annual TFP growth of the regulated firm and the U.S. economy; there is no reliable evidence that input prices have grown--or will grow--at different rates for the telecommunications industry and the U.S. as a whole.[16]

III. PRODUCTIVITY GROWTH

Technical efficiency in economics has two components. Static efficiency asks whether at any point in time, the firm has produced as much output as possible given the inputs it has used or, equivalently, whether the firm has produced its given level of output using the lowest-cost bundle of inputs. Dynamic efficiency asks whether the firm invests wisely in cost-reducing or demand-expanding technological progress to increase the maximum output possible given its inputs or to reduce the minimum cost of producing a given level of output. If price cap regulation is to provide future ratepayers with efficient telephone service, it is essential that dynamic efficiency be a major design criterion and that incentives be established so that actual LEC productivity growth is as high as

[16]Indeed, as shown below, direct measurements of the productivity differential are generally consistent with the indirect measurements based on prices. Since the indirect measurement includes the difference in input price growth rates and the direct measurement does not, the fact that the two methods produce similar results implies that the difference in input price growth rates is small over reasonably long periods of time.

possible.[17] To achieve this goal, modifications--if any--to the price cap plan should be examined in light of their possible consequences on the rate and direction of capital investment in the network.

A. Productivity Concepts

Productivity growth is an increase in the amount of output obtainable from a given set of inputs. There are a number of ways of measuring both outputs and inputs which give rise to different measures of productivity growth. While each measure has its use, the only comprehensive measure is total factor productivity (TFP).

Total (or multi) factor productivity measures the change in aggregate output corresponding to a given change in all inputs. In most calculations, aggregate output growth is measured by a revenue-weighted average of the growth rates of individual outputs, and aggregate input growth is measured by an expenditure-weighted average of the growth rates of individual inputs.[18]

[17]Establishing incentives to elicit rapid productivity growth is completely different from setting a high productivity offset. The Commission deliberately chose to set a productivity offset above the historical rate of productivity growth of the industry presumably to induce a higher growth in TFP. However, the principle feature of price caps that improves a firm's incentives to become more productive is that the productivity offset is unaffected by the firm's performance. Whether that offset is low or high does have other important effects on stockholders, on ratepayers, and on the incentives of the firm to invest in its business. If the price cap plan were modified to reduce the productivity offset, for example, investment in the regulated telephone network would become more attractive, stimulating capital investment in domestic telecommunications that might otherwise be deployed elsewhere.

[18]In contrast, single factor productivity--most often labor productivity--measures the change in aggregate output corresponding to a given change in a single input, e.g., change in output per worker. While there are some legitimate uses for labor productivity measures, labor productivity cannot be used to measure the change in the productive capacity of the firm.

1. Total (Not Partial) Factor Productivity is Implied by the Price Cap Formula

For use in the price cap formula, total factor productivity (TFP) is the only appropriate measure of productivity growth. First, use of TFP in setting a productivity offset avoids distortions in the incentives of the firm. If, for example, prices of the regulated firm were tied somehow to attainment of a labor productivity objective, the firm would have the incentive to hire labor until the point at which the average productivity of labor was maximized. This input choice rule is inconsistent with the rule followed by profit-seeking firms in unregulated markets: to hire labor until the value of the additional product made possible by the last worker just equals the wage rate.

Second, given the structure of the annual price cap adjustment formula, only total factor productivity can be used to set the productivity offset. The annual price cap adjustment formula is designed so that if the firm achieves the industry productivity goal, the allowed growth in its price cap will just equal the realized growth in industry input prices. In Appendix I we demonstrate that TFP is the appropriate foundation for a productivity offset in the price cap plan.

B. Possible Changes in the Productivity Offset

A purpose of this review of the LEC price cap plan is to determine how the LEC price cap plan should be improved if experience suggests that parameters of the plan were set incorrectly or that circumstances had changed. In this section, we examine some issues regarding the productivity parameter of the plan: an analysis of the frequency with which the productivity offset should be updated, and an assessment of different productivity comparisons implicit in the productivity offset. We conclude that if any change is

warranted, the productivity offset should be lower than the current 3.3 percent, a result that confirms the findings reported in the Christensen Associates' study in this filing.

