Q. In addition to input price discrepancies, are there any other reasons why a downward adjustment should be made to inflation index in developing a price cap system?

A. Yes. A downward adjustment or offset factor is necessary to reflect the benefits of increasing economies of scale and economies of density, and the benefits of increasing productivity within the telecommunications industry. Productivity is usually described as the ratio of output to a given level of input. Gains (or losses) in productivity are generally measured by the degree to which output is affected by a unit change in a given input (e.g., labor, capital, or other productive resource). Thus, for example, labor productivity is said to be improving if workers take fewer hours to generate the same output.

Although productivity appears to be a relatively straightforward concept, attempts to quantify it reveal a high degree of uncertainty, imprecision, and confusion. Insoluble puzzles can arise over the allocation of productive gains (or losses) to a specific factor or factors, or over how to account for changes in the quality of inputs as well as changes in the quality of outputs. Even simple matters, like how to measure the use of one input relative to others, can pose considerable difficulties. The level of technological innovation is another intractable but important variable. Often, and in almost all popularized accounts, productivity is measured in terms of physical quantities. But this ignores the often important qualitative differences in both inputs and outputs. For instance, if the mix of daytime, night, and weekend traffic is changing over time, how should this be considered in evaluating the volume of output occurring in different time periods? Similarly, should minutes of local and long distance traffic be treated as equivalent? If not, what weighing factor or differential should be used in order to place these two services on comparable terms? How does one evaluate growth in the number of access lines, relative to growth in the volume of calling? What if people are placing shorter calls, or calling longer distances? Are all minutes the same? These trends may result in increased revenues per minute, and they may involve changes in the perceived value of the service being received. Even if these points are granted, it isn't obvious how such qualitative changes should be evaluated when attempting to measure changes in the quantitative relationship between inputs and outputs (changes in productivity).

Productivity changes, in and of themselves, mean little: a context is needed. Time is a popular frame of reference, though open to charges of subjectivity (for example, how meaningful is a comparison of productivity between the time frames 1929-1933 and 1942-1945?). As a rough rule of thumb, the longer the time period over which the measurement occurs, the greater the apparent "smoothness" in productivity change. But a long-term average--e.g., for the period 1929-1989--masks the undulations from particular events such as sharp technological innovation, economic depressions, or periods of high inflation; such averages can thus mask or distort actual changes in productivity within an industry, particularly when current (and prospective) trends are of concern.

An extended family of Cobb-Douglas production functions has been routinely used by economists to estimate the contributions of various inputs to the growth of output. In these and related studies, the growth of output was ascribed to generic capital and labor inputs and productivity growth. Such an approach proved useful in estimating productivity growth over long historical epochs. A major achievement of recent economic research is the integration of the growth of intermediate, capital, and labor inputs and their qualities at the level of individual industrial sectors into the analysis of productivity growth.

This latest research has demonstrated that productivity estimated over long historical spans fails to capture accurately decade to decade rates of change in productivity. In part, this is the case because new technology and its rate of diffusion throughout an industry can cause discrete jumps in productivity. In particular, the kind of innovations characterizing the telecommunications industry would suggest that differences in productivity growth between one shorter period and another would be especially pronounced.

In price cap regulation, an adjustment for productivity changes is needed to ensure that reasonably anticipated increases in LEC productivity are reflected in the price cap index, and thus in end user rates charged by the LECs. Such an adjustment would allow ratepayers to share not only in the long-term benefits of price-cap-induced efficiencies, but in the short-term benefits as well. Ideally, the productivity differential would reflect changes in telecommunications productivity in a manner that simulates the impacts of productivity changes in a competitive industry. However, if the selected productivity measure is inaccurate, it cannot serve these stated purposes. Furthermore, even if a reasonable figure is selected based upon historic data, there is no assurance that future productivity changes will be equivalent to the past. In a competitive industry, if there is a technological breakthrough, or if the total volume of production increases enough to increase economies of scale for the typical firm, most of the benefits will flow to consumers, though possibly after a lag.

