

# 11

## Efficiency and Productivity



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When the consent decree was announced in 1982, many Americans were shocked and disbelieving. Could the U.S. government possibly think that "breaking up the most efficient telephone company in the world" would contribute to economic welfare? Service quality would undoubtedly suffer as standardization was sacrificed to the cruel forces of competition. Costs would surely rise and rates would soon follow. The crown jewel of the U.S. research establishment, Bell Labs, would doubtlessly lose its ability to pursue crucially important basic research.

The divestiture was just one of a succession of events that followed the FCC's early attempts to introduce competition into a regulated industry.<sup>1</sup> Some economists argued that competition was impossible in telephony.<sup>2</sup> Others argued that AT&T may have had an unsustainable natural monopoly.<sup>3</sup> Still others thought that even if AT&T were a

natural monopoly, it sacrificed the critical but stagnant portions of this monopoly in a cynical attempt to rid itself of the strictures of a previous decree.<sup>4</sup>

It may be too early to determine if separating AT&T from its local operating companies contributed on balance to economic welfare, but it is not too early to look for some of the manifestations most feared by the decree's critics. I shall examine the rate of growth of telephone rates, employment, output, and productivity in the industry to see if the industry has begun to perform as the critics feared it might. Because other chapters in this volume discuss the implications of the MFJ on the efficiency of relative telephone rates and service quality, I do not address the rebalancing of rates and the quality of service since 1984. Nor do I attempt to analyze the effects of the MFJ on research and development, other than through its indirect effect on productivity.

If telephony is a natural monopoly, it is presumably so because of the economies of scale or scope in the delivery of various services. Substantial scale economies are thought to exist in long-distance transmission, but not in the provision of access service.<sup>5</sup> In the latter market, there may be economies of density, but not of scale. A single metropolitan area will have many exchanges and several switching centers. Thus, it may be true that a single exchange is more efficient than competing exchanges in a given small area, but it is far from clear that efficiency requires that the owners of adjacent exchanges be part of the same enterprise.

The issues in the 1974 AT&T antitrust suit (and its predecessors) involved the use of vertical integration, either to avoid the strictures of rate regulation, or to monopolize what would otherwise be competitive markets. As a result, in the decree settling the case, the "bottleneck" monopolies—the Bell local exchange companies—were divorced from the other functions of AT&T—namely, long-distance services, manufacturing, and enhanced "information" services. It is this vertical fragmentation that is ostensibly the source of the critics' wrath, not the sacrifice of scale economies.

At first blush, it seems unlikely that vertical fragmentation of the U.S. telephone network has been the source of *static* efficiency losses. Surely, the divested BOCs can arrange to buy from AT&T or from other suppliers the equipment that they once transferred internally. In fact, it is likely that the vertical fragmentation has led to more efficient procurement decisions. Moreover, there is no a priori reason to believe that AT&T's long-distance operations are now unable to interconnect with the BOCs as efficiently as they did when they were part of the

same company. In short, it would be surprising if the U.S. sacrificed static efficiencies because it failed to keep a vertically integrated telephone sector.

The more likely argument against the vertical divestiture derives from the process of innovation. A vertically integrated AT&T could develop new equipment for delivering services through its combined long-distance and local-exchange operations. The divested BOCs, prohibited from engaging in manufacturing, are hostages to equipment suppliers and to those funding research and development, who have no stake in the delivery of local access/exchange services and could not easily obtain one. The crucial links between R&D, manufacturing, and information/communications services must have been the major reason why AT&T chose to accept a consent decree of the form of the MFJ. Otherwise, it might have chosen to offer to jettison Bell Laboratories and Western Electric to settle the antitrust suit.

On the other hand, divestiture freed the BOCs from Western Electric and forced the latter to compete with domestic foreign sellers of telephone equipment. Presumably, this competition would place downward pressure on equipment prices and perhaps even induce a more rapid adoption of new technologies.

If local access/exchange service were competitive (or contestable), the alleged evils of vertical integration would be mitigated, and we might return to a world of vertically integrated telecommunications firms, all competing with one another. This presupposes that in a competitive world there would be no need for regulation, and that the traditional capital equipment supplier/regulated firm integration would not be the source of the "evasion of the regulatory constraint" argument. We are not yet in this world, apparently, and as a result are faced with the prospects of continued vertical fragmentation of the telephone industry.

A common criticism of the MFJ is that it raised local telephone rates and, as a result, the average price of telephone service. A review of the data, however, suggests that the reversal in real telephone rates occurred at least for three years before divestiture. In 1981–1982, as inflation began to subside, telephone companies began to seek rate increases to make up for the rate compression that had occurred in the inflationary 1970s. Many of these increases were granted (table 11.1).