1. Should the Productivity Offset be Updated More Frequently?

To update the productivity offset routinely as part of the price cap plan would mitigate the very improvements in incentives that the Commission set out to create.[19] Under the current plan, the LECs' productivity offset was set at the beginning of the price cap period and is now being reviewed after three years. This arrangement differs from the inflation adjustment component of the price cap adjustment formula which is calculated anew in each annual price cap filing, based on the most recent reliable inflation data obtainable. From past evidence of the volatility of TFP growth over short periods of time, we conclude that use of short-term productivity results to make frequent productivity offset updates (i.e., every four years) would damage the workings of a price cap regulation plan.[20]

True productivity growth for a firm, an industry, or the U.S. as a whole varies a great deal from year to year because of productivity-increasing or productivity-decreasing activities that occur less frequently than once per year. For example, suppose every five years, a firm undergoes a significant restructuring in which workers and managers identified as surplus are eliminated from the payroll. Measured productivity growth from

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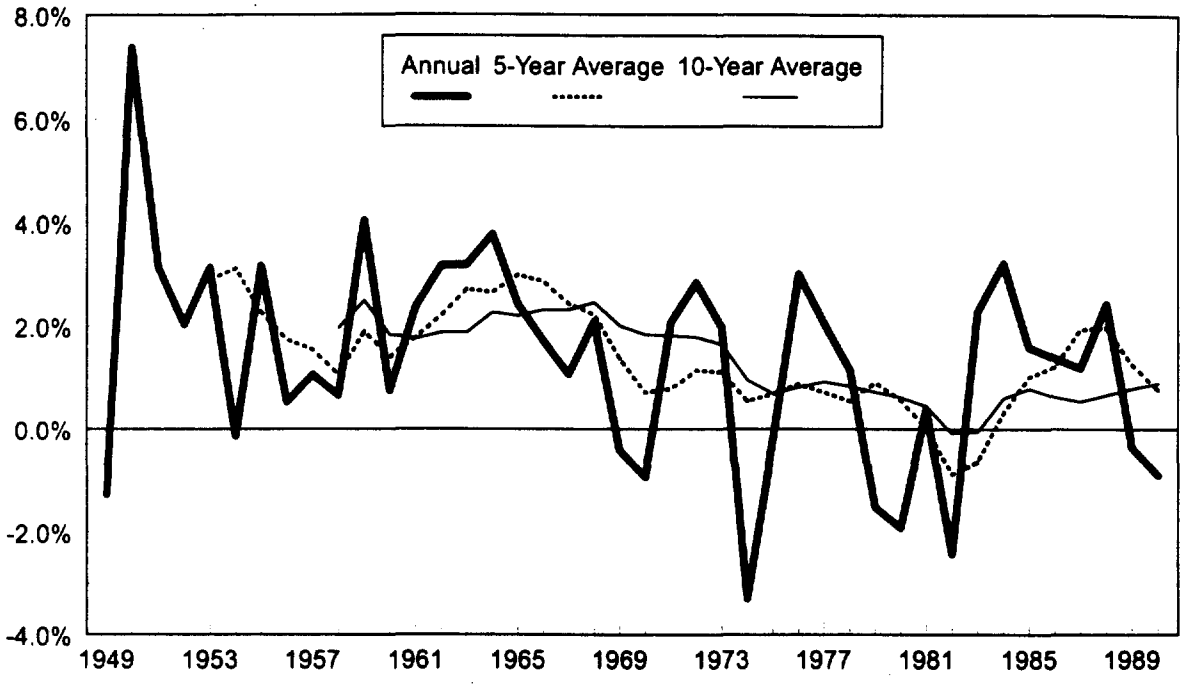
[19]Similarly, the adoption of a mechanism to adjust prices to reflect changes in interest rates would also diminish the incentive improvements of price caps relative to current RoR regulation.

[20]Volatility aside, if an individual LEC's own productivity growth were used to establish a productivity adjustment for that LEC, the incentive basis of the price cap formula would degenerate. A plan in which a LEC's TFP growth this year determined its price growth next year would be perilously close to ordinary RoR regulation.

