industry within the group, such as local exchanges. When it adjusted price changes for productivity under price caps for local exchanges and AT&T, the Commission did not use the available government-sponsored productivity series. Instead, it relied upon industry studies of price trends.[18] There is even less reason to expect that a productivity series for SIC group 481 would be an accurate reflection for a specialized industry, such as local cable operators, outside the group. Consequently, based on both Commission precedent and common sense, the BLS labor productivity index for SIC 481 is not a reliable measure of productivity improvement for cable operators.

IV. Productivity measures for the cable industry must account for rapid improvements in the quality of programming and service

Any productivity measures that are constructed for the cable industry should account for the rapid changes in the quality of cable service. Economists have long recognized the importance and difficulty of accounting for quality changes in productivity measures.[19]

Technological progress lowers costs, but quality improvements often raise costs. The combined effect of technological progress and quality improvements on productivity measures can be ambiguous. While technological progress and productivity improvements may have enabled cable operators to provide a constant-quality service at a lower cost, few if any cable operators have kept programming and service quality constant. For example, the quality of cable programming and service in 1986 was lower

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18 Traditional measures of total factor productivity examine changes in the quantities or prices of all factor inputs as part of the explanation of output price changes. The FCC studies instead examine only changes in average output price without examining input changes. See FCC, "Second Further Notice of Proposed Rulemaking," 4 FCC Rcd 2873 (1989) Appendix C and Appendix E; FCC, "Policy and Rules Concerning Rates for Dominant Carriers, Second Report and Order," CC Docket 87-313, Sept. 19, 1990, Appendix C and Appendix D.

19 Debates over quality adjustments have included both inputs (See, e.g., I. Nadiri, "Some Approaches to the Theory and Measurement of Total Factor Productivity: A Survey," *Journal of Economic Literature*, 1970, vol. 8, no. 4, pp. 1137-1177) and outputs (See, e.g., W. Nordhaus and J. Tobin, "Is Growth Obsolete?" in *Economic Research, Retrospect and Prospect: Economic Growth*, (New York: National Bureau for Economic Research), Fifteenth Anniversary Colloquium, 1972).

than the quality of cable service in 1992. Comparisons of productivity of the cable industry in two years, such as 1986 and 1992, must account for the improved quality of service.

V. Reduction of annual inflation increases by productivity offsets to the benchmark tables is unwarranted based on recent experience with changes in competitive cable rates

The benchmark approach adopted by the Commission is one method of holding certain quality characteristics constant, in this case the number of channels and the number of satellite-based networks. The benchmark tables are based on rates that would presumably be charged by competitive systems in 1992. These are not necessarily the rates that were or would have been charged by competitive cable operators in other years.[20]

If cable operators had improved efficiency between 1986 and 1992, costs and competitive prices to provide a given level of service, holding all quality characteristics constant, should have fallen. If it were possible to make comparisons between benchmark rates in 1992 and competitive rates in 1986, one could perform the following two-step exercise to compute price reduction and possible productivity changes between 1986 and 1992: (1) based on the 1992 benchmark tables, calculate regulated rates per channel for a system with its 1986 characteristics (number of channels and number of satellite-based networks); and (2) compare that competitive 1992 benchmark rate per channel (in 1992 dollars) with the actual 1986 rate per channel expressed in 1992 dollars. If the benchmark procedure captures all relevant quality characteristics of the cable system, then, with real productivity improvement, the real 1992 benchmark rate should be less than the inflation-adjusted actual 1986 rate.

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20 The benchmark tables are derived entirely from cross-sectional rather than time-series data on cable systems in 1992. Quality differences in programming and services among these systems in 1992 are relative small compared with quality differences between these systems as a group and the quality of service of competitive systems in another year. Consequently, it is difficult to make inferences from the 1992 benchmark tables about competitive rates in other years.

