

\$1.56 billion of price reductions measured by the Commission, the total consumer benefit exceeds \$2.4 billion.⁷⁷ All of this decrease both directly benefited consumers and is a result of competitive forces that cause reduced prices and greater consumer choice.

The magnitude of consumer benefits is underscored when compared to the benefits that have accrued to AT&T in the form of higher earnings. Drs. Schmalensee and Rohlfs found that AT&T's increased return for total interstate services amounted to only one-tenth the value of increased consumers' benefit.⁷⁸ Indeed, if AT&T's increased efficiencies that the Commission attributed to historically expected gains are included -- all of which benefit consumers under price cap regulation by virtue of the 2.5 percent productivity factor (before CPD) -- then the benefit to consumers more than doubles, and exceeds the benefit to AT&T from its own efficiency gains by a factor of

(footnote continued from previous page)

revenues to total interstate revenues; in 1991, switched service revenues (less CL expense) were approximately 70 percent of AT&T's total interstate revenues (less CL expense). See id., pp. 7-8.

⁷⁷ The Schmalensee & Rohlfs Study calculates the total benefits of price caps as \$1.8 billion. Id. p. 16. This figure varies from the above figure of \$2.4 billion because, inter alia, their study analyzed only three years under price caps (rather than the four years of data presented by the Commission) and addressed only switched services.

⁷⁸ See id., pp. 24-26.

more than 20.⁷⁹ Additionally, these relative benefit calculations do not account for other benefits consumers have enjoyed, such as improved service.⁸⁰

This disproportionate share of consumer benefits, as well as the magnitude of benefits attributable to customer migration, confirm that the productivity factor should not be increased. The adoption of price cap regulation purported to require AT&T to exceed historical efficiency gains by .5 percent annually (and cumulatively) before it could profit from its greater efficiencies and service innovations. In fact, the price cap index requires efficiency gains of nearly three times that magnitude -- the CPD plus an amount to overcome the effects of customer migration -- before AT&T could possibly receive increased returns as a result of greater efficiency or innovation.

Any increase in the productivity factor would thus represent a truly enormous departure from the initial purpose and scope of the CPD and price cap index. An increase would be completely inconsistent with the equitable allocation of benefits between consumers and AT&T's

79 Id.

80 Id., pp. 16-17. Consumers have clearly benefited from the improved quality of AT&T's network. During the price cap period, AT&T replaced much of its analog and microwave plant with fiber optic circuits and implemented a new call routing technology. See, e.g., NOI, ¶ 22. As a result, consumers have therefore received not only lower rates but higher quality and more reliable service.

shareholders that the Commission expected price cap regulation to produce. Indeed, the magnitude of increased customer migration indicates that the productivity factor should, if anything, be decreased if the price cap index is to approximate the Commission's initial design and if this proceeding is to account for "unintended and unexpected results."⁸¹

B. AT&T Has Experienced No Substantial Or Persistent Increase In Profitability

Even if it were consistent with price cap regulation for the Commission to examine AT&T's rate of return, that examination yields no basis for adjusting the productivity factor or price cap index. The Commission has stated that "[o]nly if [AT&T's rate of return] deviation from an acceptable level is substantial and persistent should changes be undertaken."⁸² That deviation must also be unexpected.⁸³ Yet, it is clear that AT&T's increased return is neither "substantial," "persistent," nor "unintended."

⁸¹ AT&T Price Cap Order, ¶ 557.

⁸² Further Notice, ¶ 474 (emphasis added); see also AT&T Price Cap Order, ¶ 561.

⁸³ AT&T Price Cap Order, ¶ 557.

The dispositive fact is that AT&T's returns for its Basket 1 services -- the only ones currently scheduled to remain under price cap regulation (see supra, Part I) -- are substantially below appropriate returns under a rate of return regime. The Basket 1 rate of return for the three-year price cap period was approximately 8.1 percent (7.0 percent during 1989/1990, 10.0 percent during 1990/1991, 7.4 percent during 1991/1992).⁸⁴ By no means do these figures show that AT&T's returns have increased substantially in relation to the 12.2 percent rate previously prescribed for AT&T.⁸⁵

Even if AT&T's total interstate return is considered, the increase is not substantial. As the Commission notes, AT&T's interstate return during the price cap period was 13.2 percent (the weighted average of 11.0 percent during 1989, 13.7 percent during 1990, and 13.4 percent during 1991),⁸⁶ compared to its last prescribed

⁸⁴ See Letter from J. Lubin to D. Searcy, Exhibit A (August 14, 1992).