Figure 2
U.S. Private Business TFP Growth



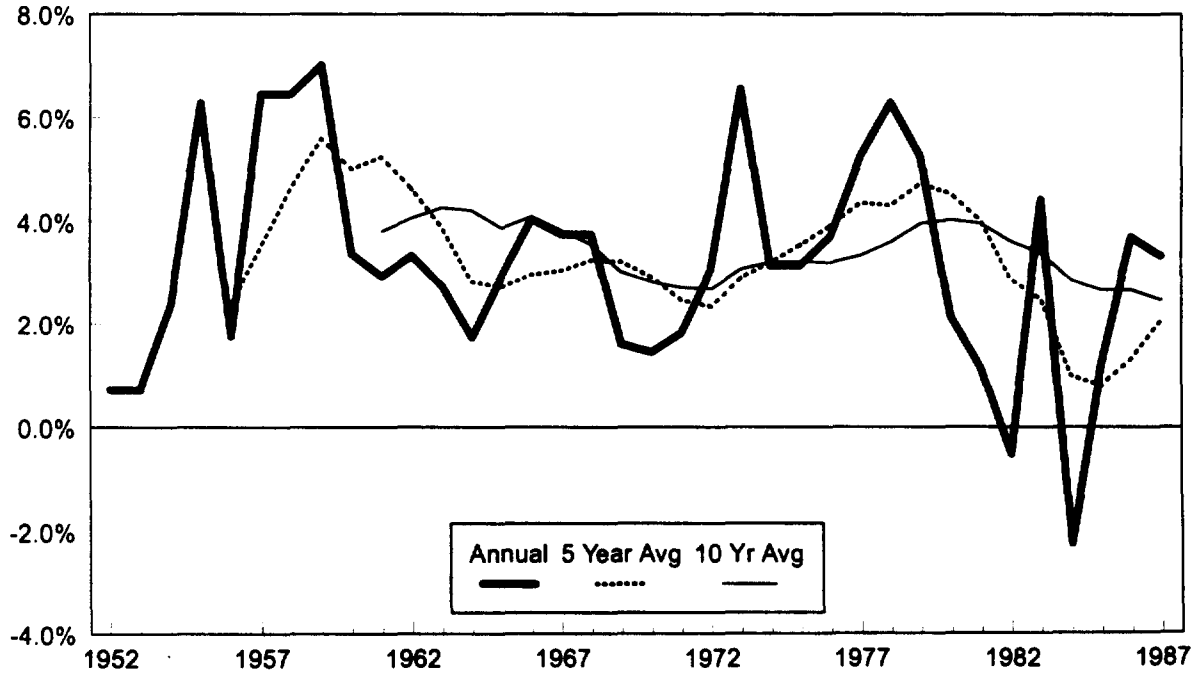
this source would show (i) no change in four years out of five and (i) a productivity increase in the fifth year that was roughly five times its long run annual rate. Obviously if this source of productivity growth were important, productivity measurement averaged over less than a five year period would yield a serious bias. In Figure 2, annual growth in U.S. TFP is shown, and it is clear that growth estimates from one or two years can seriously misstate the long run average TFP growth at any point in time. Using J. Kendrick's estimates of U.S. TFP growth from 1884 to 1969, the picture that emerges is that the volatility of TFP growth exceeds that of the U.S. business cycle, and that the average frequency of the TFP growth cycle over this period is about 3 years.[21] More recent analysis by the U.S. Department of Commerce, suggests that between 1945 and

[21]Thus annual growth in TFP rises and falls more rapidly than annual growth in GNP, averaging about 3 years between peaks or between troughs. J.W. Kendrick, Long Term Economic Growth 1860-1970, Washington D.C.: U.S. Bureau of the Census, June 1973.

1990 the business cycle length has increased to 5 years.[22] For statistical purposes then, a minimum 3 year and perhaps even a 5 year period (a complete cycle) should be treated as a single observation. Multiple 3 or 5 year periods--i.e., a minimum of 6 and maybe as many as 10 years--must be observed to calculate a meaningful average productivity measure with any degree of precision.

The volatility of annual TFP measures is greater for smaller aggregates, such as firms or industries. Figure 3 shows annual TFP growth for the telecommunications