We performed this exercise. We examined separately different types of "competitive" systems (overbuilds, municipal systems, less-than-30-percent penetration) and "non-competitive" systems. (We have placed systems in competitiveness categories based on their 1992 attributes. We do not have information to place them in 1986 competitiveness categories.) We also examined separately systems that reported that they faced rate regulation in 1986 and those that reported that they did not.[21]

As part of this proceeding, the Commission collected data on prices and system characteristics from a sample of cable systems serving 419 cable franchise areas.[22] The cable operators indicated that they served the same franchise area in 1986 in 268 cases; the Commission received complete 1986 data in 175 cases. Table 1 summarizes the frequency of the provision of 1986 data in the Commission's sample.

Table 2 compares the real 1986 revenue per subscriber-channel with rates that would have been allowed under the 1992 benchmarks. The first three columns of Table 2 present the results for systems that faced rate regulation in 1986. For most systems within each competitiveness category, the 1992 benchmark rate applied to 1986 characteristics overstated the actual real 1986 rate per channel. Average ratios (1992 benchmark rate:real 1986 rate) ranged from 119 percent for overbuilds to 166 percent for municipal systems. Clearly, these results do not support a positive productivity offset. Based on the benchmark formula, adjusted real competitive prices per channel have been rising rather than falling.

The inference to be drawn from this evidence is *not* one of productivity decline but rather of quality improvements that are not captured in the benchmark formula. As an example, cable systems in 1992

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21 Slightly over half of the systems reported that they were not subject to rate regulation in 1986. However, these systems were subject to the possibility of regulation. Our analysis of the 1986 price data revealed no significant difference in the price characteristics of those systems reporting rate regulation and those reporting no rate regulation.

22 See FCC, "Report and Order and Further Notice of Proposed Rulemaking, MM Docket 92-266, April 1, 1993, Appendix E, "Survey Results: Technical Issues;" and FCC, "FCC Cable TV Rate Survey Database: Structure of Database and Explanatory Notes," February 24, 1993.

spent substantially more on programming than in 1986 as measured by licensing fees for cable networks. Licensing fees increased from $261 million in 1986 to $1.5 billion in 1992 (approximately an increase in 1986 from $0.68 (in 1992 dollars) per subscriber month to $2.26 per subscriber month in 1992).[23] The more than trebling of licensing fees for basic networks is not accommodated directly in the benchmark tables. Increases in direct programming costs alone could be passed along to subscribers under the new cable rate regulation.[24]

The next three columns of Table 2 show similar results for systems that did not face price regulation in 1986.[25] Average ratios (benchmark rate:real 1986 rate) ranged from 102 percent for municipal systems to 140 percent for overbuilds. Again, these results do not support a positive productivity adjustment. Based on the benchmark formula, real prices have been rising rather than falling. The interpretation again is that the benchmark tables do not fully account for quality differences between 1986 and 1992 because they are based on cross-section data in which programming quality is relatively constant.

The last column of Table 2 indicates the annual real rate of price increase per channel in the benchmark table *in addition to the GNP-PI index* averaged across systems that both faced and did not face rate regulation in 1986. There is a remarkable consistency in the real annual growth rates of these rates per channel from 4.08 percent for systems with less-than-30-percent penetration to 4.77 percent for overbuilds.[26] These numbers in the last column of Table 2 indicate by how much the benchmark tables should be adjusted upward beyond GNP-PI to account for real quality improvements between 1986 and 1992.

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23 Paul Kagan Associates, *Kagan Media Index*, March 30, 1993, p. 10.

24 FCC, "Report and Order and Further Notice of Proposed Rulemaking, MM Docket 92-266, April 1, 1993, paragraphs 251-252.

25 Although more municipal systems had a higher real price in 1986 than would be indicated by the benchmark table (3 to 1), the average ratio for the four systems still shows a higher benchmark than actual 1986 rate.

26 "Non-competitive" systems had real rate increase of 4.8 percent per year.