Real local access/exchange rates rose substantially even before the FCC began to reprice telephone service through its interstate access rate policy that substituted monthly SLCs for interexchange carrier access fees. Real interstate and even intrastate toll rates have fallen dramatically during the 1980s, in part because of the repricing of access

TABLE 11.1  
 The Trend in Real Consumer Price Indexes for Telephone Service,  
 1964–1988  
 (1977 = 100)

	<i>All Telephone Service</i>	<i>Local Service</i>	<i>Interstate Toll</i>	<i>Intrastate Toll</i>
1964	152.2	NA	NA	NA
1965	147.4	NA	NA	NA
1966	140.4	NA	NA	NA
1967	138.2	NA	NA	NA
1968	132.2	NA	NA	NA
1969	127.5	NA	NA	NA
1970	121.8	NA	NA	NA
1971	122.5	NA	NA	NA
1972	125.2	NA	NA	NA
1973	121.0	NA	NA	NA
1974	113.6	NA	NA	NA
1975	107.4	NA	NA	NA
1976	105.2	NA	NA	NA
1977	100.0	100.0	100.0	100.0
1978	93.9	94.0	92.1	93.1
1979	84.2	84.0	82.2	84.5
1980	76.0	77.4	73.4	73.4
1981	75.0	78.2	72.1	68.5
1982	77.8	82.1	74.8	69.0
1983	80.3	86.1	74.0	71.5
1984	83.4	94.2	69.4	72.3
1985	83.7	98.1	64.2	70.5
1986	86.1	106.0	58.6	69.1
1987	82.6	107.4	48.1	65.4
1988	79.0	104.6	44.4	60.9
Average Percentage Change:				
1977–83	–3.7	–2.5	–5.0	–5.6
1983–88	–0.3	+3.9	–10.2	–3.2

Source: Bureau of Labor Statistics.

Note: All indexes are CPI indexes deflated by CPI-U.

charges. The overall result, however, has been a rise in the weighted average of telephone rates contained in the consumer price index (CPI), an increase that has probably been exaggerated somewhat by the historical weights applied to the various services.<sup>6</sup>



It is interesting that the CPI for telephone service rose more rapidly in 1981–1983 than in the first few years after divestiture. More importantly, the rise in real rates has now stopped. It is likely that real consumer telephone rates will now resume the 1960s and 1970s rate of decline, and perhaps fall even more rapidly as new technology proliferates in the telephone network.

Telephone rates do not provide dispositive evidence on the effects of the MFJ on productive efficiency. Virtually all telephone service is still regulated. Regulators could have been allowing rates to rise in the face of declining costs in the early 1980s. Indeed, the market-book ratios for all major telephone company stocks rose substantially in the 1980s as inflation and regulatory pressures abated (table 11.2).

I have not attempted to estimate statistical cost functions for telephone companies as a means of inferring the effects of the MFJ on carrier efficiency. Rather, I look at input prices and productivity to gain some insight into cost behavior in the industry since divestiture.

An important element in both the 1949 and 1974 AT&T antitrust suits was the theory that the vertical integration of Western Electric and AT&T had led to excessive capital equipment costs. Freeing the BOCs from the necessity of purchasing Western Electric equipment should have eliminated a large part of this alleged problem.

We know that AT&T, since 1983, has lost a sizable share of the BOC market to competitors,<sup>7</sup> but this loss may be due to a number of factors, not just lower prices or better technology. The increase in competition in central office and transmission equipment markets should have placed downward pressure on equipment prices, and stimulated more rapid technological change in equipment. AT&T had lagged badly in developing a time-division, stored program-control digital switch for local exchange operations. It has now fought back successfully with its #5ESS switch. It has also made up some lost ground in the PBX market.

Given the lead time required to develop major new telecommunications technologies, it is undoubtedly too early to tell whether the vertical fragmentation of the telephone network has proved beneficial. However, the early results appear favorable. Fiber optics is developing very rapidly. Terminal equipment prices are falling rather dramatically.<sup>8</sup> And real digital switch prices are falling at about twice their rate of decline in the years before divestiture.<sup>9</sup>

Surprisingly, relative wage rates have not fallen in the telephone service industry. In trucking and airlines, there is substantial evidence that deregulation has reduced the rents earned by labor.<sup>10</sup> Unfortunately, the telephone industry has not been deregulated. Local telephone service remains rather tightly regulated in most states, and most