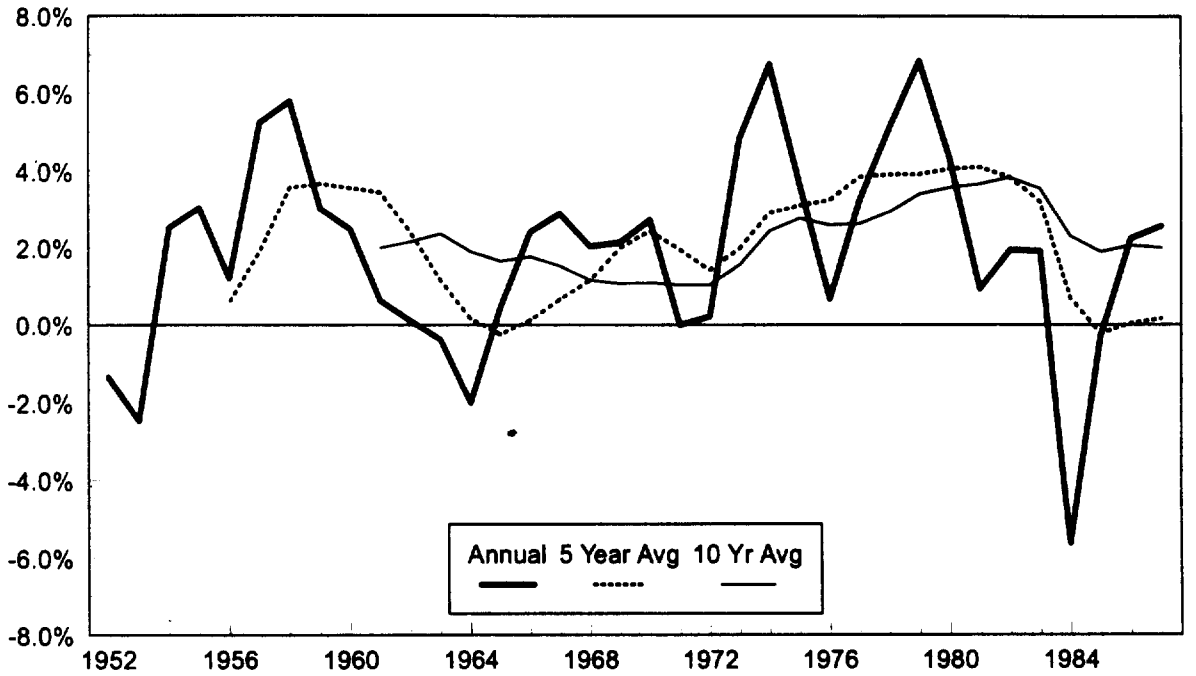
Figure 3
Telecommunications Industry TFP Growth



[22]U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, April 1992, C-25.

industry, as calculated by L.R. Christensen in his 1951-1987 study.[23] Comparison with Figure 2 shows significantly greater volatility at the industry level than for the U.S. as a whole. Finally, it is only the difference between national and firm TFP growth that matters for the productivity offset in the price cap formula. Figure 4 shows considerable variation in annual productivity differences, ranging from 6.8 to -5.6 percent per year.

Figure 4
Differences in Annual TFP Growth
Telecommunications - U.S. Private Business



The extreme differences in the ten-year moving average are reduced to a maximum of +3.8 and a minimum of 1.03 percent.

[23]L.R. Christensen, op. cit.

The picture in Figure 4 also shows clearly that the long-run productivity differential between the U.S. telephone industry and U.S. private business averages about 2 percent per year. This same 2 percent differential has been observed by most students of telecommunications productivity; possibly its strongest statement was provided by the FCC staff in the federal price cap docket where they noted a constant productivity differential (using output prices) of between 1.7 and 2 percent over the 1930-1989 period.[24] This relationship suggests that the 3.3 percent productivity differential chosen by the Commission, viewed from a long-run historical perspective, was an ambitious goal to set that would require higher than historical rates of productivity growth to accomplish.

These results show that annual productivity growth is too volatile to be used as a determinate of annual updates to the productivity offset. To obtain the full benefit of incentives to increase productivity growth and achieve the highest possible dynamic efficiency, the productivity offset must be stable over a long period of time, so that the firm will treat it as independent of any of its actions. As we discussed earlier, this gain in dynamic efficiency is purchased at the cost of a deterioration in allocative efficiency, if the firm's prices are permitted to deviate much from its costs.[25]

The risk of updating the productivity offset is that it encourages the firm to treat the offset as subject to its control or--at least--subject to uncertainty. This danger

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[24]Supplemental Notice of Proposed Rulemaking, CC Docket 87-313, (released March 12, 1990), Appendix D, "Total Telephone Productivity in the Pre and Post Divestiture Periods," by T.C. Spavins and J.M. Lande, and Second Report and Order, CC Docket 87-313, (released October 4, 1990), Appendix D, "The Long Term View of the Appropriate Productivity Factor for Interstate Exchange Access," by T.C. Spavins.