These results do not mean that cable operators have not improved efficiency. Like other industries that must invest in new technology to remain competitive, cable operators are constantly adapting new technology and providing more efficient services. These results, however, clearly indicate that the data collected by the Commission do not provide a basis to isolate the effect of productivity improvements. Any adoption of a productivity improvement offset by the Commission to reduce price increases for the benchmark tables should be coupled with a much larger quality improvement offset. The net effect of productivity and quality has been increasing prices per subscriber channel, for all competitive systems.

Historical quality improvement has been paid for by increasing prices. If regulated price increases are limited to inflation alone (GNP-PI), future quality improvements will be slower than quality improvements were between 1986 and 1992. If regulated price increases are limited to a level less than inflation, future quality improvements will be slower still.

The practical effect of a failure to account for continued quality improvement will be a reduction in the demand for cable. One impact of reduced demand will be reduced program diversity, injuring both consumers and the cable network industry alike.

VI. Future cable television productivity improvements are likely to be reduced by regulation

Productivity improvements in the cable industry in the past several years occurred without rate regulation. Particularly for an industry that is experiencing an increasing degree of regulation, we are aware of no economic basis to project that any past productivity increases will continue in the future. To the contrary, economists have generally found that regulation or increases in regulation are likely to detract from productivity

growth.[27] Consequently, any recent experience of efficiency gains in the cable industry is likely not to be repeated under price regulation.

VII. Reduction of annual inflation increases by productivity adjustment is inappropriate if Commission adopts alternative safe harbor

The Commission requested comments on whether "initial rates for cable service will be considered reasonable if they are no higher than 1986 rates adjusted forward both by a measure of inflation and a productivity offset."[28] Under this safe harbor alternative, it would be inappropriate to reduce inflation adjustments by productivity offsets without allowing potentially even greater adjustments for the additional costs of programming and service quality. As was noted for the benchmark tables, the costs associated with quality improvements for competitive systems rose more rapidly than productivity improvements between 1986 and 1992 even when the number of channels and the number of satellite networks were held constant. Under this safe harbor alternative, without holding the number of channels or satellite networks constant, the costs associated with quality improvements rose even more rapidly. The above reasons not to have a productivity offset for inflation adjustments of the benchmark tables are magnified when the number of channels and the number of satellite networks are not held constant.

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27 See, for example, E. Denison, *Accounting for Slower Economic Growth: The United States in the 1970s,* Washington: The Brookings Institution, 1979, pp. 127-131.

28 FCC, "Notice of Proposed Rulemaking," MM Docket No. 93-215, July 15, 1993, Paragraph 71.

TABLE 1

FREQUENCY OF PROVISION OF 1986 PRICE DATA FOR FCC SAMPLE OF 419 SYSTEMS

System Served Franchise Area in 1986	1986 DATA		TOTAL
	Complete	Incomplete	
Yes	175	93	268
No	0	109	109
No response	0	42	42
TOTAL	175	244	419

TABLE 2

COMPARISON OF REAL 1986 REVENUE PER SUBSCRIBER CHANNEL WITH RATES THAT WOULD HAVE BEEN ALLOWED UNDER 1992 BENCHMARK RATES

	Rates Regulated in 1986			**Rates Not Regulated in 1986**			**Total**			
	1992 Benchmark Rate Using 1986 System Attributes		1992 Benchmark Rate As A Percentage of Real 1986 Rate	1992 Benchmark Rate Using 1986 System Attributes		1992 Benchmark Rate As A Percentage of Real 1986 Rate	1992 Benchmark Rate Using 1986 System Attributes		1992 Benchmark Rate As A Percentage of Real 1986 Rate	Annualized Real Price Increase
	> Real 1986 Rate	< Real 1986 Rate		> Real 1986 Rate	< Real 1986 Rate		> Real 1986 Rate	< Real 1986 Rate		
Overbuilds	3	1	119% *	6	1	140% *	9	2	132% *	4.77% **
Municipal systems	2	1	166% *	1	3	102% *	3	4	129% *	4.40% **
Less-Than-30 Percent Penetration	6	1	122% *	4	4	132% *	10	5	127% *	4.08% **
Not "competitive"	47	17	126% *	59	19	138% *	106	36	132% *	4.80% **
Weighted Total	58	20	127% *	70	27	136% *	128	47	132% *	4.72% **