TABLE 11.2  
Market-Book Ratios for Telephone Company Equities, 1964–1988

	<i>AT&amp;T</i>	<i>GTE</i>	<i>Rochester Telephone</i>	<i>United Telephone</i>	<i>Continental Telephone</i>
1964	1.92	2.95	2.26	3.26	2.82
1965	1.63	3.34	2.33	3.45	3.52
1966	1.43	2.90	2.07	3.16	3.71
1967	1.25	2.54	1.84	3.26	3.47
1968	1.28	2.33	2.06	3.32	3.05
1969	1.14	1.77	1.56	2.15	1.98
1970	1.10	1.80	1.91	1.73	2.30
1971	0.98	1.72	1.87	1.70	2.04
1972	1.12	1.55	2.16	1.83	2.24
1973	1.02	1.23	1.33	1.29	1.45
1974	0.87	0.82	0.74	1.04	0.89
1975	0.94	1.17	0.80	1.12	1.01
1976	1.15	1.36	0.99	1.48	1.39
1977	1.01	1.22	1.00	1.36	1.14
1978	1.00	1.04	1.02	1.26	1.06
1979	0.82	0.99	0.98	1.26	1.12
1980	0.73	0.95	1.00	1.06	1.09
1981	0.87	1.08	1.28	1.19	1.12
1982	0.86	1.33	1.17	1.13	1.10
1983	0.88	1.30	1.25	1.09	1.28
1984	1.13 <sup>a</sup>	1.12	1.28	1.17	1.27
1985	1.41 <sup>a</sup>	1.43	1.43	1.40	1.34
1986	1.73 <sup>a</sup>	1.68	1.60	1.52	1.48
1987	1.52 <sup>a</sup>	1.48	1.48	1.62	1.58
1988	1.56 <sup>a</sup>	1.79	1.76	2.57	2.03

Source: Company reports; Standard & Poor's.

<sup>a</sup> AT&T and Divested Regional Holding (Operating) Companies.

industry employment is to be found in the local operating companies. AT&T's long-distance service remains regulated. Only the new OCCs (other common carriers) are essentially unregulated, but they employ no more than 3 percent of the industry's labor force. Thus, perhaps it is not surprising that the telephone industry's wage costs have not fallen relative to other industries. (table 11.3).

In the telephone *equipment* industry, wages have fallen slightly relative to all manufacturing. The increase in competition facilitated

TABLE 11.3  
Average Hourly Earnings for Production or Nonsupervisory Workers,  
1972–1988  
(\$/hour)

	<i>Total Private (nonfarm)</i>	<i>Telephone Communications Services</i>	<i>Telephone and Telegraph Equipment</i>
1972	3.70	4.10	4.18
1973	3.94	4.45	4.45
1974	4.24	4.90	4.73
1975	4.53	5.61	5.23
1976	4.86	6.33	5.70
1977	5.25	6.89	6.28
1978	5.69	7.50	6.73
1979	6.16	8.07	7.50
1980	6.66	8.72	8.24
1981	7.25	9.80	9.15
1982	7.68	10.66	9.86
1983	8.02	11.45	10.27
1984	8.32	12.00	10.69
1985	8.57	12.45	10.82
1986	8.76	12.85	10.94
1987	8.98	13.21	11.17
1988	9.29	13.46	11.62
	<i>Annual Percentage Change</i>		
1972–81	7.5	9.7	8.7
1981–88	3.5	4.5	3.4

Source: Bureau of Labor Statistics, *Employment and Earnings*.

by the MFJ is undoubtedly partly responsible, but the sharp rise in import pressures in 1983–1986 prior to the fall of the dollar must have added to this downward pressure on equipment manufacturing wages (table 11.3).

Perhaps the most surprising effect of the MFJ has been upon telephone industry employment. After rising more or less steadily through 1981, telephone industry employment began to fall dramatically in 1982. Between 1981 and 1986, the industry reduced its workforce by more than 18 percent (table 11.4). Labor productivity has continued to

TABLE 11.4  
Employment and Labor Productivity for Telephone  
Communications, 1975–1988

	Total Employment <sup>a</sup> (000s)	Production Workers <sup>a</sup> (000s)	Output per Employee Hour <sup>b</sup> (1977 = 100)
1975	966.6	739.8	85.9
1976	953.2	727.8	93.3
1977	957.3	722.4	100.0
1978	994.8	738.8	105.8
1979	1048.2	772.1	110.8
1980	1072.2	779.3	118.1
1981	1077.3	783.6	124.4
1982	1071.8	787.1	129.1
1983	956.0	701.0	145.1
1984	953.6	712.5	143.0
1985	920.9	687.3	149.9
1986	881.4	655.6	158.9
1987	893.7	661.8	166.1
1988	908.3	666.6	NA

<sup>a</sup>Bureau of Labor Statistics, *Employment and Earnings*.

<sup>b</sup>Bureau of Labor Statistics, *Productivity Measures for Selected Industries*, SIC4811.

grow at about 5 percent since 1984—a rate equal to the average for the industry in the 1960s and 1970s.

It was widely believed that liberalized entry and divestiture would sharply increase the riskiness of holding telephone company equities, thereby raising the cost of capital to the industry. In fact, the riskiness of AT&T's equities as measured by  $p$ , in the capital-asset pricing model, has stabilized at a level approximately equal to its 1960–1980 average of 0.64. Using monthly data for the 1984–1987 period to estimate the capital asset pricing model, I find the estimate of  $p$  is 0.66 for AT&T and between 0.50 and 0.66 for the BOCs.