⁸⁵ See Authorized Rate of Return for Interstate Services of AT&T Communications and Exchange Telephone Carriers, Order, CC Docket No. 84-800 (released September 17, 1986).

⁸⁶ See NOI, ¶ 20. Rates of return cannot be compared directly to percentage price changes mandated by the price cap index or otherwise achieved through efficiency gains. Rate base is of course less than total revenues, and thus any given percentage increase in output (in relation to revenue) may yield a greater percentage of return increase. More importantly, efficiency is a function of changes in output with given inputs, which include economic capital costs

return of 12.2 percent. These returns are all within the zone of "reasonableness." This conclusion is particularly clear if "reasonableness" is determined by comparing AT&T's increased return with increased consumer benefits, which exceeded by ten times AT&T's higher earnings.⁸⁷ As one comparison, consumer benefits during the price cap period just from the CPD and below-caps pricing (i.e., without including the benefits of customer migration) exceeded AT&T's entire interstate net earnings for 1989.⁸⁸ By any relevant measure, the consumer benefits dwarf the during the comparatively slight increased returns AT&T has achieved price cap period.

AT&T's interstate returns are even more clearly reasonable when evaluated as the product of price cap regulation rather than rate of return regulation. Under the former, AT&T assumes far greater risk and commensurate potential to increase profitability.⁸⁹ Indeed, all the many

(footnote continued from previous page)

rather than any changes in book capital, as used in the calculation of rates of return. See Schmalensee & Rohlfs Study, p. 13 & App. at 1-2.

87 See Schmalensee & Rohlfs Study, pp. 22-26.

88 AT&T's interstate net earnings for 1989 were approximately \$1.226 billion. See NOI, App. Chart 4. The Commission calculated the consumer benefit from price caps, due to the CPD and below caps pricing, to be \$1.561 billion. See NOI Update, Chart 3.

89 See, e.g., NOI, ¶ 9.

benefits of price cap regulation stem from this potential for increased profitability. A broader zone of reasonable returns is a necessary complement of providing both greater risk and reward, and increased returns demonstrate that the price cap system of incentives is proving successful.

AT&T's rates of return under price cap regulation are not excessive judged by any standard, and certainly not when judged against a more flexible standard that is an inherent aspect of the incentives underlying price cap regulation.

Correspondingly, AT&T's rates of return have hardly been at levels that are "unexpected and unintended" under price cap regulation. The Commission stated at the outset that it "expect[ed] that if AT&T takes advantage of its opportunity to outperform the productivity hurdle, its earnings will exceed those available under rate of return." Price Cap Reconsideration Order, ¶ 111; see also NOI ¶ 9 ("[t]he effect [of price caps] is to simulate incentives similar to those in competitive markets, where higher profits are the reward for greater efficiency and innovation"). This expectation simply reflects an aspect of the incentive structure that underlies price cap regulation, making it impossible to conclude that the slight increases occurring under price cap regulation are of a type or degree that exceed the increases both anticipated and encouraged by the initiation of price cap regulation.

Nor can any showing be made that the modestly higher interstate returns will be "persistent." It is very

possible that AT&T cannot maintain the rate of efficiency gains and service innovations achieved during the period of price cap regulation. Principles of marginal gains suggest that the greatest opportunities existed at the outset. In fact, AT&T did experience the greatest efficiency gains during the first year of price cap regulation, with less significant gains accruing in each subsequent year.⁹⁰ Because AT&T has already achieved the most significant and least costly efficiency gains, further advances will be more difficult to achieve.