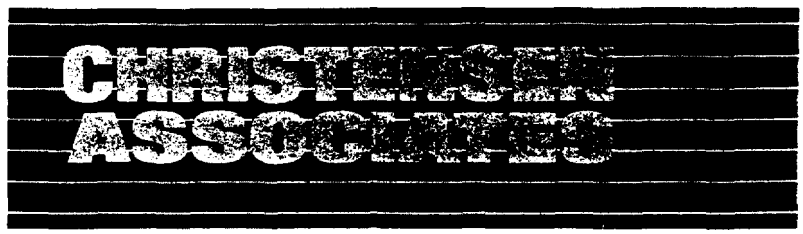
* These percentages are not significantly different from one another at a critical value of 5 percent.

** These growth rates are not significantly different from one another at a critical value of 5 percent.

ATTACHMENT B

"Productivity Growth in the Cable Television Industry"

Christensen Associates
June, 1994



Economic Analysis and Consulting

Productivity Growth in the Cable Television Industry

Laurits R. Christensen
Philip E. Schoech
Mark E. Meitzen

June 29, 1994

4610 University Avenue
Suite 700
Madison, Wisconsin 53705-2164

608 231-2266

EXECUTIVE SUMMARY

Productivity Growth in the Cable Television Industry

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

In this report we present the results of our Total Factor Productivity analysis of the cable television industry. The analysis covers the cable systems of three large Multiple System Operators. These systems serve approximately six percent of U.S. cable subscribers. We find Total Factor Productivity for these cable systems declined between 1984 and 1993 at an average annual rate of -1.9%.

A historical analysis of Total Factor Productivity is an important element in determining the appropriate productivity offset for the cable television price cap formula. The productivity offset should reflect the amount by which the cable television industry is expected to have Total Factor Productivity growth in excess of the Total Factor Productivity growth of the U.S. economy. Since 1984, the average annual rate of Total Factor Productivity growth in the U.S. economy has been .9%. Thus the productivity offset should reflect the amount by which the cable television Total Factor Productivity growth should exceed .9%. Adopting a price cap formula without a productivity offset would imply an expectation that the cable television industry would match economy-wide Total Factor Productivity growth. Given the observed decline in cable television Total Factor Productivity during the 1984-1993 period, a price cap formula without a productivity offset would imply an expectation that the cable television industry's future Total Factor Productivity growth would substantially exceed its historical performance. We conclude that the 2% productivity offset proposed by the FCC is not supported by the available evidence on historical productivity growth in the cable television industry.

Productivity Growth in the Cable Television Industry

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

In its recently released Report and Order and Further Notice of Proposed Rulemaking[1] the Federal Communications Commission (FCC) adopted a price cap mechanism to regulate cable television rates based on economy-wide inflation, as measured by the Gross National Product Price Index, and a productivity offset that reflects the expected gains from productivity improvement in the cable television industry. The FCC also tentatively proposed to set the productivity offset at two percent. This conclusion was based on the expectation that cable operators should achieve productivity gains similar to those historically realized by other communications firms. The FCC invited evidence either in support of, or opposition to, the proposed two percent productivity offset.

In adopting a price cap formula for the cable television industry, the FCC is following a precedent it set in adopting price cap formulas for telephone carriers. In setting the productivity offset for the telephone carriers, the FCC relied heavily on historical productivity studies of the telephone industry. In determining which studies were relevant, the FCC concluded that Total Factor Productivity (TFP) studies, and not partial factor productivity studies, were relevant. TFP studies compare the growth in Total Output with the growth in Total Input, while partial factor productivity studies

[1]Report and Order and Further Notice of Proposed Rulemaking, MM Docket No. 93-215 and CS Docket No. 94-28, FCC 94-39, February 22, 1994.

compare Total Output growth to growth in a single input, such as labor.