This rather cursory review suggests that the price of capital equipment may have fallen due to divestiture, but wage rates and the cost of capital have been little affected. The relative use of labor, however, has fallen substantially, suggesting substantial improvements in efficiency.

A better measure of industry efficiency or the rate of technical change in the industry is the rate of growth of total factor productivity (TFP). I



have attempted to calculate TFP growth for the entire telephone (and telegraph) industry over the period 1961–1988, and to look for any sharp breaks that might have been caused by the competitive changes in the 1970s or the MFJ in the 1980s.

To estimate TFP, I have constructed consistent series of industry output, value added, labor input, material input, and capital stock for all common carrier, local exchange, long-distance, and telegraph carriers for whom data are available from 1960 through 1988. The output measure is constructed by deflating industry revenues from various services—local, interexchange, etc.—by the appropriate Producer Price Indexes. To obtain a measure of industry value-added, the output series was multiplied by the share of industry costs<sup>11</sup> estimated to be accounted for by capital and labor.<sup>12</sup>

Total labor input is calculated by multiplying BLS measure of average weekly hours by industry-reported employment data adjusted for labor quality per Christensen.<sup>13</sup> Capital services are assumed to be proportional to the level of the capital stock. The capital stock measure is equal to 74 percent of the gross capital stock, plus 25 percent of the net capital stock calculated from industry investment data by the perpetual inventory method.<sup>14</sup>

Material input is total (noncapital) purchases by telephone companies deflated by the GNP implicit price deflator. There was a slowdown in capital formation in 1981–1988 and a sharp decline in labor input since the announcement of divestiture.

The standard Tornquist measure of TFP is calculated by using income-share weights from the FCC's *Statistics of Communications Common Carriers* and USTA *Telephone Statistics*. The resulting three-factor (labor, capital, and materials) and two-factor (labor and capital) TFP growth estimates are shown in table 11.5.

Estimated total factor productivity grows substantially more rapidly in the 1971–1983 period than in 1961–1970, the period of no competition in interexchange services. Estimated TFP growth declines in 1984–1985, a decline that may be a reflection of measurement problems. The divestiture changed the structure of the BOCs and AT&T so radically that it is impossible to know if data reported to the FCC in 1984 are comparable with 1983 and earlier years.<sup>15</sup>

After 1985, total factor productivity resumed its growth at a rate in excess of 4 percent. Thus, TFP now appears to be growing even more rapidly than before divestiture. More importantly, TFP appears to rise with increases in competition over the 1970–1987 period. Given the slowdown in industry growth in the 1980s, the continued acceleration in TFP is all the more remarkable if there are increasing returns to

TABLE 11.5  
 Estimate of Total Factor Productivity Growth for the U.S.  
 Telecommunications Sector, 1961–1987  
 (average annual growth rate, %)

<i>Period</i>	<i>Output</i>	<i>Value-Added</i>	<i>Total Factor Productivity</i>	
			<i>3-factor</i>	<i>2-factor</i>
1961–70	8.2	8.0	2.8	2.7
1971–83	7.2	8.2	3.9	4.1
1984–87	5.1	3.6	3.2	3.2

scale in certain segments of the industry. It is important, however, to stress that all of these conclusions on productivity growth must be tempered by the realization that the data on which they are based are imperfect at best.<sup>16</sup>

Despite the rather smooth short-term transition of the industry to its new vertically fragmented state, and the desirable changes in relative prices that have been triggered by the FCC, there are a number of nagging problems to be resolved.

First, rates remain regulated at the state and federal levels, generally based upon some rate-of-return concept. Attempts to replace federal rate-of-return regulation with a less distorting form of regulation have been stalled by the Congress. In 1989, the FCC managed to introduce a limited form of price cap regulation for AT&T, a considerable accomplishment in light of the political opposition to price caps.

The prospects for full deregulation of interexchange services are obviously very poor at this time. The continued regulation of AT&T while new entrants are free to set rates without government involvement creates the obvious political pressures to protect nascent carriers by keeping AT&T rates artificially high.<sup>17</sup> Equally important are the political forces on state regulators who generally use intrastate toll rates and business access rates to subsidize residential access service. These distortions create obvious incentives to avoid the use of the public switched network.

In addition, there is no blueprint for releasing the divested BOCs from the line-of-business restrictions of the decree. Judge Greene appears reluctant to allow major departures from these restrictions as long as the BOCs have a "bottleneck" on local access. But state regula-

tors are not likely to be hospitable to breaking this bottleneck, as long as they are intent on using cross-subsidies to satisfy political claimants.

At the first Triennial Review, the BOCs and the DOJ made very little headway in persuading Judge Greene to liberalize the restrictions on the BOCs. The "bypass" threat was simply not demonstrated in the documents filed before the court.<sup>18</sup> More recently, the BOCs and GTE filed reports before the FCC that show that about 5 percent of total minutes of use are now being syphoned off by facilities bypass.<sup>19</sup> If this share grows appreciably, it may suggest to the court that rate distortions are creating major incentives for users to avoid the use of regulated circuits wherever possible.