Moreover, demand growth for AT&T's services will likely decline from prior levels, making duplication of AT&T's profitability and productivity gains particularly unlikely. Both the continuing recession and a slowing of access charge reductions are expected to contribute to the relative decline in demand growth. Lower demand growth leaves existing capacity under-utilized (compared to higher growth), which, in turn, makes efficiency gains more difficult to achieve.⁹¹

In sum, even if AT&T had experienced significant and unexpected productivity and profitability gains -- which is not the case -- there would be no basis to conclude that those gains would continue.

⁹⁰ See Schmalensee & Rohlfs Study, p. 16.

⁹¹ Id., pp. 17-18.

C. An Increase In The Productivity Factor
Would Recreate The Disincentives of Rate
of Return Regulation

As demonstrated above, AT&T's performance cannot justify the changes considered in Issue Three of the NOI. Rather, they would imply a marked abandonment of the underlying purposes of price cap regulation. Those changes would penalize AT&T for responding to the incentives of price cap regulation and reimpose the efficiency-dampening features of rate of return regulation. This would be flatly inconsistent with the Commission's stated goal in this proceeding not to "recreate disincentives to further productivity gains."⁹²

As the NOI describes, the price cap system for AT&T first ensures that consumers receive lower rates than would have prevailed under continued rate of return regulation.⁹³ With consumers fully protected, "AT&T was given the incentive to achieve even higher productivity growth [than the historical baseline] because the Commission simultaneously removed limits upon . . . profits," in order to "simulate incentives similar to those in competitive markets, where higher profits are the rewards for greater efficiency and innovation, while falling profits are the

⁹² NOI, ¶ 11 (quoting AT&T Price Cap Order).

⁹³ Id., ¶ 7.

penalty for inefficiency or error."⁹⁴ The fundamental point of price cap regulation is thus to create incentives for AT&T to achieve higher efficiency: "[I]f AT&T could achieve productivity growth above the 3 percent productivity factor it would be able to retain the higher profits generated by its improved performance." NOI, ¶ 9. Indeed, the "elimination of the rate of return ceiling on AT&T's profits is essential to the implementation of a price cap regime."⁹⁵

Conversely, any attempt to eliminate or recapture the profits resulting from such higher efficiency would not only breach the promise of price cap regulation, but destroy the incentive to make the difficult decisions necessary to yield additional efficiency gains in the first place. Employing the productivity factor not as a historical baseline, but rather as a ratchet to increase with gains in AT&T's productivity and profitability, would refocus regulation upon the reasonableness of return rather than

⁹⁴ Id., ¶ 9.

⁹⁵ Price Cap Reconsideration Order, ¶ 111 (emphasis added). See also AT&T Price Cap Order, ¶ 88 ("By capping or limiting prices, instead of prescribing profits, incentive regulation enables carriers to generate profits above the current authorized return if they can introduce efficiencies and innovations that reduce their costs from current levels"); Price Cap Reconsideration Order, ¶ 73 (the Commission would not "recapture AT&T's cost savings whenever AT&T develops a way to keep its costs below the PCI" because "the very purpose of price cap regulation is to provide strong incentives for AT&T to become more efficient in the provision of common carrier services").

changes in prices. This, in turn, would reinstitute all of the undesirable effects of rate of return regulation, resurrecting a regime that "does not encourage optimal efficiency" (NOI, ¶ 4), and which results in "distorted incentives . . . and little incentive to introduce new and innovative services."⁹⁶

Nor is there any principled basis to replace or recompute the productivity factor. The existing productivity factor is an integral part of the price cap regime's attention to prices charged consumers rather than the carrier's rate of return. It establishes the long-term, historical baseline of performance that AT&T must meet and best before AT&T may profit from its efficiencies or innovations. Once that baseline has been set, price cap regulation must supplant rate of return regulation to produce the intended benefits of the new regulatory regime. There is certainly no basis to conclude that the Commission underestimated the long-term differential between national productivity rates and AT&T's productivity under rate of return regulation. The studies upon which the Commission's conclusion rests remain as valid today as three years ago, and AT&T's performance under the incentive system of price

⁹⁶ NOI, ¶ 3. Moreover, if the productivity factor were ratcheted up in this fashion, the disincentive to achieve any further increases in either productivity or profitability would itself ensure that such gains would not "persist." See supra, pp. 49-50.

cap regulation in no way suggests that a different historical baseline productivity measure should have been adopted.