The criterion used by the FCC in determining the appropriate productivity offset for the telephone carriers was the extent to which Total Factor Productivity growth in the telephone industry exceeded Total Factor Productivity growth in the U.S. economy. In arriving at the productivity offset for AT&T, the FCC determined that the historical rate of Total Factor Productivity growth for the telephone industry exceeded the Total Factor Productivity growth of the entire U.S. economy by 2.5% annually. The FCC added a Consumer Productivity Dividend of .5% to this 2.5%, in order to provide customers immediate benefits associated with moving to price caps from rate-of-return regulation. In determining the productivity offset for the Local Exchange Carriers, the FCC determined that the historical productivity growth for Local Exchange Carriers in the provision of interstate access exceeded economy-wide productivity growth by 2.8% annually. Again the FCC added a Consumer Productivity Dividend of .5% to provide customers immediate benefits associated with moving to price caps from rate-of-return regulation.

In order to determine an appropriate productivity offset for the cable television industry, it is important to know the historical rate of productivity growth in the industry. But no U.S. government agency publishes TFP figures for the cable television industry. Furthermore, there have been no TFP studies of the cable television industry published in the academic literature.

In May of 1994, the National Cable Television Association (NCTA) commissioned Christensen Associates to conduct a TFP study of the cable television

industry. Data for such a study are not published, so we approached individual cable television companies about providing us with the needed data.

During the month of May, we sent a data request to nine Multiple System Operators (MSOs), which serve approximately one-half of all cable television subscribers in the United States. This data request asked for information for the last ten years, 1984-1993, on operating expenses, operating revenues, plant and equipment in service, and number of subscribers. We requested that the MSOs provide totals for all of the systems they currently operate. Because of the short time frame and given the competing demands placed on these cable systems to comply with the FCC's revised rate regulations, six of the companies were unable to meet the strict deadline for submitting data. Three MSOs, serving 3.7 million subscribers, were able to send us the necessary data. These 3.7 million subscribers represent approximately six percent of all U.S. cable subscribers. Two of the MSOs were able to provide data for the full 1984-1993 period; the third MSO was able to provide data for 1988-1993.

The methodology employed in this study is the same as that which we employed in our 1981 study of the Bell System[2]. The Bell System study was the basis of Dr. Christensen's testimony in the AT&T antitrust trials and was also used by the FCC in determining the productivity offset for AT&T. This methodology was

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

used in our recent study of TFP growth for the Local Exchange Carriers[3], commissioned by the United State Telephone Association, and numerous TFP studies conducted for individual Local Exchange Carriers. In this cable television study, Total Factor Productivity is measured as the ratio of Total Output to Total Input. Total Output includes both basic and premium services provided by the company. Total Input includes the plant and equipment (capital), labor, and purchased materials and services (materials) used in the provision of Total Output.[4]

While the methodology is the same as that used in the telephone industry TFP studies, its application differs to some degree, due to data limitations. While the results of the cable television productivity study may not be quite as precise as the results of our previous telephone industry TFP studies, we believe they provide a reliable indication of the overall trend in productivity growth for the three MSOs studied. The results also provide a useful indication of the productivity growth trend for the entire cable television industry. In the following sections of this report, we describe the methods used to measure Total Output and Total Input.

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[3]Laurits R. Christensen, Philip E. Schoech, and Mark E. Meitzen, "Productivity of the Local Operating Telephone Companies Subject to Price Cap Regulation," Christensen Associates, May 1994.

[4]While one might desire to have a productivity study that focuses only on the provision of basic service, this is not possible, since the provision of basic and premium service includes common inputs. Any division of these common inputs into a set that provides basic service and a set that provides premium service would be arbitrary.