Perhaps the most disturbing evidence that regulation and the line-of-business restraints are creating incentives for unregulated private telecommunications networks is the sharp decline in the growth of output on the public network in the 1980s (see table 11.5). There is no deceleration in the apparent demand for telecommunications, as evidenced by the continuing growth in equipment sales, but the public network is growing much more slowly than in the 1970s. Capital stock growth for the public network since divestiture has been less than half of its pre-divestiture levels. If this shift from public to private networks is driven by distorted rate signals provided by regulatory authorities, the efficiency of telecommunications delivery will obviously be affected.

Finally, it is important to keep in mind that any temporal analysis of efficiency in telecommunications service delivery involves comparing today's performance under regulation with yesterday's performance under regulation. No one is able to compare current performance with that produced by a market unfettered by the deadening influence of rate-of-return regulation.

It would be presumptuous to suggest I have demonstrated the MFJ has had no unfavorable static efficiency effects on the domestic telecommunications sector. But even if I had, this conclusion would undoubtedly be of little long-term relevance. Telecommunications is an industry buffeted by rapid technical change. The real question for policymakers is whether a regulated vertically fragmented industry is more likely to encourage technical progress than a regulated vertically integrated industry, a deregulated vertically fragmented industry, or a deregulated vertically integrated industry. The post-divestiture experience is not likely to give us enough evidence to draw meaningful conclusions on this issue. My analysis simply argues divestiture has not created static efficiency losses in the delivery of telecommunications services.

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Robert Crandall has addressed a significant public policy issue—i.e., the effect of the Bell System divestiture in promoting the efficiency of the telecommunications services in the United States. This is an important but difficult question to answer: first, it involves comparing the performance of an industry structure that no longer exists with that of the new one that has replaced it; and second, the timespan for the new industry structure is not sufficiently long to provide firm conclusions. Nonetheless, Crandall provides an interesting and valuable set of results.

Crandall looks at a number of performance indices in the telecommunication industry and reaches the tentative judgment that there have been efficiency gains in provision of telecommunication services as a result of the divestiture. This judgment is based on four facts: the telephone rates, especially inter- and intrastate toll rates, have declined substantially in the post-divestiture period; the input prices, especially in price of capital, have fallen (though this is not true for wage rates); the level of employment, especially in the AT&T and BOC family of firms, has declined substantially; and both labor productivity and total factor productivity, as measures of efficiency, have improved substantially in the post-divestiture period.

His results also point to a disturbing phenomenon—a substantial decline in the rate of capital formation after the divestiture. The rate of investment declined from 5.5 percent in the 1971–1983 period to 2.6 percent in 1985–1987. Crandall correctly draws our attention to another problem: the incomplete deregulation of AT&T and the imposition of several restrictions on the activities of BOCs may have created an incentive to bypass the public telecommunication system.

I find most of Crandall's arguments very interesting and relevant; however, I shall raise a number of questions and issues. First, the dramatic decline in employment which Crandall reports requires further analysis; it would be important to identify the reasons for this decline. What role may have been played by changes in relative prices, demand changes, and technological change to generate such a decline in employment? Were there other causes? Similarly, to what should be attributed the decline in investment in the post-divestiture period? Could it be due to better utilization of existing capital stock, or some other factor?

The productivity indices reported by Crandall are somewhat fragile. If one includes the negative 1984 figures for both labor and productivity and total factor productivity, the magnitudes of these two indices change



substantially. Also, there are years in the pre-divestiture period in which total factor productivity was as high as those reported for the post-divestiture period. If the high growth rate of total factor productivity in 1985–1987 is to be attributed to efficiencies due to divestiture, what would be the causes of the even higher rates of productivity growth observed for 1978 and 1979? A much more direct relationship between divestiture and productivity growth needs to be established before the inference of increased efficiency is totally acceptable.

Crandall's productivity calculation rests on the assumption of constant return technology. There are a number of studies which suggest the presence of fairly large economies of scale in this industry, at least for the pre-divestiture period. It would be important to determine how the contribution of scale of operation has affected the degree of efficiency in the industry. Similarly, we might want to know the degree to which economies of scope have changed between the two periods to which economies affect the indices of efficiency reported by Crandall. Further, there is the problem of resources used up in order to change from the pre-divestiture industry to the new post-divestiture structure. These adjustment costs could be substantial and could materially affect the magnitudes of the labor, investment, and total factor productivity.

Crandall does not specifically address the effect of divestiture on the R&D activities in the telecommunication industry. I believe the effect of divestiture on R&D investment in the telephone industry will be the most telling influence on the industry's future growth, efficiency, and structure. What has happened to the size and mix of R&D investment due to the divestiture, and how in turn these developments have affected the cost structure of the telephone industry, have a great deal to tell us about the industry's future, and in particular, its long-term efficiency.