D. A "One-Time" Decrease In The Price Cap Index Is Equally Unwarranted

A "one-time" adjustment in the price cap index (NOI, ¶ 33, Issue 3) is no more justified than an increase in the productivity factor. Except for any timing differences, a "one-time" adjustment has the same effect as an increase in the annual productivity factor -- the price cap index is lower by that amount.

For all the reasons that apply to adjustments in the productivity factor, there is no support or basis for such an adjustment to the price cap index. In particular, it would transform the index from a means of ensuring that price cap regulation yields lower rates to consumers than continued rate of return regulation, to a mechanism that effectively reinstates rate of return regulation. A decrease in the price cap index on that basis would obviously reduce the desired incentives and encourage inefficient behavior.

A "one-time" index drop would therefore reintroduce the most egregious aspects of rate of return regulation. At worst, a "one-time" drop would amount to an impermissible attempt to recapture the profits and

productivity gains accrued during the initial period of price cap regulation.⁹⁷ Even if the drop were truly prospective (contrary to the lack of record support for additional productivity increases), it would constitute a significant departure from the original incentive structure of price cap regulation. Both changes raised by Issue 3 of the NOI should be rejected.

IV. ADDITIONAL MONITORING OF AT&T'S NETWORK RELIABILITY AND SERVICE QUALITY IS NOT NECESSARY

The NOI asks whether the Commission should "increase monitoring of AT&T's network reliability and service quality."⁹⁸ Additional monitoring is not necessary. Market forces and AT&T's long-standing commitment to maintaining the highest possible service standards ensure that AT&T's network is constantly upgraded to offer state-of-the-art reliability.

⁹⁷ Cf. New England Tel. & Tel. Co. v. FCC, 826 F.2d 1101 (D.C. Cir. 1987), cert. denied, 490 U.S. 1039 (1989). Any effort to recapture profits in this instance, unlike in New England Telephone, would be clearly unlawful because the Commission has not prescribed a rate of return. In fact, price cap regulation expressly disavows prescribing a rate of return. Similarly, an adjustment based upon recovery of past profits would violate the rule against retroactive ratemaking and the filed rate doctrine. In addition, any one-time change in the price cap level would be unlawful absent an adequate record concerning the impact of the change.

⁹⁸ NOI, ¶ 33, Issue 4.

Price cap regulation has not reduced AT&T's commitment to maintaining the best and most reliable telecommunications network in the world. As the Commission found after "thoroughly investigat[ing]" each of AT&T's well-publicized outages, none "appeared to be directly traceable to price cap regulation"99 In fact, AT&T's efforts to provide the highest levels of reliability and quality have increased since the advent of price cap regulation. Marketplace realities force AT&T continuously to improve the ability of its network to prevent outages and, when an unavoidable outage occurs, to restore service as quickly as possible. Interexchange customers will accept nothing less.

No other global telecommunications company in the world has a quality record comparable to AT&T's. On an average business day, AT&T's network carries approximately 135 million domestic and international calls. On the busiest day in 1991, the AT&T network carried more than 158 million calls with a call completion rate of 99.9999 percent.¹⁰⁰ AT&T is extremely proud of this record. The key point, however, is that the marketplace and customer demands -- not government rules or monitoring -- have driven

⁹⁹ NOI, ¶ 29.

¹⁰⁰ On December 2, 1991 (the Monday after Thanksgiving), AT&T handled a record 157.8 million calls, with all but 211 getting through on the first try.

AT&T to provide higher quality, more reliable (and lower priced) services. New government regulation of service quality and reliability would be unnecessary and counterproductive.

Since 1984, AT&T has invested more than \$18 billion in its network to assure the highest possible quality and reliability. This concrete, financial commitment has not diminished under price cap regulation. AT&T is investing more than \$3 billion in its network in 1992, and is spending an additional \$2 billion for network operations and maintenance.

