Productivity of the Regional Bell Operating Companies Under Rate-of-Return and Price-Cap Regulation

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(ABSTRACT)

In 1991, the Federal Communications Commission began regulating the tariffed rates of the nation's largest local exchange carriers under a new regulatory scheme: price-cap regulation. Price caps were intended to "remedy" the ills of traditional rate-of-return regulation. They were to provide incentive for the telephone companies to adopt innovative technology, cost-cutting measures and provide telephone services more efficiently. To test the effectiveness of this incentive, this study examined productivity of the regional Bell operating companies (RBOCs) under both rate-of-return regulation and price-cap regulation.

A total factor productivity model was developed and productivity gains were calculated under both regulatory regimes. The assumption of total factor productivity was then relaxed and value-added productivity and labor productivity measures were also examined. The point estimates of productivity gains indicate that price caps *have* led to greater productivity gains. Although productivity gains varied greatly across individual RBOCs, use of total RBOC data indicated that average productivity gain improved 1.3 percent under price caps using the TFP model. Similar improvements under price caps were estimated using the value-added (1.1 percent) and labor productivity measurements (1.3 percent). However, because of the variability of the annual estimates, none of the productivity improvements are statistically significant. In conclusion, calculations of RBOC productivity gains *suggest* that price caps have led to more efficient use of inputs –

labor; materials, rents and services; and capital – in the production of telephone company output. Yet, the statistical evidence is not strong enough to *unequivocally support* the assertion that price cap regulation has led to greater productivity gains.

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Chapter 1

INTRODUCTION

1.1 Regulation and Productivity of Telephone Carriers

In 1991, the Federal Communications Commission began regulating the tariffed rates of the nation's largest local exchange carriers (LECs) under a new regulatory scheme: price-cap regulation. Price caps were intended to remedy the problems of rate-of-return regulation by providing incentives for the telephone companies to adopt innovative technology, cost-cutting measures and provide telephone services more efficiently. Has price-cap regulation lived up to its expectations? This study examines productivity gains of the Regional Bell Operating Companies and tests the presumption that price-cap regulation has led to greater productivity than under rate-of-return regulation.

Measurement of the productivity of local exchange carriers and long distance carriers has been a prevailing issue since the late 1980's when price-cap regulation was first proposed as a replacement for traditional rate-of-return regulation. The Federal Communications Commission (FCC) has regulated the rates of most telephone service providers since the 1934 Communications Act. During its long reign as the largest private telephone company in the world, AT&T (the Bell System) was a vertically integrated powerhouse, providing local service, long-distance service and equipment nationwide. Regulation of its operations by the FCC fostered the inefficient behavior typical of a regulated monopoly. However, since beginnings of competition in the industry in the 1970's and the subsequent breakup the Bell System in 1984, attention has been focused on the efficiency of the incumbent service providers (AT&T, the Bell Operating Companies and the independent telephone companies). The 1996 Telecommunications Act has further opened the doors to competition, and the incumbent service providers increasingly need to behave as viable competitors, making efficient business decisions. Consumers will ultimately benefit through lower rates, better service, and more choices. Accurate measurement of

productivity is essential to effective rate-setting and for efficient decision-making in an unprecedented era of regulated competition.

1.2 Scope of this Study

Productivity of each Regional Bell Operating Companies (see Figure 1-1) is compared between two time periods – under rate-of-return regulation from 1985 to 1990 and under price-cap regulation from 1991 to 1994. Chapter 2 of this study provides a brief summary of the regulation of telephone rates under both rate-of-return and price-cap schemes. In particular, it links the productivity adjustment included in the FCC's price-cap formula to the importance for measurement of productivity gains using a total factor productivity (TFP) method. A specific methodology for measuring telephone company productivity is developed in Chapter 3. Basic productivity theory is reviewed and the productivity model used in this study is defined. Finally, Chapter 4 presents conclusions based upon the resulting calculations. The assumption of total factor productivity is relaxed and value-added productivity and labor productivity measures are also examined.

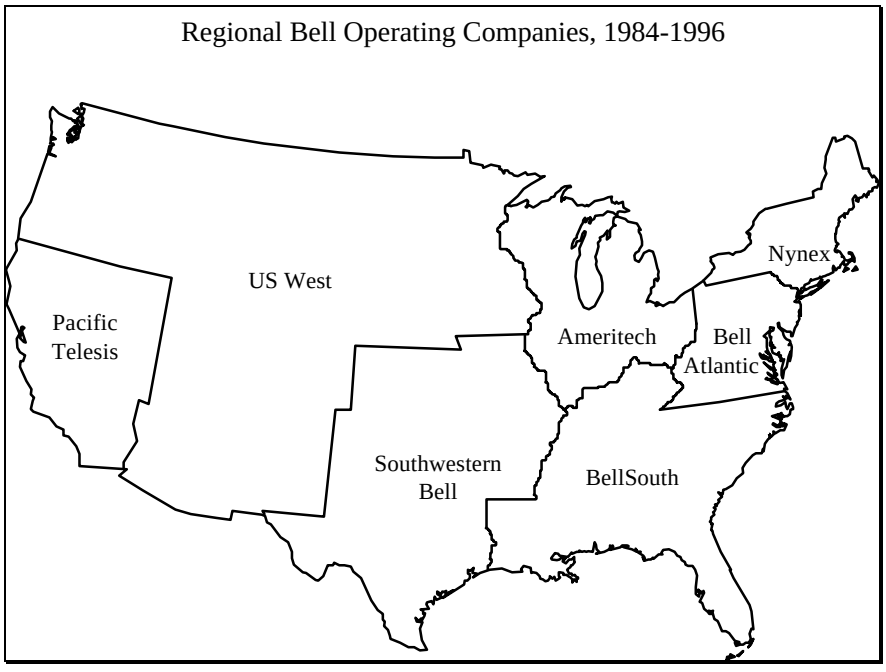

Figure 1-1. Regional Bell Operating Companies

Chapter 2

RATE REGULATION OF LOCAL TELEPHONE SERVICE

2.1 Regulation of Local Service

Rates for telephone service have been regulated by the Federal Communications Commission (FCC) ever since passage of the 1934 Communications Act. While the FCC regulates interstate, interexchange traffic and rates, the 53 state public utility commissions (PUCs)[1] regulate intrastate traffic and rates. Because of their continued monopoly in local service (the switched network being a bottleneck for all local, long-distance and information services), the Bell operating companies remained regulated after divestiture,[2] as did the independent telephone operating companies.

The passage of the Telecommunications Act of 1996 dissolved the legal boundaries between market segments.[3] The LECs may now compete in long-distance, information, equipment, and cable services, provided that certain provisions set forth in the Act have been met. Conversely, the local services market is now open to all who wish to compete. The Act stipulated that incumbent LECs must offer competitive local exchange carriers (CLECs) interconnection to their switched facilities and unbundled network elements at cost-based rates, and service for resale at wholesale rates.

Still, price regulation at the federal and state levels endures despite movement towards a competitive marketplace, in part because of concerns that the potential for abuse of market power remains. Pricing is a viable form of competition in the industry. For example, second-degree price discrimination, where volume discounts are given, are common. State and federal regulators are currently redesigning the regulatory structure of

[1]In addition to the 50 states, the District of Columbia, Puerto Rico and the U.S. Virgin Islands have commissions to regulate utilities.

[2]After being divested from AT&T in 1984 as a result of the 1982 Consent Decree, the twenty-two Bell operating companies (BOCs) under the Bell System were grouped under seven Regional Bell operating companies (RBOCs).

[3]The structural provisions of the 1982 Consent Decree recognized separate markets for local services, long-distance service, information services and the manufacturing of telephone equipment.

telecom pricing and are moving towards partial deregulation. As competition grows, and as the FCC restructures current cross-subsidy and cost allocation policies, the telephone companies will have greater incentives and regulatory flexibility to move towards cost-based pricing. However, as long as the incumbents own the bottleneck facilities, regulators will not allow them to have complete control over the interconnection, unbundled elements and resale rates they set for their competitors.

There has been considerable debate as to the best type of pricing structure and appropriate degree of oversight the regulatory agencies should apply. What boundaries should be imposed on price-discriminating tariffs? The LECs and AT&T have traditionally been subject to rate-of-return (ROR) regulation. But ROR regulation creates problems, particularly in an environment of eroding monopoly power. An alternative form of regulation was suggested in the late 1980's by leading economists to "correct" the problems of ROR: price-cap regulation (price caps). Price caps were implemented on July 1, 1989 to regulate AT&T. The FCC also adopted a mandatory price-cap system for the seven RBOCs and all the GTE telephone companies. The plan, which is optional for the remaining LECs, went into effect on January 1, 1991. Now, in a newly competitive arena, the appropriateness of price-cap regulation is itself under question. A discussion of both regulatory approaches follows.

2.2 Rate-of-Return Regulation

Under rate-of-return (ROR) regulation, AT&T and the LECs earned a fixed return on their investment over and above operating costs. Regulators determined the profits a regulated firm could earn by setting a rate-of-return on its allowable investment base. This rate was determined by estimating what unregulated firms with a similar degree of risk would earn in a competitive market.[4] Revenue requirements were determined using the following formula:

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[4]Harry M. Shooshan, III and Charles Jackson from Philip E. Stoffregen (ed.), "Telecommunications Deregulation: A State-by-State Analysis of Legislation," Presented at the Third Annual Conference on Deregulation and Competition, Washington, DC, September 1988., p. 25.

*Revenue requirements = ((Rate Base) * (Rate of Return)) + Expenses*

The FCC first prescribed the interstate rate-of-return in 1967 and subsequently represcribed the rate four more times by 1984. The rate is occasionally represcribed, primarily for use by the remaining rate-of-return LECs, and reflects the cost of debt, the cost of equity and capital structure for LEC interstate access service.[5] The last represcription was in 1990 and authorized a maximum allowable rate of return of 11.25 percent.

ROR regulation worked effectively in the past providing the needed stability to attract large amounts of capital (*i.e.*, "safe investments") because "firms operated in a monopoly environment and served a growing market."[6] However, ROR regulation may not be suited for the increasingly competitive environment and rapidly changing technology of telecommunications. Since a reduction in operating costs automatically results in reduced prices (and similarly cost increases are met through rate increases), a distinct lack of incentive to reduce costs through product innovation and efficient behavior exists.

2.2.1 Overcapitalization

Haring and Kwerel have noted that under ROR, the regulated firm has incentives to maximize costs and minimize the benefits it provides to the public. Inflated costs may take many forms: such as plush offices, overdesigned equipment, high salaries, a bloated work force, and overcapitalization.[7]

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[5]Federal Communications Commission, Report And Order, In the Matter of Amendment of Parts 65 and 69 of the Commission's Rules to Reform the Interstate Rate of Return Represcription and Enforcement Processes, CC Docket No. 92-133, FCC 95-134, Adopted March 30, 1995 and Released April 6, 1995.

[6]Shooshan and Jackson, p. 25.

[7]John Haring and Evan Kwerel, "Competition Policy in the Post-Equal Access Market," OPP Working Paper Series, Federal Communications Commission, Office of Plans and Policy, Washington, DC, February 1987, p. 8.

The tendency to overinvest in capital, a major criticism of ROR regulation, is known as the Averch-Johnson effect.[8] To lower its actual ROR to meet the prescribed ROR, a firm may either lower its profits or increase its capital rate base or both.[9] By increasing capital, the firm can retain higher absolute profits and still meet the ROR requirements. Regulators have tried to counter this effect by requiring regulated firms to gain approval for investments in new facilities. In practice, this has not worked very well.[10]

2.2.2 Undercapitalization

Ironically, while ROR regulation has been criticized for encouraging overinvestment (the Averch-Johnson effect), it has also been criticized for discouraging investment. This contradiction need not be irreconcilable when making the distinction in different types of investment. Investments in new product or service offerings, the type needed to modernize the telecommunications infrastructure, involve substantial risk because they depend upon uncertain consumer demand. Under ROR regulation, firms may overinvest in "safe" undertakings such as existing facilities. However, ROR regulation provides inadequate incentives to invest in risky, competitive markets.[11]

If an investment in new equipment or services is successful (thereby lowering costs), the firm is limited to only a "fair" rate-of-return; it will not get any extra profits for its investment. If the venture is unsuccessful, the firm stands to lose the entire amount invested since it may not pass on these costs to ratepayers. Thus, an investment needs a big payoff to make the risk worthwhile. This creates an asymmetry between risk and

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[8]Averch and Johnson, "Behavior of the Firm Under Regulatory Constraint," American Economic Review, Vol. 52 (1962), pp. 1053-1069.

[9]Dennis W. Carlton and Jeffrey M. Perloff, Modern Industrial Organization, (Glenview, Ill.: Scott, Foresman and Company, 1990), p. 804.

[10]Haring and Kwerel, p. 8.