[25]An illuminating theoretical study of this tradeoff is contained in R. Schmalensee, "Good Regulatory Regimes," The Rand Journal of Economics, Autumn 1989, pp. 417-436.

is particularly acute if the performance review is used to measure achieved productivity growth and to adjust prices or the next period productivity offset to account for productivity successes or failures.[26] The risk of not updating the offset is that prices may not move with costs over time. Given the risks and the relatively short duration of the price cap period--short relative to the volatility of TFP measures--updating the productivity offset in performance reviews or at the annual price cap filing is inferior to maintaining a stable offset as a matter of principle.

2. Productivity Conclusions

This assessment of alternatives to the current productivity offset for the LEC price cap plan is hampered by lack of data because the plan has been in existence for only three years. Nonetheless, the long-run historical picture from Figure 4 shows that the industry as a whole could not expect to achieve the productivity growth implicit in the Commissions 3.3 percent productivity offset. The inflation and productivity offset components of the price cap formula are working within the bounds contemplated by the Commission when the plan was begun, and the danger of reversing the improvements in the incentives of regulated LECs far outweighs any benefits from attempting to fine-tune these components of the plan.

[26]If prices in the next period depended on productivity growth achieved in the current period, the firm would receive the perverse signals that failures in the current period would be rewarded with higher prices in the next period and successes in the current period would be punished by lower prices in the next period.

IV. ADJUSTMENT FOR INTEREST RATE CHANGES

The Commission has requested comment on whether (i) it may be appropriate to adopt a mechanism for adjusting the price cap to reflect changes in interest rates or (ii) if a one-time change in the price cap index may be required. A rate adjustment to account for changes in interest rates is not necessary and would essentially double-count the mechanism by which changes in input prices are accounted for under the plan. There is no basis for a one-time change in the price cap index.

As shown above in equation (3), the price cap plan includes historical differences--if any--in the rate of growth of input prices between the telecommunications industry and the U.S. as a whole as part of the productivity offset X. Thus if factor prices fall, the price cap-regulated firm will benefit to the extent that its costs fall further than those of a typical firm in the U.S. economy. Conversely, when factor prices rise, the regulated firm will benefit if its costs rise less than those of other firms in the economy.

Thus, if one factor price (e.g., the price of capital services) changes because of changes in interest rates, much of the impact on the regulated firm would be captured in the GNP-PI, because all firms in the economy face the same economic conditions that would have caused a secular increase or decrease in capital costs. The regulated firm would benefit only to the extent that it could manage its business so that the effect of the factor price change on it were more favorable than on the average firm in the U.S. economy. In the current FCC price cap plan for LECs and for AT&T, the regulated firm is given that incentive to manage its input prices as best it can because the input price

growth differential in equation (3) is included as part of the productivity offset X and is not updated every year (as inflation is updated) in the annual filing.

Note that if it were determined important to adjust the price cap index for changes in input prices, it would still be incorrect to simply reset prices--or the price cap index--to flow-through a lower cost of capital. First, it would be wrong to adjust the price cap index for changes in one factor price and not all factor prices. Equations (1) and (3) show that all input price changes are present in the annual adjustment formula, and it would impart a bias in factor proportions if adjustments were made to reflect changes in one factor price but not another.[27] Hence if adjustments were made to flow-through changes in the cost of capital, the only proper way to do that would be through changes in the rate of growth of all factors of production.

Second, it would be wrong to adjust the price cap index by the change in costs associated with the changes in capital (or all factor) prices. As shown in equations (3) and (4), the annual price adjustment formula changes by the difference between the change in the telecommunications industry's factor price growth and that of the U.S. as a whole. To lower the price cap index by the change in costs implied by a lower interest rate would effectively double-count a portion of the effect of the cost change. The (assumed) reduction in interest rates reduces costs for other firms in the economy which, ultimately, are flowed through to consumers in the form of lower prices. Lower prices imply that

[27]Recall that for a cost-minimizing firm, demands for factors of production (capital, labor and raw materials) depend on the relative prices of those factors. If the price cap formula distorted the ratio of the price of capital and labor effectively faced by the firm--by passing through changes in capital prices but not labor prices in the price cap annual adjustment formula--it would subsequently distort the choices of productive technology, interfere with cost minimization, and impart a bias in factor proportions not unlike the Averch-Johnson bias of traditional RoR regulation.