AT&T has focused intensely on programs specifically designed to improve network quality and reliability. AT&T's current Network Reliability Enhancement Program calls for the expenditure of approximately \$600 million during 1992 and 1993 on reliability projects. These projects include:

- o additions to network alternate routes and fiber loops;
- o improvements in the ability of Digital Cross Connect Frames ("DACs") (i.e., network facility junction points) to detect internal faults and switch circuits to protection slots;
- o improvements in the reliability of the common channel signaling network;
- o improvements resulting in increased intra-office diversity (e.g., moving signaling links that terminate on a common equipment shelf to separate shelves);
- o upgrading power and service alarm systems; and

- o improvements in AT&T's restoration capacity to minimize the customer impact of any facility failure which occurs.¹⁰¹

Despite AT&T's best efforts, there will always remain some risk of service interruptions in the network. To reduce that risk, AT&T constantly implements new measures designed to reduce service threats to its network cables, including transmission line patrols and communications programs. As a result of AT&T's security measures, the number of cable cuts per 1000 route miles of cable dropped by 86 percent between 1978 and 1990.

One of AT&T's principal objectives is to reduce or eliminate the impact on customers of cable breaks or other network problems which may occur. In this regard, AT&T has invested heavily in redundant spare network capacity. AT&T is implementing a Restoration Capacity Initiative which, when completed, will substantially increase AT&T's available spare capacity for service restoration. In particular, AT&T is increasing the stand-by restoration capacity on existing routes to maximize AT&T's ability to produce alternate routes around a failure.

AT&T has also developed new systems designed to identify and activate alternate routes quickly in the event

¹⁰¹ The foregoing list is by no means complete. AT&T has underway several projects specifically designed to improve network quality and reliability. These projects range from employee and management education programs to communication and process improvements.

of an outage. AT&T's Real Time Network Routing system ("RTNR") is a highly successful dynamic non-hierarchical routing system which allows each switch in AT&T's network to know the available unused activated capacity of all other switches on a real time basis.

In conjunction with the RTNR system, AT&T currently is deploying enhancements to its Fast Automatic Restoration system ("FASTAR™"). In the event of an incident, the FASTAR system identifies and activates stand-by facilities kept in reserve for this purpose, allowing the restoration of service over alternative routes on a fully automated, computerized basis.¹⁰² For example, when a fiber cable between Flagstaff, Arizona and Las Vegas, Nevada was cut in July of this year, RTNR and FASTAR restored service and limited the outage to three minutes.

In light of AT&T's ongoing efforts and the marketplace incentives to improve service reliability and quality, additional Commission monitoring is unnecessary. Moreover, the Commission's existing monitoring procedures,

¹⁰² The FASTAR system's objective is to restore most traffic disrupted by a cable cut within minutes. Otherwise, it takes an average of 1-2 hours manually to begin restoration of any DS3 service in the event of a cable cut. Manual restoration of 72 DS3's, for example, may take 3 to 8 hours. With FASTAR, the first DS3 should be restored within 50 to 60 seconds, and 72 DS3's should be restored in 5 to 15 minutes. AT&T has completed the initial phase of its FASTAR implementation program and is now completing enhancements to FASTAR designed to attain these service restoration objectives.

together with the constant informal exchange of information between AT&T and the Commission, ensure that the Commission is apprised of significant AT&T network reliability or quality developments. In Docket 91-273, the Commission recently reexamined its regulation of network reliability matters and imposed additional reporting requirements on AT&T and other interexchange carriers.¹⁰³ Pursuant to the Commission's Docket 91-273 Order, AT&T and other facility-based carriers must report service disruptions due to failures in their networks meeting the reporting requirements of the Commission. Even prior to the Docket 91-273 Order, however, AT&T had a long history of providing data to the Commission concerning matters such as significant outages. As a result of the Docket 91-273 requirements and AT&T's voluntary efforts, no additional monitoring requirements are needed.

In all events, reporting requirements cannot be addressed meaningfully except with respect to requirements applicable to all facilities-based interexchange carriers. Therefore, any new reporting requirements would also have to apply to those carriers, consistent with the Commission's recognition in Docket 91-273 that problems experienced by

¹⁰³ In the Matter of Amendment of Part 63 of the Commission's Rules to Provide for Notification by Common Carriers of Service Disruptions, 7 FCC Rcd. 2010 (1992).

n/era

National Economic Research Associates, Inc.