[11]Jeffrey H. Rohlfs and Harry M. Shooshan, III, "Will Price Caps Correct Major Economic Flaws in the Current Regulatory Process?" Presented at the Twentieth Annual Williamsburg Conference, December 6, 1988, p. 4.

return: shareholders will not get rewards of profitable investment yet will bear the loss of unsuccessful investment.[12]

2.2.3 The Need for Alternatives

As stated above, ROR regulation creates adverse incentives to shift both costs and profits and a diminishment of incentives for innovation and cost savings because profits are unaffected by efficient economic behavior.[13] Furthermore, the use of historical equipment as a basis for pricing may be misleading because of technological advances. Increasingly, regulated firms will be at a competitive disadvantage since regulated prices will be higher than prices competitors can charge using new technology.

At stake was the telecommunications infrastructure which is vital to consumers' interests to improve competitiveness of the economy and economic development. Regulatory reform was needed at both state and federal levels to give firms incentive to make risky investments needed to modernize the public switched network.[14] The "safe" investments encouraged under ROR regulation by the Averch-Johnson effect will not build an adequate infrastructure.[15] An alternative form of regulation, price caps, may encourage the riskier, innovative investments needed to improve infrastructure and benefit consumers.

2.3 Price-Cap Regulation

In response to the problems created by rate-of-return regulation, the Federal Communications Commission (FCC) implemented a new form of regulation, price-cap regulation. Under price-caps, a ceiling or maximum price is set for different types of telephone services instead of a rate of return. Individual prices are unregulated

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[12]Shooshan and Jackson, p. 26.

[13]Stephen P. Bradley and Jerry A. Hausman (eds.), Future Competition in Telecommunications. (Boston: Harvard Business School Press, 1989), p. 7.

[14]Rohlfs and Shooshan, p. 5.

[15]Shooshan and Jackson, p. 27.

downward, but are capped upward for a set number of years. Carrier services are grouped together in baskets with separate price caps for each basket. The caps are adjusted annually to account for cost changes, expected productivity gains, and other factors.

2.3.1 Implementation of Price Caps

At the federal level, price-cap regulation has been in effect for AT&T since July 1989. In September 1990, the FCC approved a mandatory price cap system for the BOCs and the GTE independent telephone companies. Effective on January 1, 1991, these price caps are optional for the remaining LECs. At the state level, 25 states now use price caps to regulate intrastate telephone rates.[16] On the international arena, British Telecom (the dominant carrier) has operated under price caps in the United Kingdom ever since it was privatized in 1984.

The implementation of price caps for the LECs initially sparked a debate since the LECs were still essentially monopolies. They did not face the competitive pressures that AT&T had and therefore some did not see the need to introduce flexible pricing. However, with the passage of the 1996 Telecommunications Act, local services are now open to competitive market forces. The FCC initially addressed the issue of how it should continue to regulate LEC rates in a new competitive arena in its *Second Further Notice of Proposed Rulemaking* in September 1995.[17] A framework was proposed to eliminate price-cap regulation for those markets or services that are fully competitive.

Another potential effect of the Telecommunications Act on the price cap plan is impending access charge reform. Access to local exchange facilities is sold by the LECs to competitors and long-distance providers under a price-cap system. However, access charges are generally priced above cost to subsidize the universal service program. Both the access charge and universal service funding systems are currently under review as

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[16] State Telephone Regulation Report, Telecom Publishing Group, February 8, 1996.

[17] Federal Communications Commission, Second Further Notice of Proposed Rulemaking, In the Matter of Price Cap Performance Review for Local Exchange Carriers (CC Docket 94-1), FCC 95-393, Adopted September 14, 1995 and Released September 20, 1995.

mandated by the Telecommunications Act. On December 24, 1996, the FCC proposed two schemes to change "the existing access rate structure requirements under Part 69 of the commission's interstate access charge rules and Part 61 of its price cap restrictions."[18] The first scheme relies on market forces to bring interstate access charges down; the second establishes timeframes to change the existing rate structure. Both schemes are intended to foster competition and eliminate the need for price regulation.

2.3.2 Price-Cap Formula

The FCC administers price-cap regulation through a specific price-cap formula. The carriers' services are grouped within separate baskets and each basket is subject to a price cap index (PCI) that is adjusted annually. The basic equation for annual price cap adjustments is equal to the change in input costs less the change in productivity less changes in costs due to exogenous factors.

Price Cap Index = change in input costs - expected productivity changes - exogenous factors

= change in inflation index - X Factor - Z Factor

The use of a deflator in a price cap plan reduces uncertainty for the companies because, as rates are allowed to increase as input costs increase, the riskiness to telephone companies declines.[19] Although rates will rise as a result of this inflation adjustment, consumers get real price reductions as cost-efficient innovation is employed.

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[18]Federal Communications Commission, Third Report And Order, In the Matter of Access Charge Reform (CC Docket No. 96-262); Price Cap Performance Review for Local Exchange Carriers (CC Docket No. 94-1), Adopted December 23, 1996 and Released December 24, 1996.

[19]Economists debated over which is the best deflator to be used as an adjustment for inflation: A significant advantage of a fixed-weighted index (such as the Gross Domestic Product Fixed-Weighted Price Index or GDP-PI) is that it uses the same weights for each time period based on the particular combination of goods and services reflected in the GDP in 1987. By contrast, the weights used in the GDP implicit price deflator change each year. Hence, the GDP-PI avoids any variance due to changes in the composition of GDP from year to year and measures only the change in prices for the given basket. A broad-based GDP index represents price trends throughout the economy rather than just at the wholesale or retail level, unlike the Producer Price Index (PPI) and the Consumer Price Index (CPI). The CPI is more volatile because it will be more affected by shocks to the economy, such as oil price increases. The PPI measures prices of manufactured goods only and is, therefore, inappropriate.

Like inflation-based increases, externally imposed costs are considered when calculating the annual adjustment rate index — through the Z-Factor. For example, a change in corporate taxes, which would almost certainly be a tax increase, would affect the firm's total costs just as a rise in input prices would. If there is no mechanism to make the corresponding adjustment in rates, the telephone company cannot pass on these additional costs and will have less incentive to invest.[20]

2.3.3 The Productivity Offset

The X-Factor, or productivity offset, is an adjustment to the Price Cap Index designed to share productivity gains between ratepayers and shareholders. It represents in large part the amount by which productivity, *i.e.*, input savings relative to the volume of output produced, of the telephone companies has historically exceeded economy-wide productivity. The initial LEC price cap plan allowed LECs to choose either a 3.3 percent or 4.3 productivity offset.[21]

The FCC's *First Report and Order*, adopted on March 30, 1995, revised several aspects of the LEC price cap plan on an interim basis. This Order concluded that the X-Factor should be based on a total factor productivity (TFP) model. Productivity growth is estimated as a residual factor, explaining price changes after all other factors have been

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Although a telephone industry-specific index would be the most accurate measure of input costs, the FCC has declined to develop one. In the FCC's view, the amount of effort needed to create such an index makes this an impractical option. The FCC's original price cap plan used the Gross National Product Fixed Weighted Price Index (GNP-PI). But the Bureau of Economic Analysis of the Department of Commerce later replaced the GNP-PI with the GDP-PI. In 1996, the price cap deflator changed again – this time to the newly published Gross Domestic Product Chained-Type Price Index (GDP-CPI).

[20]Some assert that a corporate tax would be double-counted: directly through the exogenous factor adjustment and indirectly through inflation adjustment. This assertion, however, rests on the faulty assumption that exogenous changes, which are not limited to the LECs, are passed on to the inflation index. In fact, the effect of these taxes on inflation depends on how the additional revenues are spent. If government expenditures remain the same, the effect of this tax may be somewhat deflationary. If the government spends the additional tax revenue, an inflationary effect may occur, but not in the symmetrical way that has been alleged. Furthermore, if the exogenous factors are specific to the telephone industry, there is no reason to assume that the measure of inflation will be affected.

[21]Recognizing that the 3.3 productivity offset might not accurately measure productivity for all LECs, the FCC included a sharing mechanism. It allowed LECs to retain all of its interstate earnings up to 1 percent above the 11.25 percent earnings threshold (i.e., 12.25 percent).[21] The LEC would then share half of its earnings between 12.25 and 16.25 percent and all of its earnings above 16.25 percent with customers. LECs choosing the more aggressive 4.3 productivity offset were subject to a similar, but higher, sharing mechanism.

considered. The Order also adopted an interim plan for access rates which allowed LECs to choose among three X-Factors.[22]

It is important to note that the implementation of price caps is not deregulation; rather it is introducing pricing flexibility. Thus, a utility has both greater flexibility in setting prices and incentives to reduce costs. As long as prices stay below the cap, companies can raise or lower rates as it chooses to meet market conditions. And, if operating costs can be reduced, companies realize greater profits.

[22]Federal Communications Commission, Report and Order, In the Matter of Price Cap Regulation of Local Exchange Carriers; Rate-of-Return Sharing and Lower Formula Adjustment, CC Docket No. 93-179, FCC 95-133, Adopted March 30, 1995 and Released April 14, 1995.

C h a p t e r 3

A MODEL OF RBOC PRODUCTIVITY

3.1 Definitions and Concepts

Productivity theory is a measure of economic efficiency and is derived from the concept of the production function. Output is defined as goods and services; inputs may include labor; materials, rents and services; and capital costs. By relating the level of outputs to the level of inputs, and by measuring the change of this ratio over time, productivity economics enables a quantitative measurement of the efficiency of use of resources.

The concept of productivity is quite simple. An output index is created by measuring outputs and weighting them according to some logical method such as their respective unit prices or marginal costs in a base year. Similarly, all inputs associated with the production of the outputs are measured and weighted by some means such as their respective contribution towards total nominal input cost. A productivity index is then created using the ratio of the output and input indices. The distinction between the *level* of the ratio of output to inputs and the *change* in the ratio (*i.e.*, productivity versus productivity gain) is important; productivity gain is the meaningful measure. Changes in the productivity index represent changes in productivity, *i.e.*, changes in the efficiency of the inputs. The productivity growth is, thus, a residual and can be attributed to the effects of many factors including technological change, modernization, scale economies, and improved use of existing resources. This "residual method" of productivity measurement is used by FCC in its price cap calculations.

Although the concept is simple, in practice, the calculations of the individual components of the productivity equation vary greatly among studies. Furthermore, Callan suggests that multifactor productivity growth estimates are sensitive to the various structural and behavioral assumptions. He examined three alternative measurements of the electric utility and found that "residual" approach "produces estimates that suggest a substantial decline

in firm-level productivity growth after the mid-1960s." He found, after rejecting the structural assumption of constant returns to scale, that long-run scale-adjusted productivity measurements were consistently less than estimates using the residual approach. When he took his analysis one step further and rejected the behavioral assumption of long-run equilibrium, he found significant differences between the long-run and short-run scale-adjusted estimates.[23]

Total Factor Productivity (TFP) includes all factor inputs in the production function: labor; capital; and materials, rents and services. TFP became popular after the energy crises of the 1970's – the failure to include rising energy costs into the input equation led to grossly overstated productivity estimates. Denny, Fuss and Waverman explain the residual in TFP studies is the growth in outputs not explained by the growth in inputs.[24]

The two most probable reasons for productivity improvements are the presence of economies of scale and technological changes. The industry has a downward-sloping average cost function (*i.e.*, average cost per unit declines as output increases) and scale economies are movements along the cost curve. The cost savings related to output growth in the presence of economies of scale are related to capacity utilization, economies of density, and economies of scope. Yet, economies of scale will no longer be applicable since competitors can now lease the switched network under provisions of the 1996 Telecommunications Act. "If there are increasing returns to scale, part of the growth of TFP will reflect the change in the scale of operations, while the remainder can be ascribed to a shift in the production frontier itself. If there were constant returns to scale, the

[23]Scott J. Callan, "The Sensitivity of Productivity Growth Measures to Alternative Structural and Behavioral Assumptions: An Application to Electric Utilities, 1951-1984," Journal of Business and Economic Statistics, Vol. 9, No. 2, April 1991.

[24]Michael Denny, Melvyn Fuss and Leonard Waverman, "The Measurement and Interpretation of Total Factor Productivity in Regulated Industries, with an Application to Canadian Telecommunications," Chapter 8 in T. Cowing and R. Stevenson, (eds.), Productivity Measurement in Regulated Industries, (New York: Academic Press, 1981).

change in TFP would be identical to the technological shift…"[25] Technological changes are downward shifts of the cost curve. The savings attributable to technological change depend upon how fast the technologies are introduced and how much cost savings they can generate.

3.2 Total Factor Productivity Model

This study first uses the three traditional inputs to the production function: labor, capital, and materials. This is the most commonly found version of TFP in the literature. It is the most useful for analyzing individual companies. However, it is not comparable to productivity measures on national accounts since that would involve double-counting of inter-industry or inter-company purchases and sales of materials.