Total Output

Cable television systems provide both basic and premium service. Consequently a measure of Total Output must include both outputs. The quantity index for basic service is based on the number of basic service customers; likewise, the quantity index for premium service is based on the number of premium service customers. The quantity index of Total Output is a Tornqvist index[5] of basic service customers and premium service customers, with basic service revenue and premium service revenue used as weights.

Total Input

Total Input is comprised of capital, labor, and materials. The capital used includes buildings, communication equipment, and support equipment. Labor includes all company employees involved in the provision of cable television service, including, but not restricted to, employees providing customer service, maintenance of plant and equipment, and management of the company. Materials includes the materials and services purchased by the company in the provision of cable television service. Materials does not include programming costs, franchise fees, or franchise requirements. These costs are not covered by the price cap formula, and including

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[5]The Tornqvist index determines the rate of growth of Total Output by weighting the growth of each service by each service's revenue share. For example, if the quantity of basic service grew 5% and the quantity of premium service grew 4%, and if the revenue shares of basic service and premium service were .6 and .4 respectively, then the Total Output rate of growth would be (.6x5%) + (.4x4%) = 4.6%.

the services associated with these costs in Total Input would yield a Total Factor Productivity analysis inappropriate for setting a productivity offset.

The quantity of Total Input is a Tornqvist index of the quantities of capital, labor, and materials, with the costs of capital, labor, and materials used as weights. In the following paragraphs, we describe the methods used to construct the quantities and costs of capital, labor, and materials.

Capital. The quantity and cost of capital is based on the Christensen-Jorgenson methodology.[6] Three asset classes are distinguished: buildings, communications equipment, and support equipment. The quantity of capital stock is calculated for each asset class using the perpetual inventory capital stock equation, which has the form:

$$K_t = (1 - \delta) \cdot K_{t-1} + I_t \qquad (1)$$

where

K_t = the quantity of capital stock at the end of year t
I_t = the quantity of investment during year t
δ = the economic rate of replacement

The quantities of investment are obtained by dividing the book value of additions in each year by the corresponding investment price index. The MSOs provided data on book value of additions. The source for the investment price indexes is the U.S. Bureau of Economic Analysis (BEA). The BEA constructs investment price

[6]L.R. Christensen and D.W. Jorgenson, "The Measurement of U.S. Real Capital Input, 1929-1967," Review of Income and Wealth, Series 15, December 1969, pp.293-320.

indexes for numerous sectors of the economy.[7] One of these sectors, radio and television, includes the cable television industry. We use the BEA investment price indexes for the radio and television sector as the investment price indexes for buildings, communication equipment, and support equipment.[8] The economic rates of replacement used in the study are based on Jorgenson.[9] The rates of replacement are: .033 for buildings, .086 for communications equipment, and .254 for support equipment.

A starting value, or benchmark, for K must be calculated in order to apply the perpetual inventory capital stock equation. We calculate benchmarks for the first year of the study (beginning-of-year 1984 for the two MSOs which provided data back to 1984 and beginning-of-year 1988 for the MSO which provided data back to 1988) based on the gross book value of plant and equipment reported by each MSO. Each MSO reported the gross book value of buildings, communications equipment, and

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[7]A description of the BEA price indexes can be found in U.S. Department of Commerce, Bureau of Economic Analysis, Fixed Reproducible Tangible Wealth in the United States, 1925-1989, (Washington: U.S. Government Printing Office, January 1993).

[8]The BEA constructs price indexes for a number of asset categories. These asset categories needed to be mapped to buildings, communications equipment and support equipment. The mappings are as follows. Buildings includes all nonresidential structures identified by BEA. Communications equipment includes the BEA categories of communications equipment and distribution equipment. Support equipment includes the BEA categories of furniture and fixtures, office equipment, trucks, autos, and photocopy and related equipment.