Most of the issues I raise cannot be analyzed with the methodology adopted by Crandall. An analysis based on formal modeling of the cost structure of the industry would be required to identify the specific contributions of input prices, demand, scale, adjustment costs, degree of economies of scope, technological change in pre- and post-divestiture periods.

What Crandall has contributed is a look at first order consequences of divestiture. He has highlighted some important events of the post-divestiture period, such as low rate of capital formation, dramatic decline in employment and potential bypass of the public telecommunication system due to regulatory effects. His work will stimulate further discussion of the important issues he has raised.



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Due to the efforts the FCC is currently making to institute a price cap form of regulation, productivity is taking a primary role in public policy debate. In the process, we are adding considerably to the education stock of our country with regard to technical economic issues. For example, the Commission is now sending information to Congress on the differences between two-factor and three-factor productivity.

Price caps are a relatively simple scheme, at least in theory. In practice it becomes complex, as does the calculation of productivity itself. Rather than looking at the observed or predicted one-year cost of telephone companies, we look at the expected productivity based primarily upon past productivity and then use that as an adjustment to expected prices in the future. Price caps focus great attention on the expected productivity, because one percentage point difference in the productivity can mean a swing over the next four years of something between three and four billion dollars between consumers and stockholders. Consequently, there is a great deal of effort and many lawyers engaged in attempting to prove that productivity is one number versus another.

For that reason, I am particularly happy to see this new study by Robert Crandall. I do have some concerns, however. First, it is not perfectly clear exactly how output was measured. Obviously the output measure is critical. Crandall indicates he took a combination of revenues and deflated them by the appropriate producer price indexes. The normal pattern is either to use a specific price index related directly to those services, and therefore construct a revenue index of the services, or to build up an index of physical output. Each of two very well-known studies covering some of the same period, one by Christensen which was presented in the divestiture case and one by Bell Labs, used one of those two methods—Christensen, a physical output; and Bell Labs, an index. For both of those, I have compared the rate of growth of output numbers with those of Crandall's. In general, they both suggest lower growth in output numbers than does Crandall. It would be of some interest to know how the various output measures affect Crandall's results.

Second, although I ought to be proud that Crandall has used the FCC's *Statistics of Communications Common Carriers*, I know what goes into those statistics, and that makes me a little nervous. In particular, I wonder whether Crandall picked up all of the nondominant interexchange carrier output. The FCC does not require full reports from nondominant carriers. Crandall may have obtained revenue fig-

ures from other sources, but it would be of interest to know how well he is tracking the effectively deregulated parts of the industry. Anyone who looks at our FCC numbers has to be very careful, and must recognize that the universe measured by our statistics is gradually shrinking as the effectively deregulated sector grows.

As an aside, I should also put out a general caution concerning the many hazards in working with telephone statistics. In the Commission's Common Carrier Bureau, we are making an effort to clarify the statistics. The FCC's Industry Analysis Division has been asked to develop a meaningful statistical series, but it will not be an easy task. There are very well-known problems when you are looking at long-term comparisons of long-distance versus local rates, because the separation ratios have changed. In the post-divestiture period, we have deregulated some companies and have made very large changes in the structure of prices. These changes have increased the difficulty of interpreting statistical series. Statistical interpretation is further complicated by the fact that on January 1, 1988, we adopted a new accounting system and also made a number of major changes in the separations rules, changes in the accounting treatment of pension expenses, and changes in the costs the companies are required to capitalize.

All of these changes create difficulties in attempts to develop a time-series statistical analysis. The FCC hopes to be able to provide better statistics for research. But my caution and my plea to anyone seriously trying to use these statistics is to seek assistance from our people in the Industry Analysis Division to ensure an accurate understanding of what the numbers represent, and what kinds of adjustments are made to them.

The Common Carrier Bureau has done a number of studies of productivity because of the current interest in a price cap approach. Because there are problems in constructing physical output measures for total factor productivity, we have also measured the dual of total factor productivity. In a regulated industry in which prices are limited to cost, the price index itself is a measure of productivity. The price index measures changes in the cost function, which is a dual of the production function, and therefore the price index measures changes in total factor productivity. Over the last fifty years the telephone CPI has declined about two percent per year relative to the overall CPI. That is one measure of the net total factor productivity. By net productivity, I mean the productivity in this industry above the average productivity in the economy that would be embedded in the price index. Consistent with results that Crandall, Christensen, and others have obtained, the FCC's Common Carrier Bureau has observed a slight rising trend in net

productivity. Instead of the 2-percent fifty-year average, the average productivity improvement over the last ten years has been about 2.6 percent.

We have also attempted to develop productivity measures from the price indexes for the post-divestiture period on a disaggregate basis, looking separately at AT&T and the interstate portion of the local exchange carriers. For AT&T we have been able to develop a measure of productivity improvement with some confidence and have determined AT&T's net productivity gain to be 2.4 percent per year. With regard to the local exchange carriers, there are so many adjustments to be made, we still lack complete confidence in any of the numbers we have seen or have produced. We are still working to refine those measurements.