Measurement of the inputs and outputs depended largely upon the available data. The beginning year of this study was 1985. Before 1984, data were aggregated as Bell System data. After divestiture, data became available for each of the Bell operating companies. (See Table 3-1.) Eleven years of data were collected through 1994, the last year for which complete data were available. Data for the 22 BOCs were aggregated to the RBOC level because of reporting changes in recent years. Southern Bell and South Central Bell, and Mountain States Bell, Northwestern Bell, and Pacific Northwest Bell no longer report individually to the FCC; instead data are consolidated under Bell South and U.S. West.[26]

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[25]M. Ishaq Nadiri and Mark A. Schankerman, "The Structure of Production, Technological Change, and the Rate of Growth of Total Factor Productivity in the U.S. Bell System," Chapter 9 in T.Cowing and R. Stevenson (eds.), Productivity Measurement in Regulated Industries (New York: Academic Press, 1981), p. 235.

[26]The industry is currently in the process of horizontal integration. In April 1997, Pacific Telesis and Southwestern Bell merged, thus reducing the number of RBOCs to six. At this time, Bell Atlantic and Nynex have already merged their cellular operations and have applied for permission to merge their local services operations which will further reduce the number of RBOCs to five. (During the timeframe of this study, the RBOCs were organized under seven distinct business entities.).

Table 3-1. RBOCs and BOCs

Regional Bell Operating Companies	Bell Operating Companies As Reported to the FCC— 1984
Nynex	New England Telephone New York Telephone
Bell Atlantic	C&P C&P of Maryland C&P of Virginia C&P of West Virginia Diamond State Telephone New Jersey Bell Bell of Pennsylvania
Bell South	Southern Bell South Central Bell
Southwestern Bell	Southwestern Bell
U.S. West	Mountain States Bell Northwestern Bell Pacific Northwest Bell
Pacific Telesis	Pacific Bell Nevada Bell
Ameritech	Illinois Bell Indiana Bell Michigan Bell Ohio Bell Wisconsin Telephone

Thus, nine years of productivity growth, the percentage change in productivity from the previous year, were calculated for each of the seven RBOCs: from 1985 to 1986, from 1986 to 1987, etc. Five years of productivity growth are calculated under rate-of-return regulation. Price-cap regulation was in effect during the last four years of the study.

Most of the data were taken from the FCC's *Statistics of Communications Common Carriers*, a compilation of data from the Form M reports and ARMIS reports filed annually at the FCC by the individual telephone companies. Additional sources were used, as noted. Since inputs are denoted by accounting data, they are deflated using appropriate price indices. This eliminates the effects due changes in input prices, thus isolating the changes in input quantities.

3.2.1 Output

Quantities used in productivity studies may be measured in either physical terms or "real" monetary terms. Changes in monetary measures, given that they have been adjusted for price changes, approximate changes in physical units. However, unlike the Bell System Productivity Study and other studies, deflated revenues were not used because good output price indices were not available.[27]

Output, or quantity produced, is instead measured by two key statistics: 1) the number of switched access lines and, 2) usage (the number of minutes of traffic). These are only two of several items that define output of telephone companies. However, these are commonly considered the two primary outputs of telephone companies. This approach was also used by Rohlfs in 1991.[28] Switched access line data were taken from the FCC's *Statistics of Communications Common Carriers*.[29] The year-end figures are averaged, in this study, to estimate the number of switched access lines during the year. Usage in this study is measured by Total Dial Equipment Minutes (DEMs) which reflect local, state toll, and interstate calls. Since DEMs are measured as calls enter and leave telephone switches, two DEMs are counted for every conversation minute. Therefore, total DEMs are divided by two to estimate the number of total conversation minutes. Total Dial Equipment Minutes were taken from the Federal-State Joint Board's *Monitoring Report*.[30]

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[27]Crandall and Galst used aggregate data on telephone prices in their study thus assuming the prices of all telephone companies were equal. (See Robert W. Crandall and Jonathan Galst, "Productivity Growth in the U.S. Telecommunications Sector: The Impact of the AT&T Divestiture," The Brookings Institution, November 1990.) NERA rejected this assumption stating that the use of aggregate prices was inappropriate for analyzing differences between companies. (See Jeffrey H. Rohlfs, "Differences in Productivity Gains Among Telephone Companies," A Study Prepared for Centel, National Economic Research Associates, Inc., Washington, DC, September 3, 1991, p 13.)

[28]Rohlfs, p. 14.

[29]Federal Communications Commission, Statistics of Communications Common Carriers, Table 14, "Statistics of Telephone Carriers Reporting Annually to the Commission, as of December 31, 19[- -] and for the Year Then Ended," 1984-1987.

Federal Communications Commission, Statistics of Communications Common Carriers, Table 2.10, "Operating Statistics of Telephone Companies Reporting Annually to the Commission as of December 31, 19[- -]," 1988-1994.

[30]Federal State-Joint Board, Monitoring Report, Table 4.18, "Total Dial Equipment Minutes by Study Area (in millions)," May 1993.

To create an output index, marginal costs are used to weight the access and usage portions of the output in this model. Alternatively, they could be weighted by revenue share but it is inappropriate to assume that prices are proportional to marginal costs in a regulated industry.

*Output Index = (no. of lines * marginal cost per line)*
*+ (no. of minutes * marginal cost per minute)*

Rohlfs used Lewis Perl and Jonathan Falk's estimates of marginal costs to weight the outputs.[31] Typically, engineering models have been used to estimate marginal costs in telecommunications.[32] In these engineering models, components of equipment use are modeled to meet specific demand requirements. Small changes in these demands are introduced and the effect on equipment requirements and its capital and operating costs are measured. Perl and Falk, on the other hand, suggest a supplemental approach that estimates the cost functions from which marginal costs are derived — they used observed, pooled, cross-sectional, time series data on costs incurred and outputs produced.[33] Using this method, they estimated the marginal cost per access line to be $300 and the marginal cost per minute of use to be $.01. These estimates are used again in this study.

Federal State-Joint Board, Monitoring Report, Table 4.18, "Total Dial Equipment Minutes by Study Area (in thousands)," May 1996.

[31]Rohlfs, pp. 14-15.

Lewis J. Perl, and Jonathan Falk, The Use of Econometric Analysis in Estimating Marginal Cost, Presented at Bellcore and Bell Canada Industry Forum, San Diego, CA, (National Economic Research Associates: April 6, 1989).

[32]Bridger Mitchell used this approach to estimate the marginal capital costs for loops and switches. See Bridger M. Mitchell, "Incremental Cost of Telephone Access and Local Use," R-3909-ICTF, Prepared for the Incremental Cost Task Force, (The RAND Corporation, July 1990).

[33]Perl and Falk conclude that outputs (access lines, local and total usage) are "too collinear to obtain reliable estimates of marginal costs for each using time series data" alone. (Perl and Falk, p. 3.)

3.2.2 Labor Expenses

Labor expenses are taken total from annual reports filed by the companies at the FCC.[34] Nominal labor expenses were deflated using a telecommunications-specific labor cost index: the Employment Cost Index for Compensation in Transportation and Public Utilities.[35]

3.2.3 Materials Expenses

The Materials, Rents & Services (MRS) input is calculated as a residual; labor expenses and depreciation and amortization expenses are subtracted from total operating expenses.[36] Total operating expenses do not include taxes so no adjustment for taxes is needed.

> *MRS = Total Operating Expenses - Total Compensation - Depreciation & Amortization Expense.*

Nominal total operating expenses and nominal depreciation and amortization expenses were taken from the FCC's *Statistics of Communications Common Carriers*.[37] Nominal

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[34]Labor compensation data taken from:

Federal Communications Commission, Statistics of Communications Common Carriers, Table 14, "Statistics of Telephone Companies Reporting Annually to the Commission as of December 31, 19[--] and for the Year Then Ended," 1984.

Company annual "Form M" reports filed at the FCC, 1986 and 1987.

1985 labor compensation was estimated by averaging 1984 and 1986 labor compensation for each of the twenty-two companies.

Federal Communications Commission, Statistics of Communications Common Carriers, Table 2.9, "Statistics of Telephone Companies Reporting Annually to the Commission as of December 31, 19[--] and for the Year Then Ended," 1988-1994.

[35]"Employment Cost Index, Compensation, for Transportation and Public Utilities, Not Seasonally Adjusted," U.S. Dept. of Labor, Bureau of Labor Statistics, Series ID: ecu12502I. Average of quarterly data.

[36]Nominal labor and MRS expenses are consistent with the methodology used by Rohlfs. (See Rohlfs, pp. 16-17.)

[37]Data titled "Total Operating Expenses" and "Total Depreciation and Amortization Expense" taken from:

Table 14, "Statistics of Telephone Companies Reporting Annually to the Commission as of December 31, 19[--] and for the Year Then Ended," 1984-1987.

labor expenses, which were also used to calculate materials expenses, were found as previously discussed. In 1995, the Bureau of Economic Analysis replaced the Gross Domestic Product Fixed-Weighted Price Index with the Chain-Type Price Index for Gross Domestic Product (GDP-CPI). In response, the FCC recently recommended use of the GDP-CPI in the price cap formula.[38] This study follows the FCC recommendation and the remaining MRS component is then deflated by the GDP-CPI.[39]

3.2.4 Capital Costs

The capital investment needed to produce access and usage includes local loops, switching equipment, and interoffice equipment.[40] The Capital Costs component represents the annual cost of committing this capital investment or stock (all assets and equipment) to production of the annual output.

Capital stock for each year was calculated as the prior year's capital stock[41] plus new investment minus depreciation expense. Capital Stock is defined as:

$$K_{t+1} = K_t + N_{t+1} - D_{t+1}$$

where, K=capital stock, N=new investment, and D=depreciation and amortization expense.

New investment equals the change in plant in service plus retirements. Retirements are estimated as depreciation & amortization expense less annual change in cumulative depreciation and amortization.

Table 2.10, "Operating Statistics of Telephone Companies Reporting Annually to the Commission as of December 31, 19[--] and for the Year Then Ended," 1988-1994.

[38]Federal Communications Commission, Order and Notice of Proposed Rulemaking, In the Implementation of the Telecommunications Act of 1996, CC Docket No. 96-193, Adopted September 4, 1996 and Released September 12, 1996.

[39]Gross Domestic Product Chain-Type Price Index (GDP-CPI): Economic Report of the President, February 1996, Table B-4, "Quantity and Price Indexes for Gross Domestic Product, and Percent Changes, 1959-95," p. 286.

[40]Perl and Falk, pp. 5-6.

[41]K_t for the base year calculation (where K_{t+1} is capital stock in 1985) is assumed to be net telephone plant in 1984.

$$N_{t+1} = (G_{t+1} - G_t) + D_{t+1} - (A_{t+1} - A_t)$$

where, G=gross plant, D=depreciation and amortization expense, and A= accumulated depreciation and amortization.

Substituting this into the previous equation:

$$\begin{aligned} K_{t+1} &= K_t + (G_{t+1} - G_t) + D_{t+1} - (A_{t+1} - A_t) - D_{t+1} \\ &= K_t + (G_{t+1} - G_t) - (A_{t+1} - A_t) \end{aligned}$$

Thus, capital stock is net of accruals, retirements, investment, and salvage. Capital stock is then multiplied by an annualizing factor, that represents the service price of capital, to calculate annual nominal capital costs. This annualizing factor includes the predicted depreciation rate and the FCC's estimate of the LECs' cost of capital [42] Nominal capital costs is then deflated by its price (measured by the producer price index) to get an estimate of real capital costs.

Therefore, the necessary data to calculate capital costs are 1) net plant in 1984, 2) gross plant from 1984 through 1994, 3) accumulated depreciation and amortization from 1984 through 1994, and 4) a telecommunications-specific producer price index for 1985 through 1994. Gross plant, net plant, and accumulated depreciation and amortization were taken from the *Statistics of Communications Common Carriers*.[43] Capital costs

[42]This cost of capital (11.25 percent) corresponds to the rate of return on capital for LECs authorized in the FCC's 1990 Represcription Order. This rate is based on ARMIS data filed by the RBOCs and other LECs with revenues of $100 million or more. It includes three components: the cost of debt, the cost of equity, the cost of preferred stock and the proportion of each in the capital structure. In 1995, the FCC found that "the rate of return prescribed in September 1990 continues to be adequate to attract investment funds in the current capital markets but does not appear likely to yield unreasonably high profits… ." (*See* Federal Communications Commission, Report And Order, In the Matter of Amendment of Parts 65 and 69 of the Commission's Rules to Reform the Interstate Rate of Return Represcription and Enforcement Processes, CC Docket No. 92-133, FCC 95-134, Adopted March 30, 1995 and Released April 6, 1995.)

[43]Data titled "Total Plant," "Net Plant," and "Total Depreciation and Amortization" taken from:

Table 14, "Statistics of Telephone Companies Reporting Annually to the Commission as of December 31, 19[--] and for the Year Then Ended," 1984-1987.