With price cap regulation, in contrast, an increase in productivity over the historic trend will tend to result in windfall gains to the carrier, since the price cap will not decline as rapidly as costs are declining, or as rapidly as prices would drop in a competitive market.

Q. What factors influence productivity?

A. Numerous different factors affect a firm's productivity. Some of the most significant, and most interesting, factors include technological improvements; shifts from high to low cost inputs; and increased economies of density and scale.

Q. How do technological improvements affect a firm's productivity?

A. Simply stated, technological advances enable a firm to produce more output per unit of input. In the telecommunications industry, we have seen an explosion of technological improvements as the industry has evolved away from analog technology into digital technology. There have been tremendous improvements in the areas of fiber optic cables, digital multiplexing and transmission systems, operations support computers, digital cross connect systems, digital central office switches, and more. Not only have the prices of these items been declining, as they are increasingly utilized by carriers, their impact becomes more significant. All of these technologies allow the Company to generate more output, (e.g. minutes of use and numbers of access lines in use), per unit of input (e.g. hours of employee time expended).

Q. How is productivity influenced by shifts from one input to another?

A. As certain inputs become cheaper, or increase in price at a slower rate than other inputs, a firm is able to utilize more of the cheaper input, and less of the costly input, while still producing the some level of output. For example, phone companies have been able to gradually reduce their reliance on costly main-frame computers, and increase their use of less costly personal computers and workstations. Furthermore, they have been able to increase their reliance on computers, while reducing their use of costly labor. Unit labor requirements for clerical and related office staff, as well as operators, continue to decline, as computers are increasingly used to perform functions previously handled by employees, or to assist those employees in handling their jobs more quickly and accurately.

Q. You mentioned economies of density and scale. Do you have any evidence that average costs per unit of output decline as a telecommunications network expands?

A. Yes. I have developed economic cost estimates for several typical wire centers to demonstrate this phenomenon. These estimates do not correspond to any specific wire center; rather, they are indicative of the wide variety of different situations a carrier would encounter when building and operating local networks in North Carolina. To avoid submerging the key issues in a sea of different numbers, I will focus on three wire centers with strongly contrasting network characteristics--first, one serving a *rural* area, with a relatively small, widely dispersed population, requiring very long loops; second, one serving a *small town* with moderate density in a compact area, allowing relatively short loops; third, one serving an *urban area* with a dense population and numerous businesses that can easily be served using relatively short loops. In addition, I will present some cost results for an “average” wire center which lies within these contrasting extremes.

To provide an approximate indication of the extent to which costs tend to vary due to heterogenous conditions within the geographic area served by the wire center, our model provides for two zones. Zone 1 is representative of the highest density portions of the overall geographic area, which are assumed to be in the immediate vicinity of the central office or switch. Zone 2 lies beyond this vicinity, covering a much larger area, with greater loop lengths and a lower concentration of customers. Admittedly, this approach simplifies the actual conditions in each wire center, where customers may be scattered and distributed in something of a random pattern. Also, due to rounding and other complications, the cost estimates for individual zones are not as reliable as the overall estimates. Nevertheless, our model does provide some useful insights concerning into the degree to which costs can be expected to vary even within the same wire center serving area, due to the fact that customers are not uniformly dispersed . Customers who are clustered close together (e.g., in a large apartment complex) tend to be less costly to serve than customers who are widely scattered in remote areas far from the wire center.

While the overall results are the most reliable, the disaggregated results for specific zones are worth some consideration, since they provides a more complete picture of the diversity of cost conditions that exist in the state. The overall estimates can actually be viewed as composites--homogenized blends of inherently heterogeneous costs that vary with geographic, demographic, and other conditions. For many purposes, such homogenized overall cost figures for each wire center are entirely adequate. However, it is important to remember that the heterogenous cost differences are real and can be very important to an analyst attempting to predict the pattern of competitive entry, or the effects of alternative price cap systems during the transition to a more competitive market.