the growth in the measure of national inflation (GNP-PI) is lower that it otherwise would be and thus that the regulated firm's price cap index would be lower than it would have been, absent the reduction in interest rates.[28]

This is not, however, the plan that the FCC adopted for AT&T or for the LECs, and there are good reasons not to adopt such a plan. First, as shown above in Figure 1, there are no long run differences in the rate of growth of input prices between the telecommunications industry and the U.S. as a whole. Second, measured input price growth differences are extremely volatile which would impart more variability to the price cap index. Third, measurement of input price growth is difficult and imprecise, and no competent disinterested party currently calculates such indices. Finally, adjusting output prices every year to account for the differential effect on the LECs of changes in input prices eliminates their incentives to control--to whatever extent is possible--the prices of the inputs they purchase.

Having adopted an incentive regulation plan, the temptation to fine-tune the annual price adjustment formula to account for specific factors that might change short-run costs should generally be resisted; otherwise, price cap regulation would degenerate into traditional RoR regulation, and none of the incentive improvements intended by the adoption of price cap regulation would be realized. Under no circumstances would it be appropriate--or, indeed, arithmetically correct--to simply reset existing prices or the existing

[28]To adjust the price cap index--or the level of prices--for changes in interest rates amounts to treating factor price changes as exogenous cost changes. In this context, it is clear that since factor price changes affect all firms in the economy-- albeit differentially--only the difference between the effect of the cost change on the regulated firm and on the average firm in the economy would be eligible for exogenous cost treatment.

price cap index to reflect a change in rate of return. Such a suggestion is just a vestige of rate of return regulation and has no place in a price regulation plan.

V. CONCLUSIONS

We have examined evidence since 1990 regarding the LECs' experience with key economic parameters of the Price Cap Plan. With respect to the measure of inflation, we found a slight theoretical preference for use of the GDP-PI but no real difference in the behavior of the indices. Past historical trends strongly suggest that a 3.3 percent productivity differential would be difficult to achieve. If any change were warranted in the productivity offset, the evidence shows that the change would be downward. Finally, a rate adjustment to account for changes in interest rates is not necessary, would be inconsistent with the proper workings of the price cap plan adopted by the FCC, and would have to reflect differences in growth rates of <u>all</u> LEC input prices measured with respect to the growth rates of input prices in the economy.

VI. APPENDIX I

The annual price cap adjustment formula is designed so that if the firm achieves the industry productivity goal, the allowed growth in its price cap will just equal the realized growth in industry input prices. Following, we demonstrate that TFP is the appropriate foundation for a productivity offset in the price cap plan. Assume the price cap plan begins with appropriate prices so that the value of total inputs (including a normal return on capital) equals the value of total output. We can write this relationship as

$$\sum_{i=1}^{N} p_i Q_i = \sum_{j=1}^{M} w_j R_j ,$$

where the firm has N outputs (Q_i, i=1,...,N) and M inputs (R_j, j=1,...,M) and where p_i and w_j denote output and input prices respectively. We want to calculate a productivity offset so that--if the firm meets the industry productivity offset--this relationship holds identically at all points in time.

Expressing this identity in growth terms (differentiating this identity with respect to time) yields

$$\sum_{i=1}^{N} \dot{p}_i Q_i + \sum_{i=1}^{N} p_i \dot{Q}_i = \sum_{j=1}^{M} \dot{w}_j R_j + \sum_{j=1}^{M} w_j \dot{R}_j ,$$

where a dot (a derivative with respect to time) indicates growth over time. Dividing both sides of the equation by the value of output ($REV = \sum_i p_i Q_i$ or $C = \sum_j w_j R_j$), we obtain

$$\sum \dot{p}_i \left(\frac{Q_i}{REV} \right) + \sum \dot{Q}_i \left(\frac{p_i}{REV} \right) = \sum \dot{w}_j \left(\frac{R_j}{C} \right) + \sum \dot{R}_j \left(\frac{w_j}{C} \right),$$

where REV and C denote revenue and cost. If rev_i denotes the revenue share of output i and c_j denotes the cost share of input j, then

$$(5) \qquad \sum_i rev_i \, dp_i = \sum_j c_j \, dw_j - [\sum_i rev_i \, dQ_i - \sum_j c_j \, dR_j],$$