Table 2.10, "Operating Statistics of Telephone Companies Reporting Annually to the Commission as of December 31, 19[--] and for the Year Then Ended," 1988-1994.

were deflated to base-year dollars using a telephone-specific PPI; the Producer Price Index for Telephone and Telegraph Apparatus.[44]

3.2.5 TFP Index

Total Factor Productivity was first calculated for each of the seven RBOCs. TFP was also calculated using aggregated RBOC data. An index was created for inputs; each input was weighted by its contribution to the total economic cost (*i.e.*, its share of total nominal costs). As described previously, the output index was constructed by weighting each output by its marginal cost. Growth in TFP was defined as:

$$\Delta TFP = (\Delta Output\ Index - \Delta Input\ Index) \div (1 + \Delta Input\ Index)$$

Finally, the average productivity growth for each time period was calculated using the geometric mean.

[44] "Producer Price Index for Telephone and Telegraph Apparatus, Not Seasonally Adjusted," U.S. Dept. of Labor, Bureau of Labor Statistics, Series ID: pcu3661#. Average of monthly data.

C h a p t e r 4

PRICE-CAP REGULATION AND RBOC PRODUCTIVITY GAINS

4.1 Have Price Cap Incentives Encouraged Efficient Economic Behavior?

Has price-cap regulation lived up to its expectations? This study addresses this question by examining the differences in productivity, first using a TFP model, under ROR regulation and price-cap regulation. Price caps were implemented to correct specific problems with rate-of-return regulation. Several leading economists supported price cap regulation:

> *Braeutigam and Panzar: "As an alternative to rate-of-return regulation, price-cap regulation offers significant potential advantages. ... it can induce the firm to minimize costs, produce efficiently in noncore markets, undertake cost-reducing innovation as an unregulated firm would, and diversify into a noncore market if and only if diversification is efficient. Incentives to misreport cost allocations and choose an inefficient technology simply disappear, since cost allocation is not required under this regulatory scheme."* [45]
>
> *Mathios and Rogers: "The major advantage of the price cap approach is that it encourages the utility to reduce its costs and to innovate in its production technology and service offerings by creating a greater profit incentive than exists under traditional regulation. Under rate-of-return regulation, prices are set so that the utility is assured of a specific return on its investment after recouping its operating costs. Since its rates are reduced in step with decreases with costs, the utility may have relatively*

[45]Ronald R. Braeutigam, and John C. Panzar, "Diversification Incentives Under 'Price-Based' and 'Cost-Based' Regulation," The RAND Journal of Economics 20 (Autumn 1989): 390.

> *little incentive to minimize its costs or engage in innovative behavior. ... Under the price-cap approach, however, the utility would be able to profit to a greater extent from cost-reducing innovations, since its rates would not automatically be adjusted downward. This incentive to innovate follows whether the utility operates in a competitive or less than competitive environment. In addition, a price cap regulatory framework may reduce the administrative and compliance costs of regulation."* [46]

> *Johnson: "This approach [price-caps] is appealing because it would (1) sever the regulatory connection between prices and costs, rewarding the firm with whatever cost savings it achieves through improved efficiency, (2) sever the connection between profits and rate base, thereby eliminating the incentive to use excessive amounts of capital, (3) impose price ceilings on monopoly services to restrict the firm's ability to finance predatory undertakings in competitive markets, and (4) impose a smaller administrative burden."* [47]

A policy focusing on price rather than rate-of-return might encourage new investments and still protect against monopoly abuses. Firms would assume risk from investments (additional costs could not be recovered from ratepayers) but retain additional profits until the plan for price regulation is renegotiated. At time of renegotiation, regulators could insist that productivity gains from investments be passed on to customers, in the form of lower rates, if they believe profits are excessive. Usually, competition forces firms to pass additional profits from gains in productivity to the consumer. Under price caps, these gains are passed onto customers during price plan renegotiations. Consumers get lower real rates and better infrastructure. Since price caps are renegotiated periodically, firms

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[46]A.D. Mathios and R.P. Rogers, "The Impact of Alternative Forms of State Regulation of AT&T on Direct Dial Long Distance Telephone Rates," Federal Trade Commission, Working Paper Series No. 159, December 1987, pp. 4-5. (Also published in The RAND Journal of Economics 20 (Autumn 1989): 437-53.)

[47]Leland L. Johnson, "Price Caps in Telecommunications Regulatory Reform," Prepared for the John and Mary R. Markle Foundation (The RAND Corporation, January, 1989), p. v.

have incentive not to earn excessive profits.[48] Furthermore, longer regulatory lag translates into a longer time for firms and its shareholders to reap benefits of higher profits.[49] Under ROR, performance was reviewed annually. Although the price cap index is adjusted annually, price-cap renegotiations, during which the productivity offset is determined, are set for a term of four years.

4.2 Total Factor Productivity

Using the TFP methodology described in the previous chapter, productivity gains were calculated for each individual RBOC. (See Figure 4-1 and Appendix A.) Average productivity gains were greater under price caps for five RBOCs: Ameritech, Bell Atlantic, Bell South, Southwestern Bell, and U.S. West.[50] Bell Atlantic's average gain improved by 2.8 percent; Bell South's average gain improved by 3.3 percent. Four RBOCs had average gains under price caps ranging from 2.4 percent and 3.6 percent. These gains are consistent with the FCC's expectations of 3.3 percent. Productivity dropped under price caps for two RBOCs: Pacific Telesis and Nynex. Even though Pacific Telesis' productivity declined between the two periods, its productivity gain under price caps was a commendable 3.2 percent. Nynex had productivity *losses* under both regulatory regimes; the greater loss was under price caps. Annual gains for Nynex varied greatly, from a high of 9 percent in 1992 to a low of -12 percent in 1994, yielding a standard deviation 8.9 percent under price caps. Examination of the underlying Nynex data reveals that the 12 percent productivity loss in 1994 is partly due to a large gain in real MRS expenses of 48 percent (offsetting a large cut in real labor costs of 19 percent). The other six RBOCs also demonstrated wide dispersions in their annual productivity gains. For example, U.S. West had a standard deviation of 6.8 percent under ROR and

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[48]Shooshan and Jackson, p. 27.

[49]If regulators are slower to react, regulated firms have a longer period to earn increased profits. This provides incentive to cut costs. (Carlton and Perloff, p. 801)

[50]Average productivity gains were calculated as the geometric means of annual gains within each time period. See Appendix A for the annual productivity gains for each company and the total RBOC data set.

8.8 percent under price caps. Similarly, the productivity gains within a year varied greatly among RBOCs.

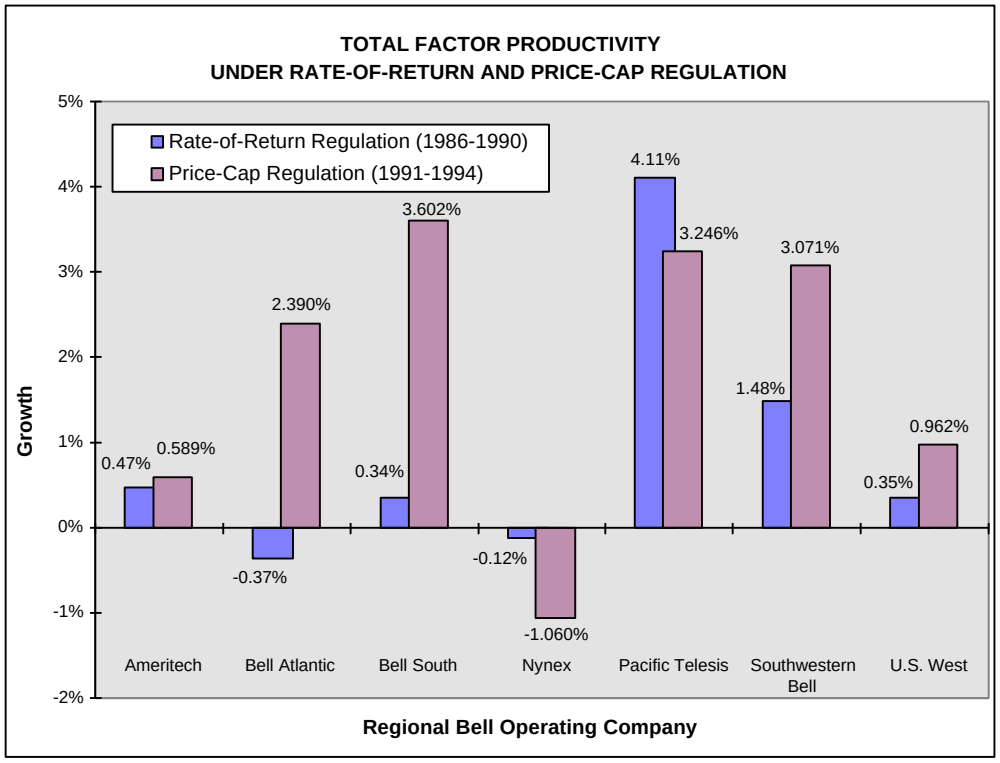

Figure 4-1. Total Factor Productivity by RBOC

Firm-specific measurements, such as those discussed above, may provide the most in-depth and accurate understanding of productivity performance. Nevertheless, as Kiss acknowledges, there are arguments against the use of the firm's own TFP measurement in a price cap formula. He notes that use of the firm's own TFP measurements is not incentive-compatible because the input and output data can be manipulated by the regulated firm. Furthermore, it is difficult to disaggregate many factor inputs that are jointly used by both regulated and unregulated services.[51] Regulators would be dependent upon the companies' method of disaggregation. (This study avoids this problem by

[51]Ferenc Kiss, "Productivity and Price Cap Regulation," Presented at the International Telecommunications Society Seventh International Conference, Massachusetts Institute of Technology, Cambridge, MA, June 29 - July 2, 1988, (Bell Communications Research, 1988), p 10.

focusing on total company productivity. Kiss observes, however, that an "all-service TFP" would systematically lead to overestimates if unregulated services grew faster and were subject to higher rates of technological change than regulated services.) Accordingly, TFP was also calculated using total RBOC data. (See Figure 4-2.)

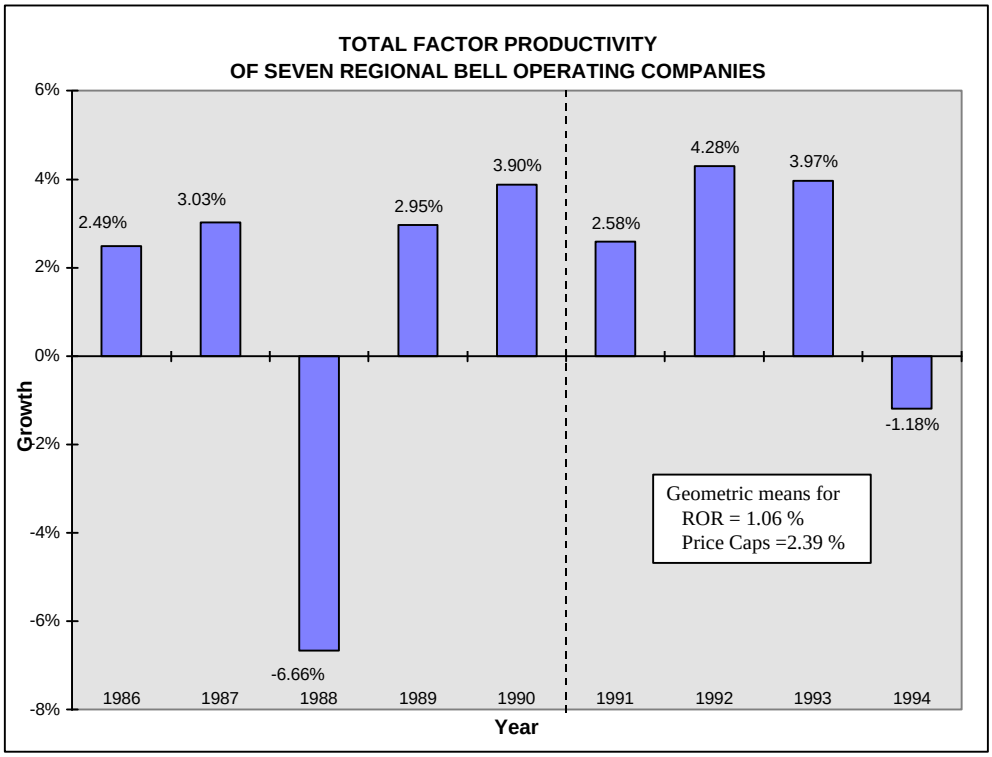

Figure 4-2. Total RBOC TFP Gains by Year

Use of an industry-wide TFP measure implies an accuracy that is dependent upon the variation of TFP gains among individual carriers. Kiss noted that annual productivity gains vary greatly among telephone carriers. Because of large deviations from any average value, "the result of any kind of industry-wide measure would be a quick succession of large windfall profits and losses" for individual firms.[52] This findings in this study support his assertion (as illustrated in Figure 4-1). When data for the RBOCs were consolidated and productivity was calculated on a total RBOC-basis, the variance across

[52]Kiss, p. 12.

individual RBOCs was concealed. The total RBOC average productivity gain was 1.3 percent higher under price caps. Some variance remains across years; there was an overall productivity loss in 1994 of 1.2 percent. This was due, in large part, to Nynex's 12 percent loss (as discussed earlier) and a 11 percent loss for U.S. West (which in turn was due partly to a 33 percent gain in capital costs). Also, in 1988, total RBOC productivity shows a huge productivity loss of 6.7 percent. Examination of individual productivity measurements reveals that *all seven* RBOCs had a productivity loss in 1988.