For example, if a model exclusively focuses on the composite cost data for wire centers as a whole, it may ignore the data that indicate whether “cream skimming” will occur when new carriers enter the market. In contrast, by looking at differences between the zone 1 and zone 2 cost patterns, our model predicts that in some wire centers most new entrants will be forced to pursue a "cream skimming" approach to their facilities construction and limit the geographic scope of their network to high density areas close to their switch. This problem could be overcome to a degree, if the Commission were to require the incumbent carrier to unbundle its network and provide loop capacity at relatively low wholesale prices, thus encouraging carriers to serve the more isolated customers on a resale basis.

Schedule 6 displays our estimates of how long run costs of a telephone loop network in North Carolina vary as the size of the network expands within a range from 90% of the current level to 130% of its current level. In the long run, total costs increase as the network expands, but the rate of increase is less than proportional to the change in size. As a result, average total costs per loop tend to decline as the network expands. For example, consider a typical rural wire center using an all-copper configuration, as summarized below:

	Total Cost	**Zones 1&2** Average Cost	**Zone 1** Average Cost	**Zone 2** Average Cost
90%	99,423	55.23	33.29	66.04
95%	99,522	52.38	31.58	62.63

100%	99,621	49.81	30.03	59.55
105%	104,393	49.71	29.96	59.44
110%	107,859	49.03	31.57	57.62
115%	107,957	46.94	30.23	55.17
120%	108,056	45.02	29.00	52.92
125%	108,155	43.26	27.87	50.84
130%	108,253	41.64	26.82	48.93

As the network expands, the average cost per loop declines from $55.23 per month to just $41.64 per month. The same basic pattern occurs within both the higher density zone 1 (close to the wire center) and the lower density zone 2 (farther from the wire center).

The rate of decline is not strictly linear, due to lumpiness of the investment needed to serve the network as it expands in the long run. However, the trend is clearly downward. Thus, as the firm expands, it will tend to experience a downward trend in its average cost per loop. As shown on other pages of this schedule, similar, though less dramatic, patterns of decline occur in the small town wire center (page 2), urban wire center (page 3), and average wire center (page 4). Although not shown here, switching costs evidence a somewhat similar pattern of declining costs with increased usage volume. However, the rate of decline is not necessarily as rapid.

The pattern of declining costs shown above and in Schedule 6 is significant, because it demonstrates that the Company is operating in a declining cost industry. Even if its input prices are increasing, its costs may not be increasing, because the uptrend in input costs tends to be offset by the benefits of economies of density and scale, which increase over time, as the total size of the market expands.

Q. Have any studies been performed to measure changes in productivity in the telecommunications industry?

A. Yes. The most extensive studies have been performed for and filed in various federal telecommunications proceedings. Early studies were performed and filed in United States v. AT&T, 552 F. Supp. 131 (D.D.C. 1982). According to the FCC, each of these studies indicated that "the telecommunications industry is a most productive sector of the economy". [In the Matter of Policy and Rules Concerning Rates for Dominant Carriers, Report and order, April 17, 1989, Docket No. 87-313, FCC 89-91, para. 200]. In concluding that its price cap formula for dominant carriers should include a productivity offset adjustment, the FCC cited three studies from United States v. AT&T which measured the productivity of Bell companies in the U.S. The first study found that Bell System productivity from 1947 to 1978 was 2.1% greater than the economy as a whole, and 3.0% greater from 1966 to 1978. [Id.]. Another study concluded that from 1972 to 1978, the differential was 3.9%. [Id.]. The third study cited by the FCC found that from 1947 to 1976, productivity within the Bell System increased annually an average of 4.09%. [Id., para. 201]. Based on these long term studies, the FCC tentatively concluded in 1989 that 2.5% was the best estimate of LEC productivity. The FCC also tentatively concluded that the productivity offset should include a .5% "Consumer Productivity Dividend". [Id., para. 693].