where d denotes a percentage growth rate: $dp_i = \dot{p}_i / p_i$. The first term in equation (5) is the revenue-weighted average of the rates of growth of output prices, and the second is the cost-weighted average of the rates of growth of input prices. The term in brackets is the difference between weighted averages of the rates of growth of outputs and inputs. It thus is a measure of the change in industry TFP. Rewriting the equation for clarity, we see that

$$dp = dw - dTFP.$$

In words, the theory underlying the LEC annual price cap adjustment formula implies that the rate of growth of a revenue-weighted output price index is equal to the rate of growth of an expenditure-weighted input price index plus the change in <u>total factor productivity</u>, not labor productivity or any other productivity measure. This equation demonstrates that total factor productivity is the appropriate foundation for a productivity offset in the price cap plan: if the plan begins with revenues which match costs--and if the firm attains a productivity goal measured in terms of industry total factor productivity--then the firm's revenues will continue to move with industry costs.

ATTACHMENT 6

Productivity of the Local Telephone Operating Companies

by

Lauritis R. Christensen, Philip E. Schoech
and Mark E. Meitzen

Productivity of the Local Operating Telephone Companies Subject to Price Cap Regulation

Laurits R. Christensen, Philip E. Schoech,

and Mark E. Meitzen

Christensen Associates

May 3, 1994

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EXECUTIVE SUMMARY

Productivity of the Local Operating Telephone Companies Subject to Price Cap Regulation

Laurits R. Christensen, Philip E. Schoech,
and Mark E. Meitzen
Christensen Associates
May 3, 1994

This report summarizes the results of the Total Factor Productivity study of the price cap Local Exchange Carriers (LECs), which was commissioned to Christensen Associates by the United States Telephone Association (USTA). Total Factor Productivity (TFP) is the ratio of total output to total input, where total output includes all services provided by the Local Exchange Carriers and total input includes the capital, labor, and materials used to provide those services.[1] The companies included in the study are Ameritech, Bell Atlantic, BellSouth, GTE, NYNEX, Pacific Telesis, Southern New England Telephone, Southwestern Bell, and U S West. The study covers the period 1984-1992. When the study was performed, this was the longest time period for which post-divestiture data were available for the LECs. In addition, this report presents a theoretical framework for analyzing sources of TFP growth, summarizes empirical studies of TFP growth in the telecommunications industry, and provides an analysis of TFP implications for LEC services subject to emerging competition.

[1]Total output consists of all services included in total operating revenue, as currently defined in the Form M.

EXECUTIVE SUMMARY

Chapter 1 presents the results of the LEC TFP study. The results of the study are that over the 1984-1992 period, total output for the price cap LECs grew at a 3.5 percent average annual rate and total input grew at a 0.9 percent average annual rate, resulting in average annual TFP growth of 2.6 percent. The productivity offset in the price cap formula is related to the differential in productivity growth between the LECs and the U.S. economy. Given that economy-wide TFP growth has averaged approximately 0.9 percent annually since 1984,[2] LEC post-divestiture TFP growth has exceeded economy-wide TFP growth, with a TFP growth differential of 1.7 percent.

The methodology employed in this study was initially developed for our 1981 study of the Bell System,[3] and subsequently has been applied in studies submitted to and accepted by the public utility commissions in North Dakota, Georgia, Illinois, Ohio, and Indiana. It is based on research conducted by Laurits Christensen and Dale Jorgenson into the measurement of TFP growth in the U.S. economy.[4] The data

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[2]The economy-wide TFP figure is based on the U.S. Bureau of Labor Statistics' measure of "multifactor" productivity for the private business sector of the U.S. economy. Bureau of Labor Statistics multifactor productivity measures are reported in the BLS publication, Monthly Labor Review.

[3]Laurits R. Christensen, Dianne C. Christensen, and Philip E. Schoech, "Total Factor Productivity in the Bell System, 1947-1979." Christensen Associates, September 1981.

[4]L.R. Christensen and D.W. Jorgenson, "The Measurement of U.S. Real Capital Input, 1929-1967," Review of Income and Wealth, Series 15, December 1969, pp. 293-320; L.R. Christensen and D.W. Jorgenson, "U.S. Real Product and Real Factor Input, 1929-1967," Review of Income and Wealth, Series 16, March 1970, pp. 19-50; and L.R. Christensen and D.W. Jorgenson, "U.S. Income, Savings and Wealth, 1929-1969," Review of Income and Wealth, Series 19, December 1973, pp. 329-362.