Consulting Economists

1800 M Street, N.W.
Washington, D.C. 20036
(202) 466-3510
Facsimile (202) 466-3605

**PRODUCTIVITY GAINS RESULTING
FROM INTERSTATE PRICE CAPS
FOR AT&T**

by

Richard Schmalensee

and

Jeffrey H. Rohlfs

September 3, 1992

A Marsh & McLennan Company

White Plains, NY / Washington, DC / Los Angeles / Cambridge, MA / Philadelphia / San Francisco / New York, NY / Ithaca, NY / Seattle / London / Madrid

**PRODUCTIVITY GAINS RESULTING
FROM INTERSTATE PRICE CAPS
FOR AT&T¹**

by

Richard Schmalensee

and

Jeffrey H. Rohlfs²

I. INTRODUCTION

In 1989 the Federal Communications Commission (FCC) decided to regulate AT&T in a new way. It replaced traditional rate-of-return (ROR) regulation with a price-cap mechanism that directly limits AT&T's average prices. The price-cap formula established for the 1989 to 1993 period included automatic adjustments for changes in certain types of expenses, most importantly access costs. Apart from these adjustments, price caps for this period did not depend on changes in AT&T's actual costs. In this case and in general, price caps lack the cost-plus character of traditional ROR regulation. Hence, price caps are widely recognized to provide sharper incentives for efficiency than does traditional regulation.³

We now have three years of experience with interstate price caps. We can therefore develop preliminary estimates of how much benefit has actually been derived from the sharper efficiency incentives. This study develops such estimates by comparing productivity growth before and after the imposition of price-cap regulation. The analysis specifically addresses and controls for nonregulatory developments that affected productivity.

¹ This study was commissioned by AT&T, but the views expressed are solely those of the authors.

² The first author is Director of the Center for Energy and Environmental Policy Research, Gordon Y. Billard Professor of Economics and Management at the Massachusetts Institute of Technology and a Special Consultant to National Economic Research Associates, Inc. (NERA). The second author is Vice President of NERA. The authors gratefully acknowledge diligent research support from Tracey E. Kelly and helpful comments from John Haring and Charles L. Jackson.

³ For example, see Ronald R. Braeutigam and John C. Panzar, "Diversification Incentives Under 'Price-Based' and 'Cost-Based' Regulation," *RAND Journal of Economics*, Vol. 20, No. 3, Autumn 1989, pp. 373-391.

This study also considers *who* benefitted from the efficiency gains. In particular, how much of the gains went to AT&T customers and how much went to AT&T stockholders? This question was actively debated prior to the FCC's decision to adopt price caps. We can now answer the question on the basis of actual, albeit limited, experience.

Conclusions of the study are as follows:

1. During the price-cap period, AT&T reversed the previous upward trend in real noncapital costs (labor, materials, rents and services). AT&T also thoroughly modernized its network, replacing antiquated analog equipment with digital equipment. Overall, we conservatively estimate that price caps yielded \$1.8 billion in cumulative productivity gains over the 1989 to 1991 period. These gains were over and above historical trends.
2. During the price-cap period, customers benefitted by paying lower prices for interexchange services. AT&T benefitted from increased profits. The customer benefits, apart from historical productivity growth, were 10 times the benefit to AT&T. The customer benefits, including historical productivity growth, were over 20 times the benefit to AT&T.

II. FRAMEWORK

A. Approach

We compare AT&T's productivity before price caps (1986 to 1988)⁴ with productivity under price caps (1989 to 1991).⁵ Interstate data for 1984, the year in which the AT&T divestiture was implemented, are unreliable due to divestiture-related data irregularities in that year. Therefore, 1985 is the earliest year that could be included in our statistical analysis. Although price caps were not formally instituted until July 1, 1989, it was clear several months earlier that the FCC would adopt some form of price caps.⁶ Consequently, for some time before price caps went into effect, AT&T knew (and presumably based its planning on the knowledge) that it would retain the benefits of any productivity gains that it made; i.e., it would not be forced to lower rates to pass on such gains to customers. It follows that AT&T's incentives to improve productivity were sharpened several months earlier than the imposition of price caps. We reflect this consideration by including all of 1989 in the price-cap period.