These anomalies in the calculated gains led the relaxation of the assumption of TFP in the model. The model was adjusted to, at first, exclude real MRS expenses and then to exclude real capital costs in the input equation. The weights for the remaining inputs were appropriately adjusted in each case. This process provided some additional insight into the underlying reasons for the anomalies and variance of the TFP gains.

4.3 Alternative Measures of Productivity

The previous estimates are based on a three-factor model – total factor productivity. Ferenc Kiss states, "[i]deally, the productivity adjustment of the price cap would be equal to the perfectly foreseen total factor productivity gain in the firm's production of regulated services in each year of the contract period. … Only TFP is capable of reflecting the totality of factor input and, thus, cost savings, while any other formula is partial and can only be understood as a surrogate for TFP."[53] In fact, the FCC specifies use a total factor productivity model in calculation of the X-Factor. Here, however, two alternative measures of productivity are examined – value-added productivity and labor productivity.

4.3.1 Value-Added Productivity

In 1988, a new Uniform System of Accounts (USOA) for the telephone industry became effective. Since MRS was calculated as a residual (total operating expenses minus labor and depreciation expenses), it is possible that the accounting change had an effect on the

[53]Kiss, p 10.

productivity results. Figure 4-3 depicts the growth in each input.[54] Real MRS growth was consistently high for each RBOC in 1988. On a total RBOC-basis, real MRS expenses grew 39.3 percent in 1988 – a 33 percent deviation from the ROR mean. The standard deviations for individual RBOC MRS growth rates ranged from 12.6 percent to 31.2 percent under ROR and from 4.9 percent to 29.8 percent under price caps – indicating a large variance in the underlying MRS data. The statistical evidence suggests that the 1988 MRS input data contain irregularities. Therefore, another model of productivity was examined which eliminated MRS – value-added productivity.

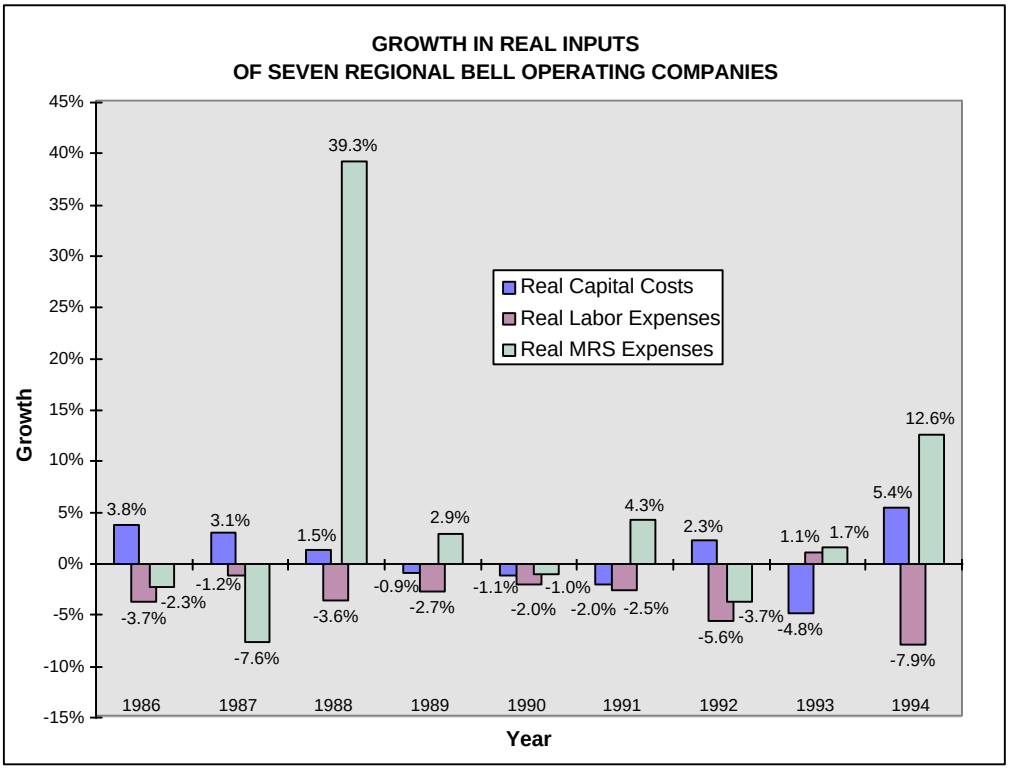

Figure 4-3. Total RBOC Growth in Real Inputs

[54]Growth rates were aggregated into an input index by weighting them according to each input's contribution to total nominal cost each year. For the total RBOC data, the *average* weights were 27.8 percent for the labor input, 28.4 percent for the MRS input, and 43.8 percent for the capital input.

Unlike total factor productivity, which measures the sum of all inputs to production, value-added productivity measurement excludes the value of intermediate materials, rents and services (MRS). This version represents output produced by factors internal to the company. It is consistent with gross national product measurements because it avoids double-counting of inter-industry or inter-company purchases and sales of MRS. On a national basis, productivity is calculated by the Bureau of Labor Statistics using the value-added method (although it has misnamed its measurement as total factor). The Bell System productivity studies, which were once published annually, measured both total factor and value-added productivity. For the latter, only two inputs were used — the cost of labor and the annual cost of gross capital. Norsworthy and Jang assert that use of a value-added productivity measurement in the telecommunications industry is a common error. "[V]alue added is not useful as the productivity measure for a rapidly advancing industry such as telecommunications, because both the technology of production and the price of output are distorted by omitting energy, materials, and purchased services."[55]

[55]J.R. Norsworthy and S.L. Jang, Empirical Measurement and Analysis of Productivity and Technological Change: Applications in High-Technology and Service Industries, (Amsterdam: North Holland, 1992), p. 228.

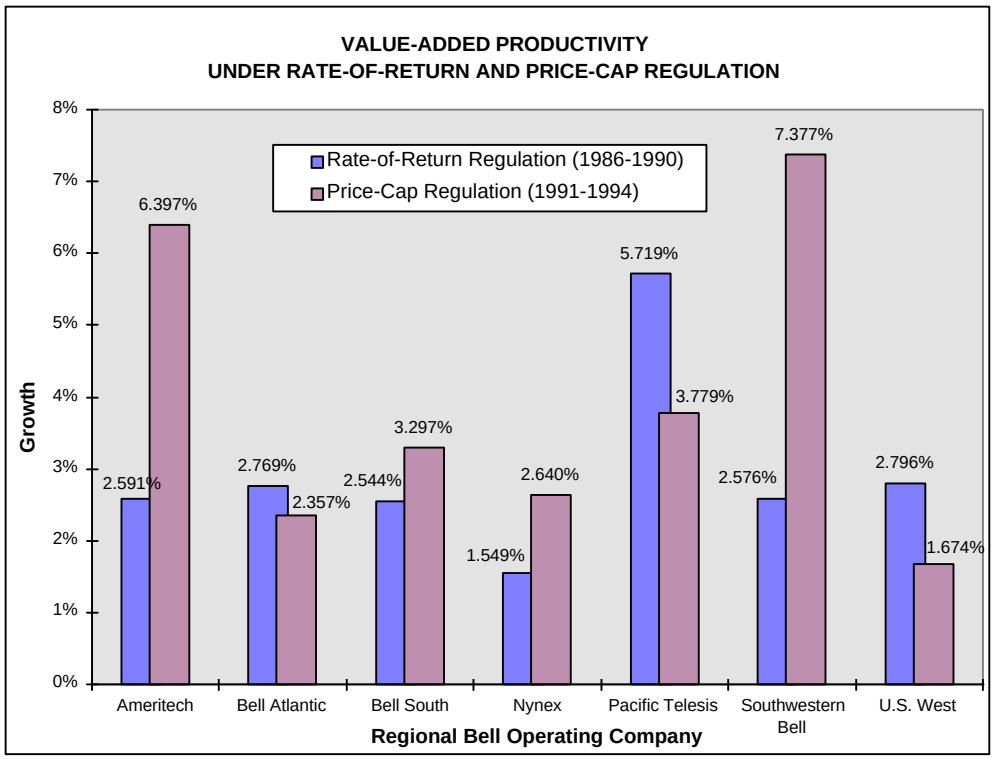

Figure 4-4. Value-Added Productivity by RBOC

The results of the value-added calculations are depicted in Figure 4-4 and Figure 4-5. After removing the MRS component, all average productivity gains were positive. Four RBOCs improved under price caps, including Nynex, indicating more efficient use of capital and labor. Productivity gains in 1988 were now comparable with the other years' gains. Overall, value-added productivity improved 1.1 percent under price caps.

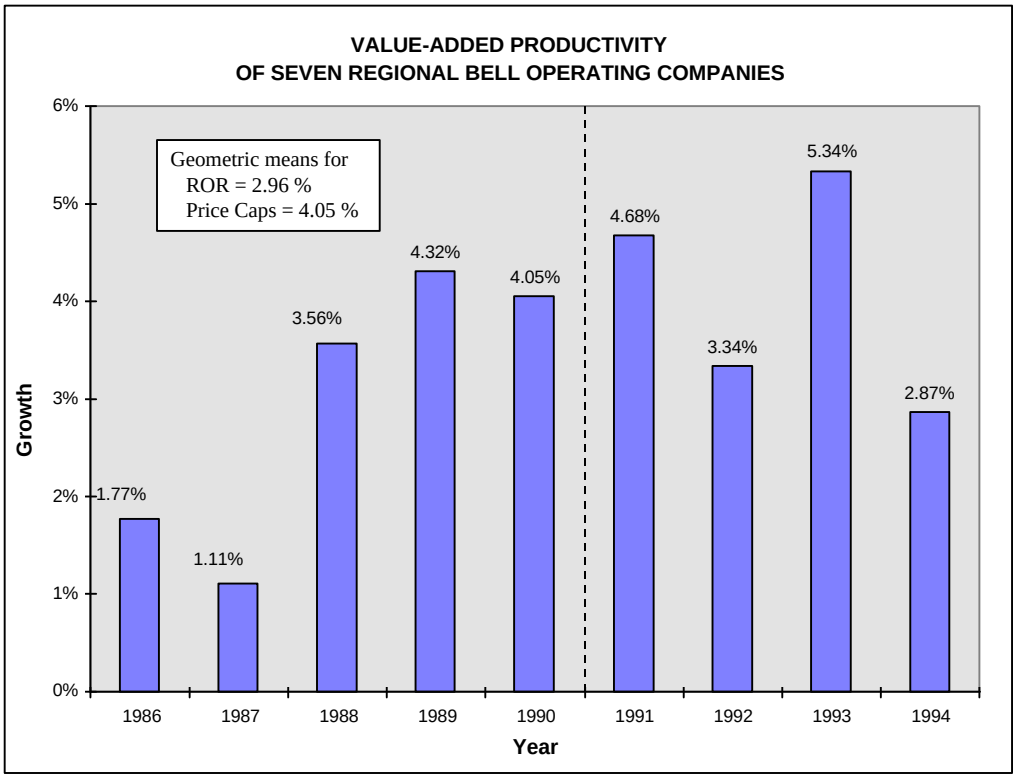

Figure 4-5. Total RBOC Value-Added Productivity Gains
by Year

4.3.2 Labor Productivity

One final model was used – labor productivity. Labor productivity relates only the cost of labor to the outputs. In 1988, Kiss considered whether labor productivity could be used as a surrogate in a price cap formula and concluded that labor productivity gains were a poor substitute for TFP measures. Even though labor represented a large input (30 to 40 percent of total production costs during the late 1970's), capital and labor have a tendency to undergo changes in opposite directions due to their strong substitutability.[56]

[56]Kiss, p. 12.