To summarize, productivity analysis is taking on increasing importance, not only as an academic pursuit or as a tool for evaluating broad public policies, but also in setting specific regulated prices. We at the FCC are continuing to attempt to refine the productivity numbers in the telephone industry. I greatly welcome the Crandall study, but I have some concerns about certain of its technical components.

*Gerald R. Faulhaber*

Robert Crandall has done his usual excellent job of tackling a tough issue. However, I think he would agree that his effort is merely a start, and much still needs to be done in studying efficiency and productivity in telecommunications.

Before making some general comments about divestiture and efficiency, I should point out an omission in Crandall's discussion. His table 11.5 unfortunately reveals only sketchily how output and capital stock are calculated. The standard measurement trick in the service sector (where we cannot count physical output because we do not know what it is) is to deflate revenues by a price deflator. But there is general agreement that telecommunications prices track quantities badly: most local calls are priced at zero, toll call prices most likely carry a subsidy burden, etc. Clearly, as real output proportions change, as is likely with the changing pattern of prices since divestiture, this approach to output estimation is poor at best.

Crandall and others in this volume have appropriately emphasized that, although the actual divestiture occurred at a particular point in time, the event which we normally subsume under the rubric of divest-

iture really goes back almost a decade, to the procompetitive policies of the FCC in the mid to late 1970s. The divestiture is simply the most public symbol of a very long process of introducing new players into the telecommunications game in the name of competition. When viewed in this light, we should expand our view of what constitutes "divestiture" to include, for example, the FCC CPE registration decision.

If I am allowed the license to include registration within the penumbra of divestiture, I would suggest that there were five major efficiency-affecting changes that occurred in association with this more broadly defined divestiture.

The *least* politically affected efficiency change was the very substantial market entry and product proliferation that occurred subsequent to the FCC registration decision. This change affected both the *price* at which CPE could be purchased, but even more importantly, the *set of products* consumers could purchase. The market changed from a rental market of plain vanilla (but absolutely bullet proof) telephone sets, to a highly diverse high-volume consumer electronic market. My unsupported view is that the efficiency gains from this change were very large.

The *most* affected efficiency change was the tremendous outpouring of state regulatory generosity to the BOCs just before and after the divestiture, when they feared that "their" BOCs were about to go "belly up." Difficult though it is to imagine today, there was great public sympathy for the BOCs just after the announcement of the MFJ in early 1982. Many state regulators feared the telephone behemoths under their care would be in dire financial straits. Local rates increased significantly over this two-year period. Since the service in question, access, is highly inelastic, the efficiency losses were small, but the transfers were rather great.

Similarly, the FCC made sure that AT&T's long-distance rates fully reflected every reduction the Commission engineered in carrier access charges. As a result, the period since divestiture has been marked by aggressively declining long-distance rates, just as all we economists predicted. But my guess is that the cause of that decline was due more to FCC pressure than to the competitive pressure of William McGowan and his colleagues.

On the supply side, the big post-divestiture news (but no big surprise) was that all parts of the old Bell System were overstaffed. The BOCs' as well as AT&T's blood flowed thick and fast. Crandall documents a reduction of 18 percent in the work force; I estimate it was closer to 35 percent. There are two views of this reduction: it was a



human tragedy, and it was a substantial efficiency gain. I think both views are accurate.

Finally, two changes occurred on the supply side of long-distance. First, AT&T decided it had facilities sufficient to last for a very long time if only they were used more efficiently than in the past. So its construction program slowed substantially. The second change was the nationwide fiber optic binge by both MCI and US Sprint (as shown in data presented by Bolter and McConnaughey in this volume), which has resulted in more transmission capacity nationally than we are likely to need for many years. I am not sure where these two effects show up in Crandall's numbers; I suspect he is picking up AT&T-BOC only in his figures concerning capital stock. If so, I view the slowdown of capital stock growth as a very healthy signal of increasingly efficient use of capital. On the other hand, the excess capacity that now exists in long-distance transmission facilities has also been a spur to competition in a long-distance market that many of us thought would not be competitive until after 1990.

Both my comments and those of Crandall are focused on the efficiency area that economists can say something about, i.e. price and cost reductions. However, we are less able to measure what may be the far more important area of *product* innovation, such as has occurred in the CPE market. But, as Bruce Greenwald notes earlier in this volume, we have yet to see that type of flowering in the telecommunications market since the divestiture. In spite of the ritual invocation of ISDN, the "engineers' fantasy" of a brave new telecommunications world has not occurred.