In 1990, the FCC considered, in addition to the previous long term studies, an analysis performed by FCC staff concerning LEC productivity from 1984 and 1989. As mentioned earlier, the FCC concluded that the offset should be increased to either 3.3% or 4.3% depending upon the level of profit sharing an LEC chooses. [In the

Matter of Policy and Rules Concerning Rates for Dominant Carriers, Second Report and Order, September 19, 1989, Docket No. 87-313, FCC 89-91, para. 74].

In 1994, the FCC initiated a docket to review LEC performance under the price cap rules established in 1990. [In re: Price Cap performance Review for Local Exchange Carriers, CC Docket No. 94-1, FCC 95-132.]. In this docket, the FCC considered several recent studies regarding LEC productivity. The first study, known as the "Christensen" study, was performed for United States Telephone Association (USTA). This study concluded that from 1984 to 1992, LEC productivity growth averaged 2.6% per year. [Id., First Report and Order, p. 50]. The second study, performed by National Economic Research Associates, Inc. (NERA), also on behalf of USTA, essentially reaffirmed the Christensen study. However, several parties commenting on the USTA studies, and using USTA data, concluded the productivity offset should be significantly higher than 2.6%, with recommendations ranging from 5.0% to 5.9%. [Id., para. 102].

AT&T submitted its "Direct Model" for estimating LEC productivity, and concluded that LECs achieved an average X-Factor of 5.97% under price caps. After including additional data, AT&T revised its X-Factor to 5.54%. [Id., p.61]. AT&T also performed another study to calculate Regional Bell Operating Company (RBOC) productivity, using the method used by the Commission in the original price cap proceeding. Based on its calculations, AT&T asserted that from 1991 to 1993, RBOCs achieved an annual X-Factor of 6.96%. [Id., p. 62]. Several other parties submitted reports and studies, with X-Factor recommendations ranging from 1.7% to 5.9%. [Id., p. 64].

Based upon these studies and other evidence, the FCC concluded that the previous price cap scheme used X-factors (offsets below overall inflation) that were too low. Upon reconsideration, the FCC set the minimum X-factor at 4.0%. Higher X-factors of 4.7% and 5.3% can be chosen by the LEC, it they want to limit, or eliminate, the extent to which excess profits are shared with customers.

Q. Have other jurisdictions approved price cap plans which include an offset below the general inflation rate?

A. Yes. Numerous states have had occasion to review price cap plans proposed by LECs. A summary of plans approved across the country for RBOCs has been compiled by BellSouth. [Regulatory Reform - A Nationwide Summary, Issue No. 17, BellSouth Telecommunications, June 1995.]. In its summary, BellSouth categorizes price regulation plans into two groups: "Price Adjustment" plans (i.e., price caps), and "Rate Moratorium" plans. BellSouth lists nine states, as of the date of publication, that have approved price cap plans for RBOCs.

The table below lists the states that have approved price cap plans for RBOCs with numeric offsets.

State	Company	Offset
Delaware	Bell Atlantic	3.0%
Illinois	Ameritech	4.3%
Maine	Nynex	4.5%
Massachusetts	Nynex	4.1%
Michigan	Ameritech	1.0%
North Dakota	US West	2.8%
Pennsylvania	Bell Atlantic	2.9%
Wisconsin	Ameritech	3.0%
Average		3.2%

Of the nine plans included in the BellSouth publication, eight use the GDP-PI as an inflation index. Ameritech's plan in Michigan uses the CPI. Also, eight of the nine plans include a fixed percentage offset. Bell Atlantic's plan in Virginia uses one half the change in GDP-PI, similar to Southern Bell's original proposal in this proceeding. The lowest offset, 1.0%, applies to Ameritech in Michigan. The highest offset, 4.5%, applies to Nynex in Maine. The average offset for the eight plans is 3.2%