[9]D.W. Jorgenson, "Productivity and Economic Growth," in E.R. Berndt and J.E. Triplett, eds., Fifty Years if Economic Measurement (Chicago: University of Chicago Press), pp. 19-118. Jorgenson lists rates of replacement for the asset categories used by BEA. We obtain the rates for buildings, communications equipment, and support equipment by using the mapping described in the previous footnote.

support equipment. It was necessary to convert the gross book value of the plant and equipment to an estimate of economic value before applying it to the perpetual inventory equation (1). This adjustment must incorporate two factors. First it must incorporate the fact that assets deteriorate in their efficiency as they age. Second, it must incorporate the fact that the replacement cost of assets changes over time as the price of new plant and equipment changes. Based on a review of the plant and equipment data that the MSOs were able to provide us, we calculated adjustment factors for each of the asset classes.

Once the quantity indexes are computed for each of the asset classes, they must be aggregated into an overall capital input index. The weights used to aggregate the asset classes are the annual capital costs of each asset class (also referred to as the "implicit rental" costs). The annual cost of capital services for each asset class is calculated using the Christensen-Jorgenson methodology and includes four components: (1) the opportunity cost of the capital held in the form of plant and equipment; (2) plus the cost of declines in efficiency of plant and equipment; (3) less the economic revaluation of plant and equipment; (4) plus the cost of taxes.[10]

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[10]See Christensen and Jorgenson, 1969. The Christensen-Jorgenson formula for the implicit rental price is:

$$v_t = [(1 - u \cdot z - k + .5k \cdot u \cdot z)/(1-u)] \cdot [r_t \cdot p_{t-1} + \delta \cdot p_t - (p_t - p_{t-1})]$$

where u is the rate of taxation on income, z is the present value of tax depreciation allowances, k is the investment tax credit rate, r is the interest rate (Moody's yield on public utility bonds), p is the investment price index, and δ is the rate of economic replacement (representing the declines in efficiency). The income tax rate, investment tax credit rate, and the present value of tax depreciation allowances are based on the statutory rates in effect during the study period.

For each of the asset classes, the four components of annual capital costs are calculated as follows. First, the opportunity cost of the capital held in the form of plant and equipment is calculated by multiplying the current economic value of plant and equipment by the appropriate interest rate. The current economic value of plant and equipment is obtained by multiplying the quantity of the capital stock by the relevant investment price index. The interest rate used as the opportunity cost is Moody's Composite Yield on Public Utility Bonds. Second, the cost of declines in efficiency is obtained by multiplying the economic rates of replacement by the current economic value of plant and equipment. Third, the economic revaluation of plant and equipment is obtained by multiplying the quantity of capital stock by the change in the relevant investment price index. Fourth, the cost of taxes is based on the statutory tax rates in effect at the time.

Once the quantity indexes and costs are calculated for each of the asset classes, the quantity index of total capital input is computed as a Tornqvist index of the asset classes, with their capital service costs as weights. The total cost of capital input is equal to the sum of the costs for the three asset classes.

Labor. The cost of labor input is equal to wages and salaries, pensions and benefits, and Social Security Taxes paid by the company. Each MSO provided us annual data on the wages and salaries and pensions and benefits reported as operating expense, and Social Security Taxes reported as operating taxes.

The quantity of labor input can be computed in one of two ways. The first approach is to compute the number of hours worked for different occupational groups, then to construct an index of these work hours. The second approach is to divide labor cost by an index that represents changes over time in compensation per hour. Conceptually, these two approaches produce identical results; differences in practice are a result of the quality of the data available.

The MSOs were unable to provide us with the hours data needed to implement the first approach. Consequently, we constructed quantity indexes of labor by dividing labor cost by an index representing changes over time in compensation per hour. The index used is the Employment Cost Index for Service Producing Industries, published by the U.S. Bureau of Labor Statistics. This index represents changes in compensation (wages plus benefits) per hour; consequently it is an appropriate index for deflating labor cost.