⁴ This period includes productivity gains from 1985 to 1986, from 1986 to 1987, and from 1987 to 1988.

⁵ This period includes productivity gains from 1988 to 1989, from 1989 to 1990, and from 1990 to 1991.

⁶ The inception of price caps for telecommunications actually began 1987 with the FCC's *Notice of Proposed Rulemaking (NPRM)* [*Notice of Proposed Rulemaking, In the Matter of Policy and Rules Concerning Rates for Dominant Carriers*, CC Docket No. 87-313, Federal Communications Commission, Adopted August 4, 1987 and Released August 21, 1987. 2 FCC Rcd 5208 (1987)]. At this time, the FCC examined ROR regulation of AT&T and local exchange carriers (LECs) and tentatively concluded that a better regulatory system would be one that provided incentives to enhance efficiency and passed some of the resulting gains to consumers.

A specific plan for price-cap regulation was set forth in the FCC's *Further Notice of Proposed Rulemaking (FNPRM)* [*Further Notice of Proposed Rulemaking, In the Matter of Policy and Rules Concerning Rates for Dominant Carriers*, CC Docket No. 87-313, Federal Communications Commission, Adopted May 12, 1988 and Released May 23, 1988. 3 FCC Rcd 3195 (1988)].

With the FCC's *Report and Order and Second Further Notice of Proposed Rulemaking (SFNPRM)*, price caps were mandated for AT&T with implementation to be effective July 1, 1989 [*Report and Order and Second Further Notice of Proposed Rulemaking, In the Matter of Policy and Rules Concerning Rates for Dominant Carriers*, CC Docket No. 87-313, Federal Communications Commission, Adopted March 16, 1989 and Released April 17, 1989. 4 FCC Rcd 2873 (1989)].

The actual plan for AT&T largely conformed to the outline developed in the NPRM in 1987. However, the final plan imposed further restrictions (baskets, bands, floors) on AT&T's ability to alter prices of individual services.

An estimate of the difference in cumulative productivity growth between the two time periods was developed using standard economic procedures for measuring productivity growth, described in Section III.

B. Data

AT&T's *Form M Annual Reports* and quarterly access reports were the primary sources of AT&T data. *FDC Reports* from 1984 through 1988 and AT&T Communications *Interstate Rate of Return Reports* from 1989 through 1991 also provided key financial data. AT&T provided additional detail on some data.⁷

Data were extracted and derived for the years 1985 through 1991. In several instances, there was not a single data source that spanned the entire period; so we had to use multiple data sources.⁸ In these cases, every effort was made to keep the data consistent. Where two data sources shared a common year, we used the standard statistical technique of splicing the two series. In the few instances in which source data were unavailable, they were extrapolated from available years' data.⁹

Economic time series data were drawn from Federal Government publications by the Federal Reserve Board, the Department of Commerce, and the Bureau of Labor Statistics. The Federal-State Joint Board staff's *Comprehensive Monitoring Report* provided information on access charges.

⁷ These included data on revenues, access expense, actual versus planned retirements of plant, actual versus recommended depreciation reserves, interstate plant in service, and one-time expenditures.

⁸ Specifically, multiple sources were used to complete interstate series for revenues (including operating, service, duodirectional, unidirectional, and international MTS revenues), expenses and taxes, carrier's carrier charges, operating taxes, and rate base.

⁹ Extrapolation was necessary to complete three data series: the ratio of labor to noncapital costs, adjustments for additional fringe benefits, and interstate depreciation and amortization expense.