Furthermore, I have the uneasy feeling we are looking into the wrong place for product innovation. Telecommunications is a "techie" business, and at the mention of innovation we all think of Bell Laboratories, because we think of innovation as *things*, as *hardware*. Let me suggest a change of thinking about what innovation can mean: shortly after Bell Labs was giving us Picturephone, one anonymous AT&T employee thought up a new service with the awkward name of "IN-WATS", now known as "800 Service." This service innovation has created an entire mail-order industry, changed the face of retail trade, and enabled firms to reach their customers in new ways undreamed of before. In my view, the telephone company added more value to the U.S. economy with the "simple" innovation of 800 Service than all the Bell Labs' hardware of the 1970s. Perhaps it is the marketeers and not the "men in the white coats" who will be the principal source of innovation in the coming decades.



## ENDNOTES

1. For a discussion of these events, see Gerald W. Brock, *The Telecommunications Industry: Dynamics of Market Structure* (Cambridge, Mass.: Harvard University Press, 1981). Gerald R. Faulhaber, *Telecommunications in Turmoil: Technology and Public Policy* (Cambridge, Mass.: Ballinger, 1987). *Telecommunications in Transition: The Status of Competition in the Telecommunications Industry*, Report of the Majority Staff of the Subcommittee on Telecommunications, Consumer Protection, and Finance of the Committee on Energy and Commerce, U.S. House of Representatives, November 3, 1981.

2. Almarin Phillips, "The Impossibility of Competition in Telecommunications: Public Policy Gone Awry," in Michael A. Crew, ed., *Regulatory Reform and Public Utilities* (Lexington, Mass.: Lexington Books, 1982).

3. See Faulhaber, *Telecommunications in Turmoil*; and William J. Baumol et al., *Contestable Markets and the Theory of Industry Structure* (New York: Harcourt Brace Jovanovich, 1982).

4. Paul W. MacAvoy and Kenneth Robinson, "Winning by Losing: The AT&T Settlement and Its Impact on Telecommunications," *Yale Journal on Regulation* (1983), vol. I.

5. For a review of the empirical evidence on this issue, see Leonard Waverman, "U.S. Interexchange Competition," in Robert W. Crandall and Kenneth S. Flamm, eds., *Changing the Rules: Technical Change, International Competition, and Regulation in the Telecommunications Industry* (Washington, D.C.: Brookings Institution, 1989).

6. The relative importance of interstate long-distance service has been increasing while local service has been declining in relative importance.

7. See Robert W. Crandall, "The Role of Local Exchange Carriers," in Crandall and Flamm, eds., *Changing the Rules*.

8. Recent data show that PBX and key telephone prices have been declining at a real rate of 7 to 8 percent per year—substantially more rapidly than in the five years prior to divestiture.

9. Bellcore and New York Telephone data on switch costs per line, 1972–1988.

10. For example, see Nancy L. Rose, "Labor Rent-Sharing and Regulation: Evidence from the Trucking Industry," *Journal of Political Economy* (1987).

11. These data are drawn from the FCC's *Statistics of Communications Common Carriers* and USTA's *Telephone Statistics*. Capital income is equal to net income before taxes, fixed charges, and depreciation and amortization. Labor costs are total compensation, including pensions.

12. The value added measure is theoretically inferior to a gross output measure if materials are not weakly separable from capital and labor in the production function. See Ference Kiss, "Productivity Gains in Bell Canada," in L. Courville et al., eds., *Economic Analysis of Telecommunications* (Amsterdam: North Holland Press, 1983), p. 97.

13. The labor hours are adjusted for quality differences, as reported by Christensen et al. through 1979, but since 1979 the BLS data show little change in

employment shares by the categories used in Christensen's analysis. Therefore, the mix of employees is assumed constant for 1979–1988.

14. This is the measure of capital suggested by Edward Denison in *Accounting for Slower Economic Growth, The United States in the 1970s* (Washington, D.C.: Brookings Institution, 1979), pp. 50–52. Alternative approaches are shown in the Appendix to his chapter. In 1984, consumer premises equipment was detariffed for BOCs. This resulted in a decline in the capital stock in service in the telecommunications sector and required a reduction of \$6.9 billion from the net capital stock and \$14.5 billion from the gross capital stock in 1984.

15. An adjustment was made to smooth the abrupt decline in capital's share in the SOCCC data that was apparently caused by the \$5.5 billion writeoff taken by AT&T at the end of 1983.

16. It is reassuring, however, that the average TFP growth for 1961–1980 reported in table 11.5 is 3.4 percent. This compares with an average of 3.44 percent reported by Kiss for Bell Canada and 3.3 obtained by Christensen et al. for AT&T in 1961–1979.

17. John Haring and Kathy Levitz, "What Makes The Dominant Firm Dominant?" Federal Communications Commission, Office of Plans and Policy, OPP Working Paper #25, April 1989.

18. See U.S. Department of Justice, *The Geodesic Network: 1987 Report on Competition in the Telephone Industry* (The Huber Report), ch. 3.

19. Filed in CC Docket 87-339, 1988.