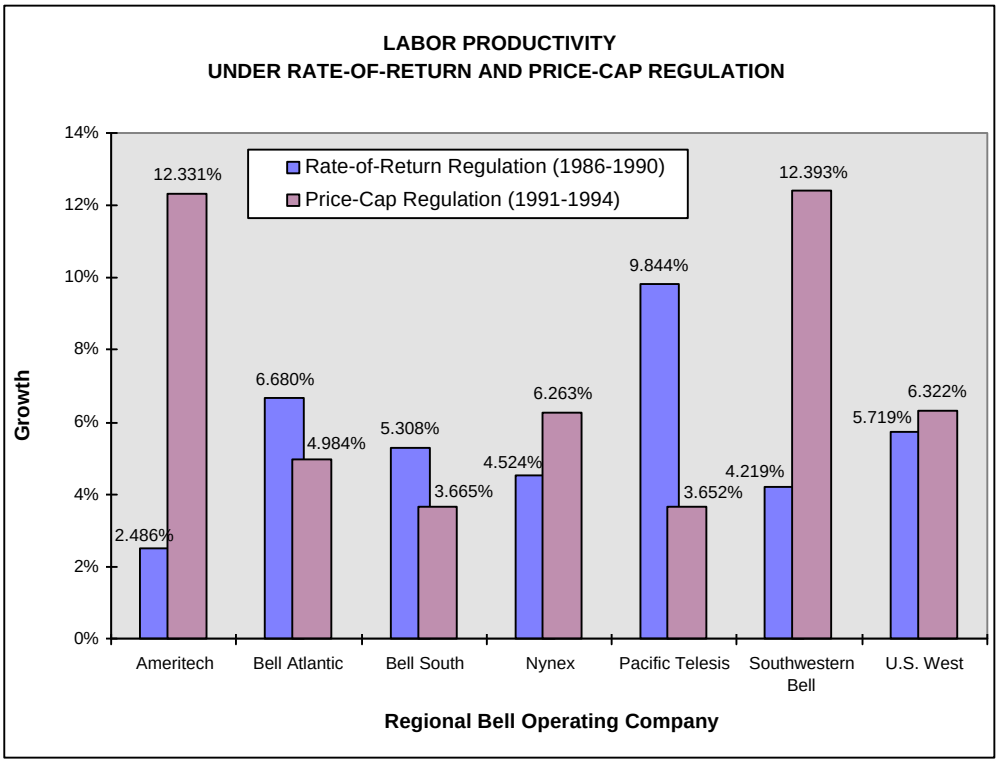

Figure 4-6. Labor Productivity by RBOC

The results of the labor productivity model are show in Figure 4-6 and Figure 4-7. Four RBOCs (Ameritech, Nynex, Southwestern Bell, and U.S. West) showed improvement under price caps. The standard deviations for productivity growth under price caps were higher than those with the value-added model, in part due to large fluctuations in Nynex and Pacific Telesis labor expenses. These fluctuations led to a relatively small total RBOC gain in 1993 (1.6 percent) and a large gain in 1994 (12.2 percent). Overall labor productivity, however, improved 1.3 percent under price caps.

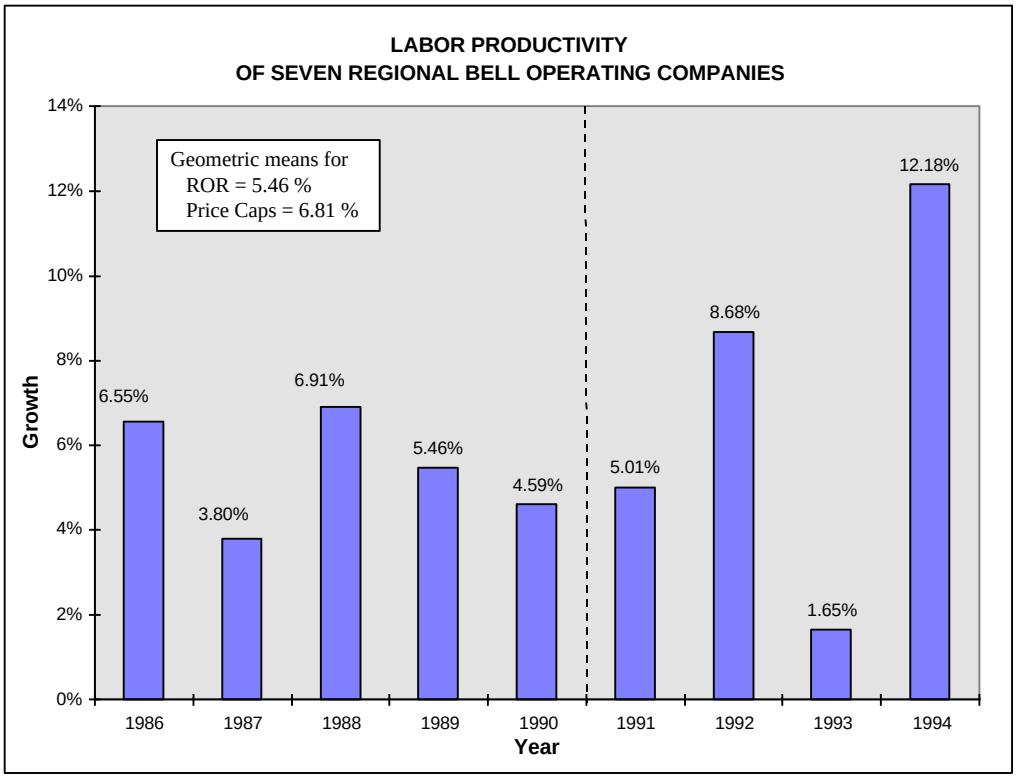

Figure 4-7. Total RBOC Labor Productivity Gains by Year

4.4 Conclusions

The point estimates of all three productivity measurements indicate that price caps *have* led to greater productivity gains. (See Table 4-1. Average Productivity Gains for All Regional Bell Operating Companies Under Rate-of-Return and Price-Cap Regulation.) Although productivity gains varied greatly across individual RBOCs and varied greatly between years, use of total RBOC data (which represents the large majority, in terms of revenues, of local telephone companies under price cap regulation) indicated that average productivity gains changed from 1.1 percent to 2.4 percent under the TFP method – an improvement of 1.3 percent. Similar improvements were estimated using value-added productivity (1.1 percent) and labor productivity measurements (1.3 percent).

Table 4-1. Average Productivity Gains for All Regional Bell Operating Companies Under Rate-of-Return and Price-Cap Regulation

Method of Measurement	ROR	Price Caps	Difference
Total Factor Productivity	1.061%	2.392%	1.331%
Value-Added Productivity	2.955%	4.053%	1.098%
Labor Productivity	5.456%	6.805%	1.349%

However, because of the variability of the annual estimates, the productivity improvements are not statistically significant. The individual RBOC annual estimates were pooled for each regulatory period yielding 35 observations under rate-of-return regulation and 28 observations under price-cap regulation. Several one-tailed t-tests were examined to test the null hypothesis that the mean difference between the two data sets is zero. (See Appendix B for the results of these t-tests.) The first set of t-tests used a 5 percent level of significance; a second set used a 10 percent level of significance. All three measures of productivity were tested and none supported the alternative hypothesis that price caps have led to greater productivity gains. These t-tests were duplicated, except that the 7 questionable data points from 1988 were excluded forming two data sets with 28 observations in each. Again, at both 5 percent and 10 percent levels of significance, the null hypothesis was not rejected indicating that there was no improvement under price caps.

In conclusion, calculations of RBOC productivity gains *suggest* that price caps have led to more efficient use of inputs – labor; materials, rents and services; and capital – in the production of telephone company output. However, the statistical evidence is not strong enough to *unequivocally support* the alternative hypothesis that price cap regulation has led to greater productivity gains.

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APPENDIX A. PRODUCTIVITY CALCULATIONS

Total Factor Productivity

Productivity Growth TFP	RBOC							
Year	Ameritech	Bell Atlantic	Bell South	Nynex	Pacific Telesis	Southwestern Bell	U.S. West	All RBOCs
1986	2.142%	-2.005%	2.581%	0.497%	8.787%	2.952%	1.355%	2.485%
1987	5.768%	2.789%	0.195%	-0.652%	7.302%	3.899%	3.459%	3.027%
1988	-9.636%	-3.851%	-5.968%	-3.523%	-7.442%	-8.288%	-10.831%	-6.655%
1989	2.329%	-0.622%	1.193%	1.030%	9.102%	6.472%	1.207%	2.948%
1990	2.483%	2.009%	4.008%	2.161%	3.752%	3.056%	7.553%	3.898%
1991	0.589%	-0.558%	4.877%	-2.741%	1.987%	8.780%	5.489%	2.584%
1992	0.279%	3.249%	4.038%	9.024%	7.144%	-0.269%	0.052%	4.284%
1993	5.934%	2.453%	2.415%	2.631%	0.641%	0.769%	10.002%	3.974%
1994	-4.193%	4.485%	3.096%	-11.945%	3.327%	3.236%	-10.503%	-1.179%
Average[1] Productivity Growth (1986-90)	0.471%	-0.367%	0.342%	-0.116%	4.109%	1.483%	0.353%	1.061%
Average[1] Productivity Growth (1991-94)	0.589%	2.390%	3.602%	-1.060%	3.246%	3.071%	0.962%	2.392%
Mean (1986-90)	0.617%	-0.336%	0.402%	-0.097%	4.300%	1.618%	0.549%	1.141%
Standard Deviation (1986-90)	5.924%	2.761%	3.841%	2.166%	6.899%	5.717%	6.857%	4.388%
Variance (1986-90)	0.351%	0.076%	0.148%	0.047%	0.476%	0.327%	0.470%	0.193%
Mean (1991-94)	0.652%	2.407%	3.606%	-0.758%	3.275%	3.129%	1.260%	2.416%
Standard Deviation (1991-94)	4.144%	2.146%	1.077%	8.874%	2.803%	4.044%	8.834%	2.508%
Variance (1991-94)	0.172%	0.046%	0.012%	0.788%	0.079%	0.164%	0.780%	0.063%

[1] Geometric mean

Value-Added Productivity

Value-Added Productivity

Productivity Growth VA	RBOC							
Year	Ameritech	Bell Atlantic	Bell South	Nynex	Pacific Telesis	Southwestern Bell	U.S. West	All RBOCs
1986	0.933%	-2.307%	4.141%	3.918%	3.218%	0.195%	1.959%	1.775%
1987	3.834%	2.694%	-1.544%	-3.162%	3.954%	1.359%	1.901%	1.113%
1988	1.619%	8.709%	4.895%	1.718%	4.553%	1.190%	1.351%	3.561%
1989	4.678%	2.529%	1.531%	7.209%	5.792%	3.790%	4.055%	4.315%
1990	1.938%	2.516%	3.830%	-1.595%	11.271%	6.471%	4.757%	4.051%
1991	8.950%	2.394%	6.933%	-0.130%	0.534%	8.646%	4.637%	4.680%
1992	2.295%	1.932%	-1.145%	2.278%	10.397%	7.577%	1.848%	3.343%
1993	8.968%	3.209%	2.201%	3.057%	-3.897%	9.537%	16.624%	5.340%
1994	5.518%	1.899%	5.385%	5.431%	8.752%	3.837%	-14.016%	2.867%
Average[1] Productivity Growth (1986-90)	2.591%	2.769%	2.544%	1.549%	5.719%	2.576%	2.796%	2.955%
Average[1] Productivity Growth (1991-94)	6.397%	2.357%	3.297%	2.640%	3.779%	7.377%	1.674%	4.053%
Mean (1986-90)	2.600%	2.828%	2.571%	1.617%	5.758%	2.601%	2.805%	2.963%
Standard Deviation (1986-90)	1.583%	3.910%	2.621%	4.175%	3.223%	2.535%	1.502%	1.432%
Variance (1986-90)	0.025%	0.153%	0.069%	0.174%	0.104%	0.064%	0.023%	0.021%
Mean (1991-94)	6.433%	2.358%	3.344%	2.659%	3.946%	7.399%	2.273%	4.058%
Standard Deviation (1991-94)	3.200%	0.610%	3.583%	2.292%	6.779%	2.506%	12.610%	1.149%
Variance (1991-94)	0.102%	0.004%	0.128%	0.053%	0.460%	0.063%	1.590%	0.013%

[1] Geometric mean

Labor Productivity

Labor Productivity

Productivity Growth Labor	RBOC							
Year	Ameritech	Bell Atlantic	Bell South	Nynex	Pacific Telesis	Southwestern Bell	U.S. West	All RBOCs
1986	2.750%	4.577%	9.701%	10.310%	9.220%	1.565%	6.972%	6.549%
1987	2.042%	4.966%	2.519%	0.329%	5.083%	8.320%	4.855%	3.796%
1988	3.333%	11.731%	13.697%	3.441%	9.552%	3.930%	2.117%	6.913%
1989	5.694%	2.989%	-2.365%	19.283%	2.943%	3.706%	5.257%	5.464%
1990	-1.264%	9.384%	3.737%	-8.639%	23.545%	3.692%	9.537%	4.591%
1991	20.522%	5.509%	10.407%	-3.651%	-10.239%	9.175%	7.530%	5.005%
1992	7.624%	6.656%	-4.437%	12.054%	20.323%	19.312%	3.691%	8.681%
1993	15.129%	4.950%	1.868%	-7.199%	-12.844%	15.941%	5.378%	1.646%
1994	6.620%	2.856%	7.449%	27.263%	22.623%	5.662%	8.762%	12.178%
Average[1] Productivity Growth (1986-90)	2.486%	6.680%	5.308%	4.524%	9.844%	4.219%	5.719%	5.456%
Average[1] Productivity Growth (1991-94)	12.331%	4.984%	3.665%	6.263%	3.652%	12.393%	6.322%	6.805%
Mean (1986-90)	2.511%	6.729%	5.458%	4.945%	10.069%	4.242%	5.748%	5.462%
Standard Deviation (1986-90)	2.517%	3.667%	6.299%	10.517%	8.035%	2.474%	2.742%	1.306%
Variance (1986-90)	0.063%	0.134%	0.397%	1.106%	0.646%	0.061%	0.075%	0.017%
Mean (1991-94)	12.474%	4.993%	3.822%	7.117%	4.966%	12.523%	6.340%	6.878%
Standard Deviation (1991-94)	6.573%	1.591%	6.546%	15.824%	19.114%	6.220%	2.253%	4.554%
Variance (1991-94)	0.432%	0.025%	0.428%	2.504%	3.653%	0.387%	0.051%	0.207%