III. METHODOLOGY FOR ESTIMATING AT&T'S PRODUCTIVITY GROWTH

A. Measures of Productivity

Growth in total factor productivity (TFP) is the difference between growth in output and growth in input factors. In other words, it is a measure of efficiency of production, represented by a change in the number of units that can be produced with given inputs.¹⁰ If input prices remain constant, productivity growth is equal to minus the percentage change in the per-unit cost of production. To calculate productivity growth, we must distinguish the per-unit cost change resulting from change in productivity from the per-unit cost change resulting from changes in input prices (e.g., a rise in the cost of capital). Reductions in input prices do *not* reflect more efficient operation, but rather, are a change

¹⁰ Productivity analyses are often based on continuous models, which have simpler formulae than discrete models. Another common approach is to use the Törnqvist approximation (for example, see Michael Denny, Melvyn Fuss and Leonard Waverman, "The Measurement and Interpretation of Total Factor Productivity in Regulated Industries, with an Application to Canadian Telecommunications," *Productivity Measurement in Regulated Industries*, Academic Press, Inc., 1981, p. 188). In order to (slightly) improve accuracy, our analysis instead uses an exact discrete model. We formally define growth in TFP as follows:

Let the function $g(Z)$ denote growth of Z .

$$g(Z) = \frac{Z_{t+1} - Z_t}{Z_t}$$

where, Z is any variable and
 t subscripts denote year.

Growth in inputs in year t can be expressed in the usual way as:

$$\sum_j w_j g(X_j)$$

where, X_j = the quantity index (or physical quantity) of input j in year t ; and
 w_j = cost of input j in year t divided by total costs in year t .

Exact growth in TFP, is defined so that:

$$1 + g(Y) = [1 + g(TFP)] [1 + \sum_j w_j g(X_j)]$$

where, Y_t = quantity of output in year t .

It follows that:

$$g(TFP) = \frac{g(Y) - \sum_j w_j g(X_j)}{1 + \sum_j w_j g(X_j)}$$

in cost beyond the control of the firm.¹¹ We control for changes in input prices by using price deflators for the inputs of labor, capital and material costs and by using physical units for access inputs.

We focused on productivity growth in the interstate jurisdiction, since the FCC's price-cap plan applies only to interstate services. We used Division of Revenues cost allocations, where data were available. In some instances, we developed our own attributions of interstate costs.¹² Apart from access prices (which are exogenous in our analysis and do not directly affect our estimate of AT&T's productivity), the formulae for making interstate allocations did not change significantly during the period we analyzed.

B. Output Index

Two measures of outputs are commonly used in productivity analyses: deflated revenues and the physical quantity produced. Deflated revenues use prices as weights for quantities. This is appropriate if, as usual in unregulated industries, prices are reasonable proxies for marginal costs. However, in regulated industries prices often differ substantially from marginal costs. In interstate telecommunications, prices are certainly not reasonable proxies for marginal costs. Some analysts have attempted to deal with this problem by developing independent estimates of marginal costs.¹³ However, we have no data or studies on AT&T's marginal costs and could not adopt this approach.

We therefore used a physical measure of output. The index we used is the growth rate of AT&T's purchases of common line (CL) switched access minutes—originating plus terminating. This measure reflects AT&T's output of interstate switched services. Our analysis focuses entirely on switched services. Any productivity gains associated with nonswitched services are over and above those we estimate.

¹¹ In this regard, we used macroeconomic, rather than firm-specific, indices of input prices. Firm-specific input prices are not exogenous. They are affected by the firm's skill in purchasing and bargaining for inputs.

¹² Total company taxes were multiplied by the ratio of interstate net earnings to total net earnings in order to estimate 1989 through 1991 interstate taxes. Similarly, interstate depreciation and amortization expenses (1989 through 1991) were estimated using total depreciation and amortization expenses and ratios extrapolated from 1985 through 1988 data.

¹³ For example, Perl and Falk used a pooled time-series analysis to estimate marginal costs and productivity growth simultaneously. See Lewis J. Perl and Jonathan Falk, "The Use of Econometric Analysis in Estimating Marginal Cost," National Economic Research Associates, presented at the Bellcore and Bell Canada Industry Forum, San Diego, California, April 6, 1989. See also, R. Crandall and J. Galst, "Productivity Growth in the U.S. Telecommunications Sector: The Impact of the AT&T Divestiture," The Brookings Institution, July 23, 1990, p. 13.