Materials. The cost of materials is equal to total operating expense, less depreciation, wages and salaries, pensions and benefits, programming costs, franchise fees, and franchise requirements.[11] The MSOs provided us with the operating expense detail necessary to compute the cost of materials. The Gross Domestic Product Price Index is used to represent the price of materials, since this category is

[11]Some companies reported net interest as part of operating expense. In these instances, net interest was also subtracted from operating expense.

comprised of a diverse set of inputs. The quantity index of materials is obtained by dividing materials cost by its price.

Total Output, Total Input, and Total Factor Productivity--Results

The index of TFP is computed as the ratio of the quantity index of Total Output to the quantity index of Total Input. Equivalently, the rate of growth of TFP is computed as the rate of growth of the quantity index of Total Output minus the rate of growth of the quantity index of Total Input.

Table 1 summarizes the results of the TFP analysis. This table shows the annual average rate of TFP growth, the average rate of Total Output growth, and the average rate of Total Input growth for the systems covered in the study. Over the 1984-1993 period, Total Output grew at an average annual rate of 8.5%. Among the inputs, capital grew at an average annual rate of 11.9%, labor grew at an average annual rate of 9.4%, and materials grew at an average annual rate of 9.3%. Total Input grew at an average annual rate of 10.3% and TFP declined at an average annual rate of -1.9%.

The finding of negative TFP growth over a period as long as a decade may seem surprising. We note, however, that it is not unusual for industries in the U.S. to experience negative TFP growth for even longer periods. A study of TFP growth (by Dale Jorgenson, Frank Gollop, and Barbara Fraumeni) for forty-five U.S. industries over a thirty-year period (1948-1979) found negative TFP growth for one-third of the

industries.[12] Among the fifteen industries with negative TFP growth was "radio and television broadcasting", with an average annual rate of TFP growth of -2.05%.

A decline in TFP does not imply that an industry has become less efficient. In spite of increased efficiency an industry may need to expend additional resources to accomplish such objectives as unmeasured increases in the quantity or quality of output, increased environmental quality, or increased worker safety. In the case of the cable television industry, at least part of the explanation for measured declines in TFP would seem to be improved quality of services. The costs of improving cable quality may have out-paced the rate of efficiency improvement, leading to the decline in TFP. The price cap formula adopted for the cable television industry does not incorporate quality improvements, nor does our TFP study.

Implications for Price Cap Productivity Offset. Conceptually, the productivity offset in a price cap formula is based on the differential between productivity growth achieved by the industry in question and the U.S. economy. The U.S. Bureau of Labor Statistics regularly publishes TFP growth for major sectors of the U.S. economy.[13] The most comprehensive TFP measure published by the Bureau of Labor Statistics is for the private business sector. Currently, the TFP index for the private business

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[12]Dale Jorgenson, Frank Gollop, and Barbara Fraumeni, Productivity and U.S. Economic Growth, (Cambridge: Harvard University Press, 1987), pp.206-208.

[13]The Bureau of Labor Statistics refers to its TFP measures as "multifactor" productivity. These measures are reported in the Bureau of Labor Statistics publication, Monthly Labor Review.

sector is available through 1990. The average annual rate of growth for the private business sector between 1984 and 1990 was 0.9%. Thus, for the historical evidence to support a positive productivity offset for the price cap formula, the cable television companies would have had to attain annual TFP growth in excess of 0.9%. For the historical evidence to support the FCC's proposed productivity offset of 2%, the companies would have had to attain annual TFP growth of 2.9%.

The cable television systems studied did not approach economy-wide productivity growth of 0.9%, let alone the targeted level of 2.9%. Thus, based on the historical evidence, there is no basis for applying a positive productivity offset to the price cap formula for cable television companies. Indeed, adopting a price cap formula with no productivity offset would still provide a significant challenge to the industry, since it would represent expected productivity growth well in excess of the industry's historical performance.

Table 1
Average Annual Rate of TFP Growth

Average Annual Growth Rate:	1984-1993
Total Output	8.5%
Total Input	10.3%
Capital	11.9%
Labor	9.4%
Materials	9.3%
Total Factor Productivity	-1.9%