[1] Geometric mean

Growth Rates of Output and Inputs

Growth Rate of Outputs	RBOC							
Year	Ameritech	Bell Atlantic	Bell South	Nynex	Pacific Telesis	Southwestern Bell	U.S. West	All RBOCs
1986	1.180%	2.781%	3.304%	2.963%	3.433%	1.732%	2.507%	2.557%
1987	1.502%	3.304%	3.844%	2.829%	3.675%	0.442%	1.658%	2.543%
1988	2.593%	3.755%	4.528%	3.489%	3.265%	0.169%	2.720%	3.056%
1989	2.258%	3.562%	3.661%	1.685%	3.487%	1.754%	1.481%	2.634%
1990	2.135%	1.501%	3.352%	0.484%	4.040%	3.509%	3.300%	2.526%
1991	1.599%	0.420%	3.122%	0.449%	5.487%	2.906%	3.493%	2.372%
1992	2.108%	2.314%	3.265%	0.057%	4.422%	3.210%	2.838%	2.572%
1993	2.911%	1.903%	2.935%	2.031%	2.339%	4.217%	3.744%	2.800%
1994	3.953%	3.482%	4.600%	3.573%	0.631%	2.836%	3.930%	3.354%
Average[1] Growth (1986-90)	1.933%	2.978%	3.737%	2.284%	3.580%	1.514%	2.331%	2.663%
Average[1] Growth (1991-94)	2.639%	2.024%	3.478%	1.518%	3.203%	3.291%	3.500%	2.774%
Mean (1986-90)	1.934%	2.981%	3.738%	2.290%	3.580%	1.521%	2.333%	2.663%
Standard Deviation (1986-90)	0.578%	0.904%	0.495%	1.205%	0.296%	1.327%	0.758%	0.223%
Variance (1986-90)	0.003%	0.008%	0.002%	0.015%	0.001%	0.018%	0.006%	0.000%
Mean (1991-94)	2.643%	2.030%	3.480%	1.528%	3.220%	3.292%	3.501%	2.775%
Standard Deviation (1991-94)	1.027%	1.265%	0.758%	1.608%	2.165%	0.637%	0.477%	0.424%
Variance (1991-94)	0.011%	0.016%	0.006%	0.026%	0.047%	0.004%	0.002%	0.002%

[1] Geometric mean

Growth Rate of Real Labor	RBOC							
Year	Ameritech	Bell Atlantic	Bell South	Nynex	Pacific Telesis	Southwestern Bell	U.S. West	All RBOCs
1986	-1.527%	-1.717%	-5.831%	-6.661%	-5.299%	0.165%	-4.174%	-3.747%
1987	-0.529%	-1.583%	1.293%	2.491%	-1.340%	-7.273%	-3.049%	-1.206%
1988	-0.716%	-7.139%	-8.065%	0.047%	-5.739%	-3.618%	0.590%	-3.608%
1989	-3.250%	0.556%	6.172%	-14.753%	0.528%	-1.882%	-3.587%	-2.684%
1990	3.443%	-7.206%	-0.371%	9.986%	-15.788%	-0.176%	-5.694%	-1.974%
1991	-15.701%	-4.824%	-6.598%	4.256%	17.519%	-5.742%	-3.754%	-2.507%
1992	-5.126%	-4.070%	8.059%	-10.707%	-13.215%	-13.495%	-0.823%	-5.621%
1993	-10.613%	-2.903%	1.047%	9.947%	17.420%	-10.113%	-1.551%	1.135%
1994	-2.501%	0.609%	-2.652%	-18.615%	-17.935%	-2.675%	-4.442%	-7.866%
Average[1] Growth (1986-90)	-0.540%	-3.470%	-1.492%	-2.142%	-5.703%	-2.595%	-3.205%	-2.649%
Average[1] Growth (1991-94)	-8.628%	-2.819%	-0.180%	-4.465%	-0.434%	-8.099%	-2.654%	-3.774%
Mean (1986-90)	-0.516%	-3.418%	-1.360%	-1.778%	-5.527%	-2.557%	-3.183%	-2.644%
Standard Deviation (1986-90)	2.460%	3.544%	5.694%	9.383%	6.316%	3.037%	2.329%	1.080%
Variance (1986-90)	0.061%	0.126%	0.324%	0.880%	0.399%	0.092%	0.054%	0.012%
Mean (1991-94)	-8.485%	-2.797%	-0.036%	-3.780%	0.947%	-8.006%	-2.643%	-3.715%
Standard Deviation (1991-94)	5.879%	2.404%	6.234%	13.179%	19.175%	4.765%	1.730%	3.909%
Variance (1991-94)	0.346%	0.058%	0.389%	1.737%	3.677%	0.227%	0.030%	0.153%

[1] Geometric mean

Growth Rate of Real MRS	RBOC							
Year	Ameritech	Bell Atlantic	Bell South	Nynex	Pacific Telesis	Southwestern Bell	U.S. West	All RBOCs
1986	-5.28%	3.83%	6.05%	11.23%	-24.35%	-13.60%	3.24%	-2.34%
1987	-11.25%	0.20%	-3.46%	-4.25%	-17.71%	-16.46%	-7.42%	-7.62%
1988	47.51%	35.91%	41.75%	20.47%	49.58%	45.96%	49.81%	39.27%
1989	5.45%	10.66%	3.32%	12.10%	-15.13%	-14.41%	6.45%	2.95%
1990	-1.65%	0.46%	-1.06%	-9.85%	17.91%	11.57%	-10.16%	-0.97%
1991	15.98%	6.11%	2.75%	8.64%	-0.55%	-5.80%	-3.84%	4.26%
1992	5.44%	-3.20%	-15.54%	-23.28%	4.28%	23.14%	6.90%	-3.67%
1993	1.67%	0.75%	-0.09%	0.41%	-12.02%	20.44%	4.58%	1.66%
1994	22.00%	-5.73%	7.31%	48.27%	9.08%	0.78%	5.99%	12.57%
Average[1] Growth (1986-90)	5.160%	9.468%	8.205%	5.333%	-1.402%	0.120%	6.487%	5.078%
Average[1] Growth (1991-94)	10.976%	-0.620%	-1.786%	5.546%	-0.120%	8.930%	3.316%	3.543%
Mean (1986-90)	6.956%	10.212%	9.317%	5.940%	2.060%	2.612%	8.382%	6.259%
Standard Deviation (1986-90)	23.462%	14.972%	18.503%	12.552%	31.198%	26.815%	24.190%	18.841%
Variance (1986-90)	5.505%	2.242%	3.424%	1.575%	9.733%	7.190%	5.851%	3.550%
Mean (1991-94)	11.271%	-0.521%	-1.392%	8.512%	0.196%	9.640%	3.407%	3.707%
Standard Deviation (1991-94)	9.373%	5.162%	9.910%	29.761%	9.045%	14.328%	4.924%	6.770%
Variance (1991-94)	0.878%	0.266%	0.982%	8.857%	0.818%	2.053%	0.242%	0.458%

[1] Geometric mean

Growth Rate of Real Capital Costs	RBOC							
Year	Ameritech	Bell Atlantic	Bell South	Nynex	Pacific Telesis	Southwestern Bell	U.S. West	All RBOCs
1986	1.472%	9.779%	2.175%	3.558%	4.010%	2.469%	3.481%	3.803%
1987	-3.454%	1.964%	7.771%	8.866%	0.450%	2.960%	1.418%	3.082%
1988	2.138%	-2.958%	3.526%	2.970%	1.649%	0.553%	1.807%	1.452%
1989	-1.650%	1.290%	-0.115%	0.826%	-4.020%	-2.009%	-1.807%	-0.946%
1990	-2.279%	2.593%	-0.510%	-3.593%	-1.015%	-4.474%	1.059%	-1.146%
1991	-0.769%	-0.282%	-1.909%	-2.359%	-4.525%	-4.978%	0.407%	-2.010%
1992	2.992%	2.837%	2.295%	3.951%	-0.097%	1.528%	2.000%	2.288%
1993	-2.547%	-0.371%	0.517%	-10.775%	-2.585%	-1.972%	-17.614%	-4.781%
1994	-0.874%	2.072%	0.408%	9.635%	-0.186%	-0.032%	33.638%	5.436%
Average[1] Growth (1986-90)	-0.778%	2.452%	2.526%	2.446%	0.179%	-0.140%	1.177%	1.229%
Average[1] Growth (1991-94)	-0.320%	1.054%	0.316%	-0.178%	-1.866%	-1.393%	3.047%	0.157%
Mean (1986-90)	-0.754%	2.534%	2.569%	2.525%	0.215%	-0.100%	1.191%	1.249%
Standard Deviation (1986-90)	2.436%	4.597%	3.347%	4.522%	2.999%	3.129%	1.916%	2.263%
Variance (1986-90)	0.059%	0.211%	0.112%	0.204%	0.090%	0.098%	0.037%	0.051%
Mean (1991-94)	-0.300%	1.064%	0.328%	0.113%	-1.848%	-1.363%	4.608%	0.233%
Standard Deviation (1991-94)	2.341%	1.636%	1.724%	8.757%	2.124%	2.803%	21.299%	4.526%
Variance (1991-94)	0.055%	0.027%	0.030%	0.767%	0.045%	0.079%	4.537%	0.205%

[1] Geometric mean

APPENDIX B. TESTS OF SIGNIFICANCE USING POOLED DATA

Test 1: .05 level of significance; includes 1988

t-Test: Two-Sample Assuming Unequal Variances

TFP	***ROR***	***Price Caps***
Mean	0.010075335	0.019388627
Variance	0.002449201	0.002497058
Observations	35	28
Hypothesized Mean Difference	0	
df	58	
t Stat	-0.738225865	
P(T<=t) one-tail	0.23167694	
t Critical one-tail	1.671553491	

Accept the null hypothesis: no improvement under price caps

VALUE-ADDED PRODUCTIVITY	***ROR***	***Price Caps***
Mean	0.029685085	0.040589358
Variance	0.000867828	0.003041862
Observations	35	28
Hypothesized Mean Difference	0	
df	39	
t Stat	-0.943984852	
P(T<=t) one-tail	0.175494523	
t Critical one-tail	1.684875315	

Accept the null hypothesis: no improvement under price caps

LABOR PRODUCTIVITY	***ROR***	***Price Caps***
Mean	0.056716148	0.074620206
Variance	0.003407055	0.009462627
Observations	35	28
Hypothesized Mean Difference	0	
df	42	
t Stat	-0.858142552	
P(T<=t) one-tail	0.197842317	
t Critical one-tail	1.681951289	

Accept the null hypothesis: no improvement under price caps

Test 2: .10 level of significance; includes 1988

t-Test: Two-Sample Assuming Unequal Variances

TFP	***ROR***	***Price Caps***
Mean	0.010075335	0.019388627
Variance	0.002449201	0.002497058
Observations	35	28
Hypothesized Mean Difference	0	
df	58	
t Stat	-0.738225865	
P(T<=t) one-tail	0.23167694	
t Critical one-tail	1.296318715	

Accept the null hypothesis: no improvement under price caps

VALUE-ADDED PRODUCTIVITY	***ROR***	***Price Caps***
Mean	0.029685085	0.040589358
Variance	0.000867828	0.003041862
Observations	35	28
Hypothesized Mean Difference	0	
df	39	
t Stat	-0.943984852	
P(T<=t) one-tail	0.175494523	
t Critical one-tail	1.303637873	

Accept the null hypothesis: no improvement under price caps

LABOR PRODUCTIVITY	***ROR***	***Price Caps***
Mean	0.056716148	0.074620206
Variance	0.003407055	0.009462627
Observations	35	28
Hypothesized Mean Difference	0	
df	42	
t Stat	-0.858142552	
P(T<=t) one-tail	0.197842317	
t Critical one-tail	1.302034889	

Accept the null hypothesis: no improvement under price caps

Test 3: .05 level of significance; excludes 1988

t-Test: Two-Sample Assuming Unequal Variances

TFP	***ROR***	***Price Caps***
Mean	0.030286624	0.019388627
Variance	0.00079382	0.002497058
Observations	28	28
Hypothesized Mean Difference	0	
df	43	
t Stat	1.005240106	
P(T<=t) one-tail	0.160202379	
t Critical one-tail	1.681071353	

Accept the null hypothesis: no improvement under price caps

VALUE-ADDED PRODUCTIVITY	***ROR***	***Price Caps***
Mean	0.028522594	0.040589358
Variance	0.000912386	0.003041862
Observations	28	28
Hypothesized Mean Difference	0	
df	42	
t Stat	-1.01540161	
P(T<=t) one-tail	0.157864186	
t Critical one-tail	1.681951289	

Accept the null hypothesis: no improvement under price caps

LABOR PRODUCTIVITY	***ROR***	***Price Caps***
Mean	0.053823274	0.074620206
Variance	0.003754629	0.009462627
Observations	28	28
Hypothesized Mean Difference	0	
df	46	
t Stat	-0.9572109	
P(T<=t) one-tail	0.1717324	
t Critical one-tail	1.678658919	

Accept the null hypothesis: no improvement under price caps

Test 4: .10 level of significance; excludes 1988

t-Test: Two-Sample Assuming Unequal Variances

TFP	***ROR***	***Price Caps***
Mean	0.030286624	0.019388627
Variance	0.00079382	0.002497058
Observations	28	28
Hypothesized Mean Difference	0	
df	43	
t Stat	1.005240106	
P(T<=t) one-tail	0.160202379	
t Critical one-tail	1.30155172	

Accept the null hypothesis: no improvement under price caps

VALUE-ADDED PRODUCTIVITY	***ROR***	***Price Caps***
Mean	0.028522594	0.040589358
Variance	0.000912386	0.003041862
Observations	28	28
Hypothesized Mean Difference	0	
df	42	
t Stat	-1.01540161	
P(T<=t) one-tail	0.157864186	
t Critical one-tail	1.302034889	

Accept the null hypothesis: no improvement under price caps

LABOR PRODUCTIVITY	***ROR***	***Price Caps***
Mean	0.053823274	0.074620206
Variance	0.003754629	0.009462627
Observations	28	28
Hypothesized Mean Difference	0	
df	46	
t Stat	-0.9572109	
P(T<=t) one-tail	0.1717324	
t Critical one-tail	1.300227268	

Accept the null hypothesis: no improvement under price caps

APPENDIX C. GLOSSARY

Access Charge. Monies collected by local phone companies for use of their circuits to originate and terminate long distance calls. Can be per minute fees levied on long distance companies, Subscriber Line Charges (SLCs) levied directly on regular local lines, fixed monthly fees for special telco circuits (i.e. WAL, DAL,T-1), or Special Access Surcharge (SAS) on special access circuits.

Access Line. A telephone circuit which connects a customer location to a network switching center.

Bell Operating Company (BOC). One of the local telephone companies formerly part of the Bell System. The BOCs primarily provide local service; but, as stipulated by the 1996 Telecommunications Act, they may now enter other markets such as long distance communications. The BOCs are grouped under the Regional Bell Operating Companies.

Carrier. A company which uses primarily its own transmission facilities, as opposed to resellers which lease or buy most or all transmission facilities from carriers. Many people refer to any type of telecom company, whether it has its own network or not, as a carrier, so the term is not as restrictive as it used to be.

Exchange. A telephone switching center.

Facilities. Typically refers to transmission lines or circuits, or long distance services. A caller's facilities are the circuits available to make calls.

Federal Communications Commission (FCC). The government agency established by the Communications Act of 1934 which regulates the interstate communications industry.

Interstate. Any connection made between two states.

Intrastate. Any connection made that remains within the boundaries of a single state.

Local Access And Transport Area (LATA). A geographic area (called "exchange" or "exchange area" the MFJ) within each BOC's franchised area that has established by a BOC in accordance with the provisions of the MFJ for the purpose of defining the territory which a BOC may offer its telecommunications services.

Local Exchange Carrier (LEC). A local telephone company, either one of the Bell Operating Companies or one of the more than 1,400 independent local telephone companies. The BOCs primarily provide intraexchange, intraLATA service (*i.e.*, local service) to approximately 80 percent of the 84 million households with telephone service; the independents serve the remaining households. In addition to local service, the LECs provide users access to long-distance (interexchange) carriers, usually through their switched networks.

Modified Final Judgment (MFJ). The agreement between the U.S. Department of Justice and AT&T governing the breakup of the pre-Divestiture Bell System into AT&T and 22 Bell Operating Companies (grouped under seven Regional Bell Operating Companies) and other entities. On August 26, 1982, U. S. District Court Judge Harold Greene accepted, with modifications, an AT&T/Justice Department settlement terminating the government's 1974 antitrust suit against AT&T. This is known as the 1982 Consent Decree. The structural separation provisions of the 1982 Consent Decree recognized separate markets for local service, long-distance service, and telephone equipment. In doing so, it prevented the use of bottleneck facilities (the local switched networks) in hindering competitive entry into long-distance and information services and equipment. It also prevented illegal cross-subsidies from monopoly markets and encouraged competitive procurement policies for equipment.

Network. A collection of switches connected to one another by transmission facilities.

Public Utility Commission (PUC)/Public Service Commission (PSC). The state commissions regulating intrastate communications.

Regional Bell Operating Company (RBOC). The RBOCs function as parent companies or holding companies (and, therefore, are also known as regional holding companies or RHCs) for the Bell Operating Companies (BOCs).

Switch. Any device that makes or changes electrical connections in a circuit.

Switched Access Lines. A communications link for which the physical path may vary with each usage, such as the public telephone network.

Switched Access. Connection between caller's phone system and switch of chosen long distance carrier when a regular long distance call using regular local lines is made. Also the connection between the switch of caller's long distance carrier in the distant city and the phone being called.

Telecommunications. The transmission of voice and/or data through a medium by means of electrical impulses and includes all aspects of transmitting information.

Toll Call. Any call to a point outside the local service area.

Traffic. Calls being sent and received over a communications network.

VITA

TRACEY ELIZABETH KELLY

EDUCATION

M.A., Economics, Virginia Polytechnic Institute and State University, 1997.

B.A., Economics, *Magna Cum Laude*, The George Washington University, 1987.

WORK EXPERIENCE

1996 - Present: Mitretek Systems, Telecommunications & Networking Division, McLean, VA

Mrs. Kelly has conducted many quantitative analyses of traffic and cost data of telecommunications services and networks. She has modeled telecommunications demand using forecasting and spreadsheet software. Mrs. Kelly has also conducted several cost analyses which examined the cost of telecommunications services on existing networks versus various alternative scenarios. In addition, she has developed models of telecommunications costs for several federal agencies, including the U.S. Department of Agriculture. One model FTS2000 costs, LEC long distance, local, wireless, contractor and other telecom costs and staffing levels by agency within USDA. A second model examined USDA FTS2000 costs by city and included estimates of current backbone costs and forecasts through FY2002. The conclusions from this model were used to brief both the CIO and the Enterprise Network Working Group.

Mrs. Kelly examined the telecommunications networks (often virtual private networks) for various states. She analyzed the current costs for outbound long-distance and 800 services and the potential costs under the FTS2000 contract. Mrs. Kelly conducted a cost analysis task of the outbound and inbound traffic data of the House of Representatives and determined the potential costs under FTS2000 prices. Mrs. Kelly also performed a detailed review of the current cost structures and accounting data of the Washington Interagency Telecommunications Systems (WITS).

1994 - 1996: Mackay Consulting, Vienna, VA

Ms. Kelly provided supporting financial data and analysis for consulting projects. She prepared documentation for litigation. Project work often required gathering data from financial reports and on-line sources and developing databases for analysis. Ms. Kelly was responsible for spreadsheet development and use of statistical software for analysis. Specific project work included downloading bond data from CRSP tapes, writing macro

routines in Lotus 1-2-3 to format data, and data analysis for the Virginia Retirement System.

1992 - 1996: Virginia Polytechnic Institute and State University, Falls Church, VA

Ms. Kelly acted as a graduate assistant for both the Department of Economics and for the Center for Study of Futures and Options Markets at Virginia Tech while studying for a masters degree in economics. Responsibilities included collection of financial and economic data and articles, statistical analysis, and editing reports. Ms. Kelly downloaded data (such as money and deficit data) from various on-line sources include Dialog, Dow Jones/New Retrieval, and F.R.E.D. (the Federal Reserve Bank of St. Louis' electronic database). Data sources also included publications such as those from the Federal Reserve System and the Department of Commerce.

1990 - 1992: National Economic Research Associates, Inc., Washington, DC

Ms. Kelly was involved in qualitative and quantitative studies in the broadcast, cable, local telephone, and long-distance marketplaces, often in support of regulatory proceedings at the FCC. Responsibilities included collection and analysis of government, industry, and company data; research of relevant economic theory; and writing and editing final reports. Project work incorporated a variety of economic topics, including; market structure and concentration, competition under regulation, rate regulation, demand forecasting, productivity analysis, consumer and producer surplus, and price discrimination. Specific projects included: cost analysis of fiber-based access, econometric modeling of switched access services, research of spatial price discrimination models, estimation of AT&T's productivity gains under price-cap regulation, and calculation of loss of consumer and producer surplus due to delay in licensing cellular services.

Research at this position involved collecting and analyzing data and information from a large variety of sources including but not limited to economic data from government publications of the U.S. Department of Labor, U.S. Department of Commerce, and the Federal Reserve System; balance sheet and income statement data filed by telephone companies at the Federal Communications Commission; various publications located at the National Association of Broadcasters' library; financial data from Standard & Poor's; and marketing materials from manufacturers of telephone network equipment. Researched economic theory using published economic articles (e.g., from the American Economic Review).

1989 - 1990: Federal Maritime Commission, Washington, DC

Ms. Kelly served as a regulatory economist for the Federal Maritime Commission, Bureau of Trade Monitoring, an independent regulatory agency. She performed economic research and analysis, reviewed proposed and existing trade agreements among components of the ocean transportation industry. Ms. Kelly examined market structures and applied basic economic techniques to assess the economic impact of such agreements on the level and cost of service in the trade. She researched and wrote trade profiles and conference monitoring reports and monitored activities of the shipping industry to detect

carrier participation in prohibited acts as stated in the Shipping Act of 1984 and the 46 CFR. She prepared responses to Congressional inquiries. Mrs. Kelly assisted the Commission's legal staff by developing, analyzing and evaluating economic evidence introduced in various proceedings.

1987 - 1989: Management Consulting & Research, Inc., Falls Church, VA

Mrs. Kelly was involved in various cost and economic analyses primarily for the Department of Defense. She collected, normalized and analyzed programmatic, technical and quantitative data. She developed spreadsheets and computer programs to format and analyze data. Mrs. Kelly wrote and edited technical reports. Her experience in statistical analysis included sampling, hypothesis testing, and regression analysis.

CONFERENCES/TRAINING

The 14th Annual Conference on Telecommunications Policy and Regulation, Federal Communications Bar Association and the Practising Law Institute, Washington, DC, December 1996.

"Innovative Pricing Strategies in Telecoms," International Institute for Research, Washington, DC, November 1996.

"Telecommunications Technologies for the Non-Engineering Professional," Data-Tech Institute, Baltimore, MD, August 1996.

The 14th Annual International Communications Forecasting Conference (ICFC): Demand Analysis and Forecasting With Competition in the Information Age, Dallas, TX, April 1996.

PUBLICATIONS

"Estimate of the Loss to the United States Caused by the FCC's Delay in Licensing Cellular Communications," (with Dr. Jeffrey Rohlfs and Dr. Charles Jackson), National Economic Research Associates, November 1991.

"Analysis of the Stability of the FCC's Models of Switched Access Demand," A Study Conducted for Lincoln Telephone Company, National Economic Research Associates, February 1992.

Lead Researcher for:

Rohlfs, Jeffrey H. and John Haring, "A Theory of Price Discrimination Under Regulated Competition: With Application to Long-Distance Telecommunications," National Economic Research Associates, November 1991.

Schmalensee, Richard and Jeffrey H. Rohlfs, "Productivity Gains Resulting from Interstate Price Caps for AT&T," National Economic Research Associates, September 1992.

Schmalensee, Richard and Jeffrey H. Rohlfs, "Evaluation of Alternative Policies for Regulation of AT&T," National Economic Research Associates, September 1992.

Mackay, Robert J. and Don Chance, "Report on the VRS's Managed Futures Program," Center for Study of Futures and Options Markets, Pamplin College of Business, Virginia Polytechnic Institute and State University, June 1994.

ASSOCIATION MEMBERSHIPS

Phi Beta Kappa National Honor Society
The Federal Communications Bar Association
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